SCHEME :K

Name :_____
Roll No.:_____Year : 20 __20
Exam Seat No. :_____

LABORATORY MANUAL FOR

INDUSTRIAL HYDRAULICS AND PNEUMATICS (316363)

MECHANICAL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous)(ISO21001:2018)(ISO/IEC27001:2013)

VISION:

To ensure that the Diploma level technical education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation. Evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirement.
- Industry readiness and improved employability of Diploma holders.
- Synergistic relationship with industry.
- Collective and Cooperative development of all stake holders.
- Technological interventions in societal development.
- Access to uniform quality technical education.

A Practical Manual for

INDUSTRIAL HYDRAULICS AND PNEUMATICS (316363)

Semester– (VI)

"K-SCHEME"

(Diploma in Mechanical Engineering)
(ME)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO-21001:2018) (ISO/IEC27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO 21001: 2018) (ISO/IEC27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed on December, 2025)

Maharashtra State Board of Technical Education, Mumbai

Certificate

This is to certify that Mr. / Ms. .....Roll No……. of Sixth Semester of Diploma in …… of Institute ……. (Code……) has completed the term work satisfactorily in course **INDUSTRIAL HYDRAULICS AND PNEUMATICS (316363)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place: …… Enrollment No……

Date: ..... Exam Seat No. ……..

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much-needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'K' Scheme curricula for engineering diploma programmes with National Education Policy2020 (NEP2020) and outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. Accordingly, the 'K' scheme laboratory manual development team designed the practical to ***focus*** on the ***outcomes***, rather than the traditional age-old practice of conducting practical to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

This Industrial Hydraulics and Pneumatics Lab Manual is designed to provide students with hands-on experience in the fundamentals of Hydraulics and Pneumatics systems and their practical applications in various sectors. Students will gain practical knowledge in development of simple hydraulic and pneumatic circuits for low cost automation and use and preliminary maintenance of these systems in industries.

By working through these exercises, students will develop essential skills for selection and use of hydraulic/pneumatic system components to develop various circuits, use of PLC programming in these circuits and practical applications for semi-automation, automation of machines/equipment required at shop floor.

The Practical manual development team wishes to thank MSBTE who took initiative in the development of curriculum and implementation and also acknowledge the contribution of individual course experts who have been involved in laboratory manual as well as curriculum development (K scheme) directly or indirectly.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Lab Manual Development Team

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs are expected to be achieved through the practicals of the (Theory of machines) course.

PO1. Basic and Discipline specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the mechanical engineering problems.

PO 2. Problem analysis: Identify and analyse well-defined mechanical engineering problems using codified standard methods.

PO 3. Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs in mechanical engineering.

PO 4. Engineering Tools, Experimentation and Testing: Apply modern mechanical engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities in diverse and multidisciplinary fields.

PO 7. Life-long learning: Ability to analyse individual needs and engage in updating in the context of technological changes in mechanical engineering.

List of Industry Relevant Skills-

The following industry relevant skills or the competency are expected to be developed in you by undertaking the practical of this laboratory manual.

1. Identify various components of hydraulic and pneumatic system.
2. Understanding the Construction, working principles of each component.
3. Selection of appropriate component for given hydraulic and pneumatic circuit.
4. Develop hydraulic and pneumatic circuit diagram for given practical application.
5. Identify the use of special valves in hydraulic and pneumatic circuits.
6. Use of PLC programming in hydraulic and pneumatic circuits.
7. Identify faults and suggest remedies for hydraulic and pneumatic system.

Practical- Course Outcome matrix

Course Outcomes (COs)

CO1 - Identify various components of hydraulic and pneumatic systems from their symbols
CO2 - Select pump, compressor and actuator for given fluid operated system.
CO3 - Select appropriate control valves for given fluid operated system.
CO4 - Select appropriate special components for advanced fluid operated system.
CO5 - Develop hydraulic and pneumatic circuits for given applications

Sr. No.	Laboratory Practical Titles	CO 1	CO 2	CO 3	CO 4	CO 5
1	*Identification of hydraulic and pneumatic system components	√	-	-	-	-
2	*ISO Symbols of hydraulic and pneumatic components	√	-	-	-	-
3	Hydraulic Pumps used in hydraulic system	-	√	-	-	-
4	Compressor and FRL unit used in pneumatics	-	√	-	-	-
5	*Hydraulic and pneumatic linear actuators	-	√	-	-	-
6	Hydraulic and pneumatic rotary actuators	-	√	-	-	-
7	Linear and rotary actuators movement by direct method using suitable DC valves	-	-	√	-	√
8	*Linear and rotary actuators movement by indirect method using suitable DC valves	-	-	-	-	√
9	*Pressure relief and sequence valve circuits	-	-	√	-	√
10	*Speed control circuit for hydraulic (meter in and meter out circuits)	-	-	-	-	√
11	Speed control circuit for pneumatic actuators	-	√	-	-	√
12	*Pneumatic circuits involving use of Quick exhaust valve, logic OR, AND functions	-	-	-	√	√
13	Special purpose actuators pneumatic circuits	-	-	-	√	√
14	Ladder diagram for simple circuits	-	-	-	√	√
15	*Simple maintenance of hydraulics/pneumatics	-	-	-	-	√

Guidelines to Teachers

1. ***Teacher need to ensure that a dated log book*** for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practical.
3. For difficult practical if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teacher can maintain various practical related question banks for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher*** in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Technical Manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practical.

Content Page

List of Practical and Progressive Assessment Sheet

Note: To be transferred to Proforma of CIAAN-2023.

A suggestive list of LLOs is given in the above table. More such LLOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

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Practical No.01 *Identification of Hydraulic and Pneumatic system components

I. Practical Significance

Understanding the components of hydraulic and pneumatic system is necessary before development of various circuits for both the systems. The various hydraulic and pneumatic components are arranged systematically in a general layout of hydraulic as well as pneumatic system. The hydraulic and pneumatic system trainers are designed for educational purpose in which various components are mounted with reference to general layout along with hose pipes required for making connections.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Identify various components of hydraulic and pneumatic system.
2. Understanding the construction and working principles of each component.

III. Course Level Learning Outcome (CO)

CO1- Identify various components of hydraulic and pneumatic systems from their symbols.

IV. Laboratory Learning Outcome(s)

- Identify the components of hydraulic and pneumatic trainers.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Before performing this practical student must have knowledge of general layout of hydraulic and pneumatic system. The hydraulic systems consist of storage tank, filter, hydraulic pump, pressure regulator, control valve, hydraulic cylinder, piston and leak proof fluid flow pipelines. The pneumatic systems consist of compressor unit, air receiver, filter, Air dryer, air servicing unit which includes Filter, Regulator and Lubricator, Actuators, Muffler and leak proof fluid flow pipelines. The figure 1.1 and 1.2 shows general layout hydraulic and pneumatic system respectively.

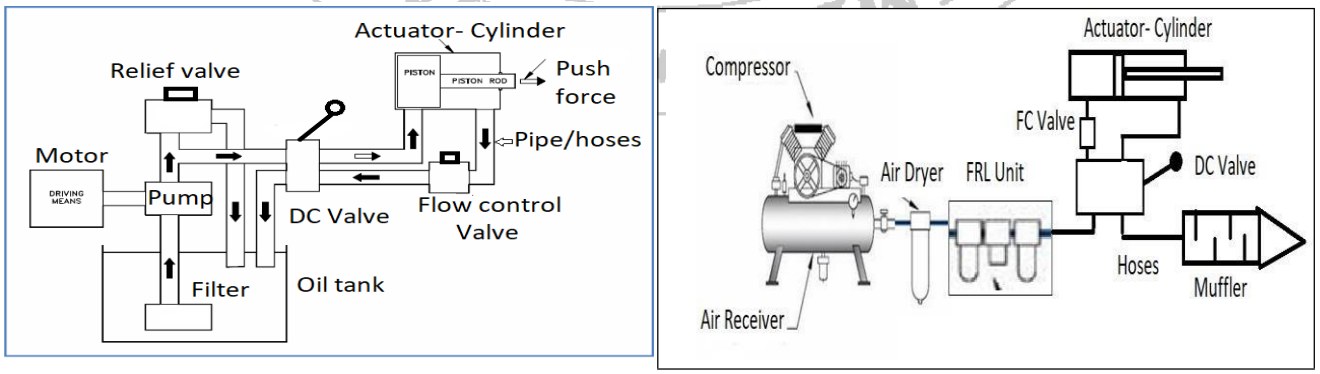


Fig 1.1: General Layout of Hydraulic and Pneumatic system

VII. Experimental setup

Students are suggested to visit Industrial Robotics laboratory to identify various components of robotic system.

Fig 1.2: Components of Hydraulics/Pneumatic system

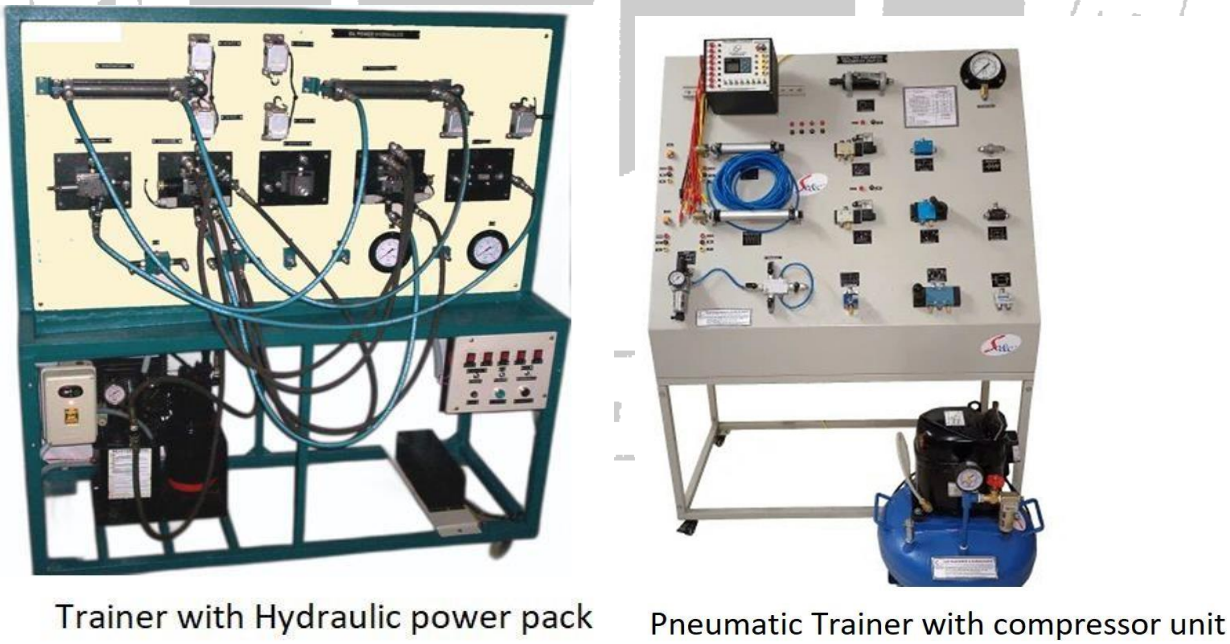


Fig 1.3: Hydraulics/Pneumatic Trainers

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic trainer with various components	Transparent /actual working components	1
2	Pneumatic trainer with portable compressor	Transparent/ actual working components Compressor: Pressure 0-10 bar	1
3	Demonstration Models of pumps, cylinders, valves, other components	Working / actual/ Cut section	Each 1
4	Tool kit	Standard	1

IX. Precautions to be Followed

- Do not forcefully connect to ports/connectors to avoid the damage.
- Perform practical under observation of instructor.
- Avoid improper/loose connections of components.

X. Procedure

Oil Hydraulic Trainer

1. Locate oil hydraulic trainer in the lab. Observe the components carefully.
2. Identify various components one by one referring general layout of hydraulic system.
3. Identify components of oil hydraulic trainer such as oil tank, pump, pressure relief valve, DC valve, Actuators, hose pipe fittings and connections.
4. Connect components as per general layout and run the system.
5. Write components name in table below, write its description and function.
6. Repeat procedure number 5 for all identified components.

Pneumatic Trainer

7. Locate oil Pneumatic trainer in the lab. Observe the components carefully.
8. Identify various components one by one referring general layout of Pneumatic system.
9. Identify components of oil hydraulic trainer such as Air receiver, compressor, FRL unit, DC valve, Actuators, hose pipe fittings and connections.
10. Connect components as per general layout and run the system.
11. Write components name in table below, write its description and function.
12. Repeat procedure number 11 for all identified components.

XI. Observations and calculations

Oil Hydraulic Trainer

Name of the Components 1: _____Location:_____		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 2:----------Location:_____		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 3: ----------		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 4: ----------		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 5: ----------		

Description:		
Function:		**Draw Simple Sketch**
Name of the Components 6: ----------		
Description:		
Function:		**Draw Simple Sketch**

Pneumatic Trainer

Name of the Components 1: _____Location:_____		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 2:----------Location:_____		
Description:		
Function:		**Draw Simple Sketch**
Name of the Components 3: ----------		
Description:		**Draw Simple Sketch**

Function:		
Name of the Components 4: ----------		
Description:		**Draw Simple Sketch**
Function:		
Name of the Components 5: ----------		
Description:		**Draw Simple Sketch**
Function:		
Name of the Components 6: ----------		
Description:		**Draw Simple Sketch**
Function:		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List components needed in oil hydraulic system.
2. List components of Pneumatic trainer.
3. Explain functions of pump and compressor.
4. Compare oil hydraulic and pneumatic system on the basis of medium, device to increase pressure, return lines needed, pressure range and applications

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1 1	Handling of the Instruments	30%
2	Observation and readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No:02 *ISO Symbols of hydraulic and pneumatic components

I. Practical Significance

Similar to electrical or electronic circuit system, the components of oil hydraulic and pneumatic system were represented by ISO symbols. It is easy to understand connections of various components in the hydraulic and pneumatic circuits as per the task to be performed. Therefore, students should have knowledge of ISO symbols of various components before design and construct the circuits.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

Identify symbols of components of hydraulic and pneumatic circuits

III. Course Level Learning Outcome (CO)

CO1- Identify various components of hydraulic and pneumatic systems from their symbols.

IV. Laboratory Learning Outcome(s)

- Draw ISO symbols of the components of hydraulic and pneumatic trainers

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Before performing this practical student must have knowledge of general layout of oil hydraulic and pneumatic system. He/She should know the primary function and shape of the various components of oil hydraulic and pneumatic system for easy understanding of ISO symbols

VII. Experimental setup (Model)-

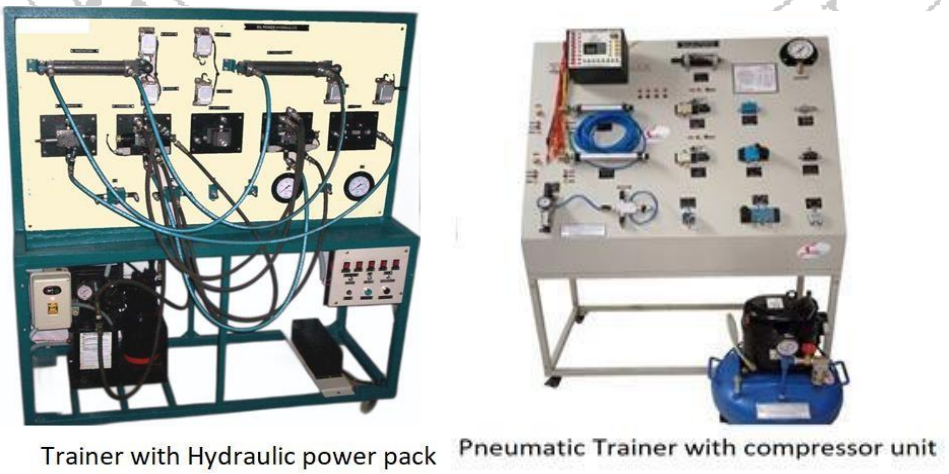


Fig 2.1 Hydraulic and Pneumatic Trainers

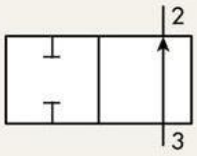
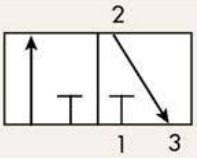
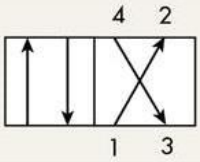
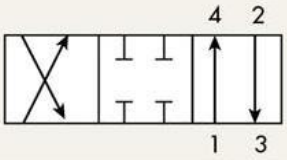
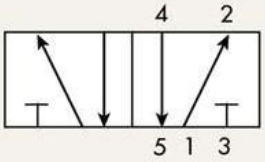
DIRECTION CONTROL VALVES (DCVs)		
Symbol	Component	Explaination
	2/2 way valve	Two closed ports in the closed neutral position and flow during actuated position
	3/2 way valve	In the first position flow takes place to the cylinder. In the second position flow takes out of the cylinder to the exhaust (Single acting cylinder)
	4/2 way valve	For double acting cylinder all the ports are open
	4/3 way valve	Two open positions and one closed neutral position
	5/2 way valve	Two open positions with two exhaust ports

Fig 2.2: Standard symbols charts for reference

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic Trainer	Transparent / Actual components	01
2	Pneumatic Trainer with portable compressor	Transparent / Actual components	01
3	ISO Symbols of Components	Standard charts for ISO symbols	Set

IX. Precautions to be Followed

- Do not connect the components in a loose or improper way and Observe the leakages if any
- Perform practical under observation of instructor.

X. Procedure

1. Observe the shape, geometry, function Oil Hydraulic/Pneumatic Trainer components.
2. Refer the ISO standard charts available for learning of symbols.
3. Understand the symbol geometry and designated arrows, alphabets shown
4. Redraw the symbols and write explanation in observation table
5. Revise yourself to identify the components from the symbols

XI. Observations and Drawing of Symbols

A. Oil Hydraulic Trainer

Name of Component	Symbol	Explanation

B. Pneumatic Trainer

Name of Component	Symbol	Explanation

XII. Results

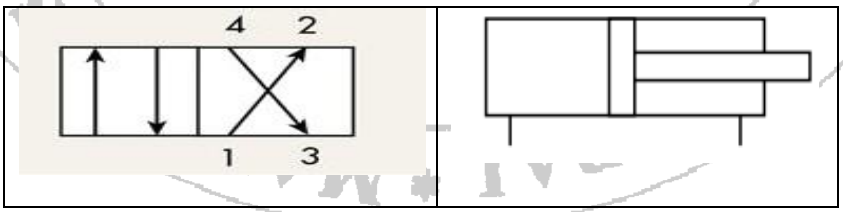
XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List various standards adopted for generation of Symbols of Hydraulic and Pneumatics
2. State the difference between symbols of Hydraulic and Pneumatics.
3. Draw the symbols for a. DA Cylinder b. 3/2 DC valve
4. Identify the given symbols



[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.youtube.com/watch?v=kzqkPx8F3D8
- https://www.youtube.com/watch?v=-iwttJ3ahFo

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the set up	30%
2	Observation and Drawing symbols	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No:03 Hydraulic Pumps used in hydraulic system

I. Practical Significance

Pump is the power source for supplying high pressure oil in of hydraulic system. Pump are mainly classified as positive displacement and roto-dynamic pumps.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

1. Selection of suitable pump for given fluid operated system.

III. Course Level Learning Outcome (CO)

CO2- Select pump, compressor and actuator for given fluid operated system.

IV. Laboratory Learning Outcome(s)

1. Use pumps mounted on hydraulic trainer.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Before performing this practical student must have knowledge of types of pumps, construction and working of Gear pump, Vane pump, screw pump, Axial piston and Radial piston pump. The pump selection depends upon flow rate capacity, power consumption, drive speed, pressure delivered at the outlet and efficiency of the pump.

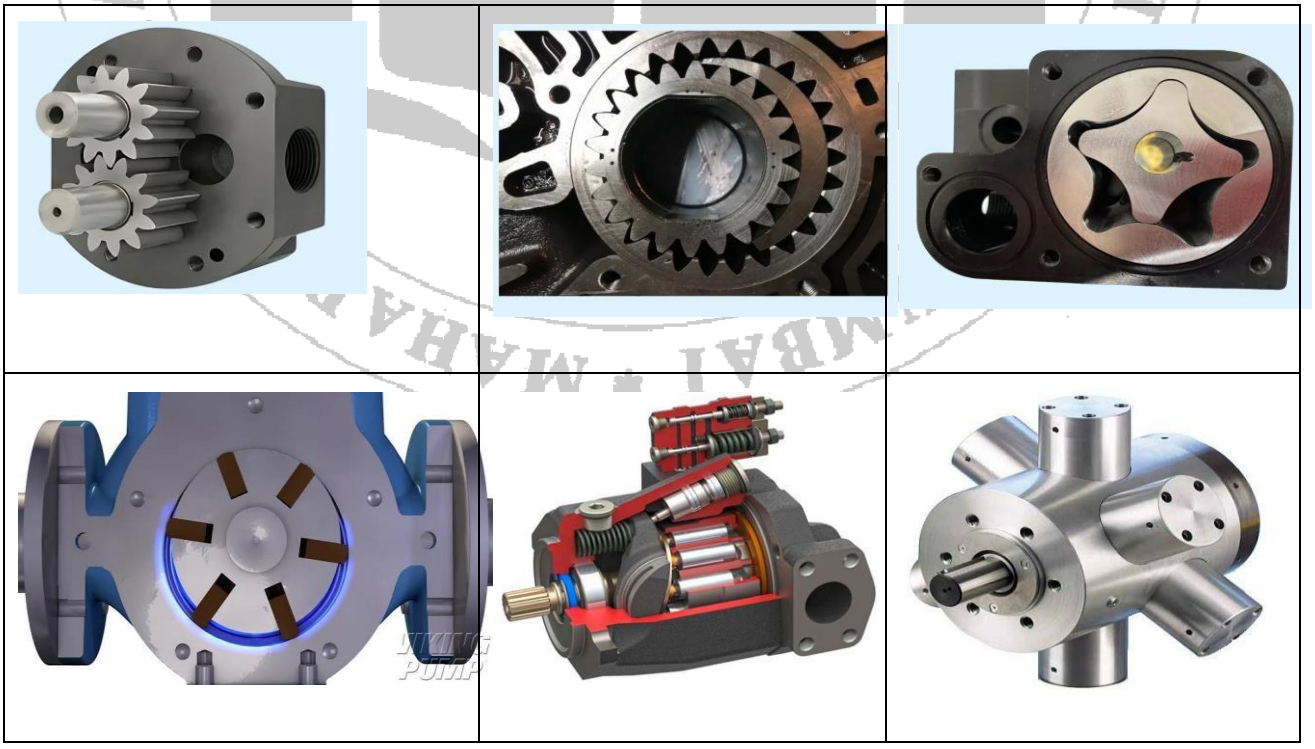


Fig.3.1 Types of Oil hydraulic pumps

VII. Experimental setup -

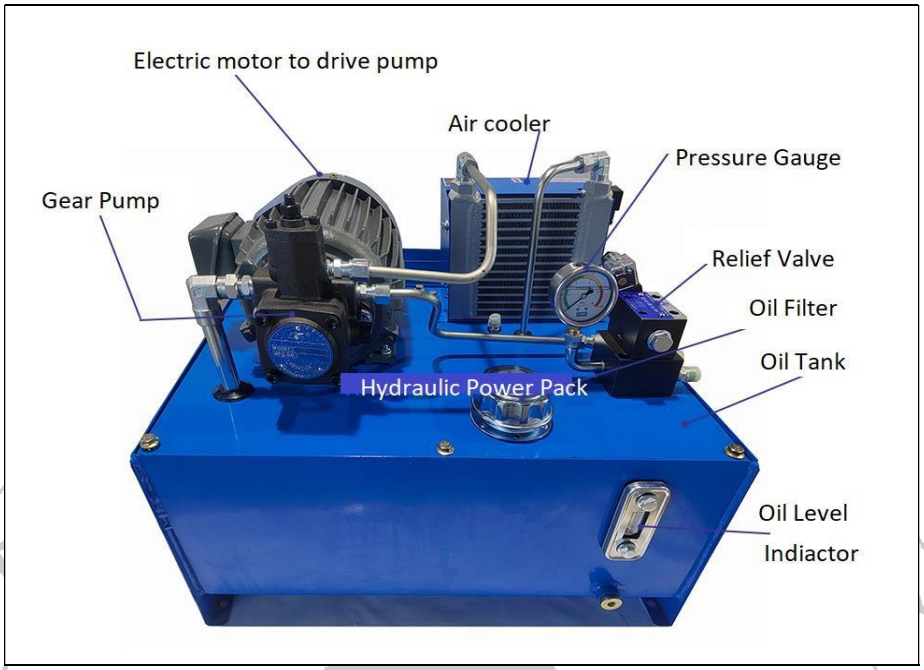


Fig 3.2 : Hydraulic power pack provided on trainer

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hydraulic Trainer	With Hydraulic power pack	01
2	Pump	Actual or working model	01
3	Flow meter	Standard up to 0 - 20 lit/sec	01
3	Pressure gauge	Standard up to 30 Kg/cm²	01

IX. Precautions to be Followed

- Ensure proper 3 Phase Electrical connections of electric motor for correct direction of rotation of pump.
- Check connections before trial and perform practical under observation of instructor.

X. Procedure

1. Initially check the level of hydraulic oil to ensure adequate oil in the tank.
2. Make connections of pump discharge to the pressure gauge and flow meter.
3. Allow the trainer in ON position for 5 minutes for initial warm-up.
4. Note down the pressure of oil and flow rate generated by the pump.

XI. Observations and calculations –

- **Type of hydraulic oil: _____**
- **Pump power in KW or HP: _____**
- **Motor /Pump Speed: _____**

Sr. No.	Type of Pump	Oil pressure (Kg/cm²)	Oil pressure (PSI)	Flow rate (LPH)

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List pumps in ascending order according to the pressure developed by the pumps.
2. Draw sketch of External gear pump.
3. Explain factors for selection of pump in oil hydraulic system.
4. List any four manufacturers of vane pumps and gear pumps.

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.youtube.com/watch?v=-x7XYLj6Jhg
- https://www.youtube.com/watch?v=Zc13A6xJLKE
- https://www.youtube.com/watch?v=O_2BZs3WiQY
- https://www.youtube.com/watch?v=j8ALHGOQTQ0

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60**%)
1	Handling of the set up	30%
2	Observations of set up	30%
	Product Related (10 Marks)	**(40**%)
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	T**otal**	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No 04 Compressor and FRL unit used in pneumatics

I. Practical Significance

Pneumatic system operates mainly operates using compressor as compressed air is a medium for pneumatics. FRL unit is necessary for removal of contaminants, maintain stable pressure and add lubricating oil particles in the compressed air for smooth and efficient functioning of pneumatic system.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Selection of compressor, FRL unit for given practical application.

III. Course Level Learning Outcome (CO)

CO2- Select pump, compressor and actuator for given fluid operated system.

IV. Laboratory Learning Outcome(s)

1. Use compressor and FRL unit mounted on Pneumatic trainer

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Before performing this practical student must have knowledge of general layout of pneumatic system. He/She should know the principle, construction and working of reciprocating compressor. Also the function and use of Filter, Regulator, Lubricator known as FRL unit in pneumatic system.

Fig.4.1 Role of Compressor and FRL unit in pneumatics

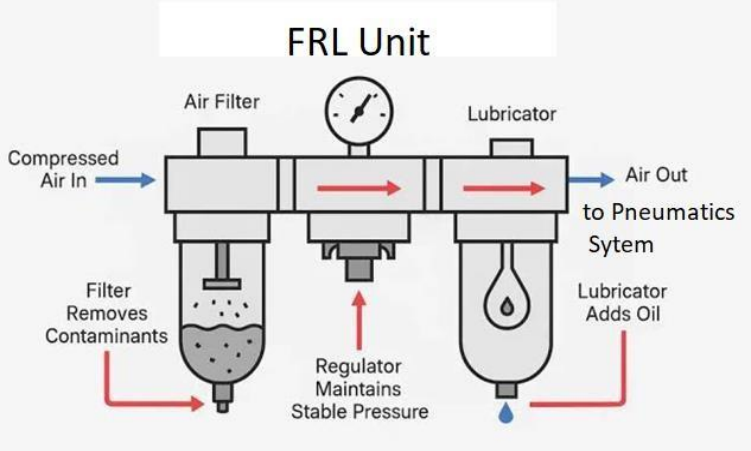


Fig.4.2 Compressor and FRL unit

VII. Experimental setup-

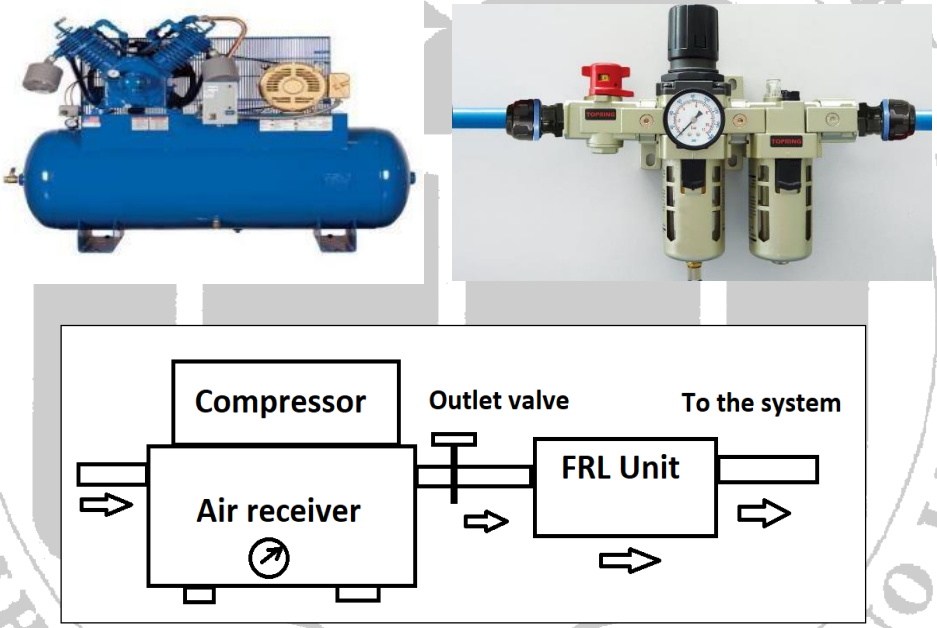


Fig.4.3 Connections of Compressor and FRL unit

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pneumatic Trainer	Transparent /Actual working components	01
2	Compressor unit with air receiver	Two stage Reciprocating compressor or Portable compressor Pressure up to 15 bar, Air receiver capacity: 160 liters	01
3	FRL unit	Port size: ¼, 3/8 , ½ Grade of filtration: 20-40 Microns Type of Drain: Manual Pressure regulator range: 1-12 bar, Lubricating oil : ISO VG 32	01

IX. Precautions to be Followed

- When recording a new point, ensure it is saved in a new program.
- Perform practical under observation of instructor.

X. Procedure

1. Connect compressor with power supply and Switch 'ON' unit
2. Run the compressor for specific period to develop pressure in the receiver.
3. Note down readings of pressure gauge.
4. Connect discharge pipe of compressor to the inlet of FRL unit.
5. The outlet of the FRL unit is to be connected to the manifold to supply air to the system.
6. Note down specifications of FRL unit.

XI. Observations Table-

Compressor unit details

- Make or brand : _____
- Type of Drive: _____
- Type(Single/multistage):_____
- Air receiver capacity: _____
- Pressure Gauge range **:**_____

Sr. No.	Type of Compressor	Specifications (Power of Motor)	Speed of the motor (RPM)	Pressure developed (kg/cm^2)

FRL Unit :

- Make or brand : _____
- Size of inlet connection: _____

Sr. No.	Element	Specifications	Operating range/capacity	ISO Symbol
1	Filter	Rating in microns:		
2	Regulator	Range:		
3	Lubricator	Oil grade:		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. If air is containing moisture, state the effect on Pneumatic system.
2. List factors for selection of compressor in pneumatic system.
3. State the problems may occur if FRL unit may be connected in wrong manner.
4. Visit the dentist to collect type of compressor used for dental pneumatic system,

[Space for Answer]

XVI. References / Suggestions for Further Reading

- Compressor: https://www.youtube.com/watch?v=bJluUxA7aaY 2
- FRL unit: https://www.youtube.com/watch?v=QilLtDMXO1

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the set up	30%
2	Observations of set up	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 05 *Hydraulic and pneumatic linear actuators

I. Practical Significance

The energy of fluid (oil/air) is converted in to mechanical movement using the actuators. It may produce push or pull force, rotary or angular movement as per type of actuator. The construction of hydraulic and pneumatic linear actuators is similar. However, they differ at their operating pressure ranges. Typical pressure of hydraulic cylinders is about 100 bars and of pneumatic system is around 10 bar.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

1. Select suitable type of actuator for given fluid operated application/s.

III. Course Level Learning Outcome (CO)

CO2- Select pump, compressor and actuator for given fluid operated system.

IV. Laboratory Learning Outcome(s)

1. Use linear actuators mounted on hydraulic and Pneumatic trainer
2. Measure velocity of linear actuators in both the strokes using suitable speed measurement device.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Actuators are output devices to apply forces/motion to perform the task. Actuators can be classified into two types. **1. Linear actuators:** These devices convert hydraulic/pneumatic energy into linear motion. **2. Rotary actuators:** These devices convert hydraulic/pneumatic energy into rotary motion.

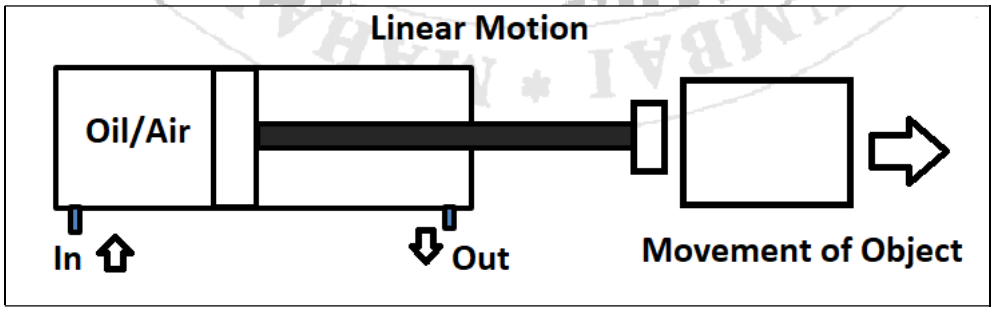


Fig.5.1 Example of Linear actuator

VII. Experimental setup -

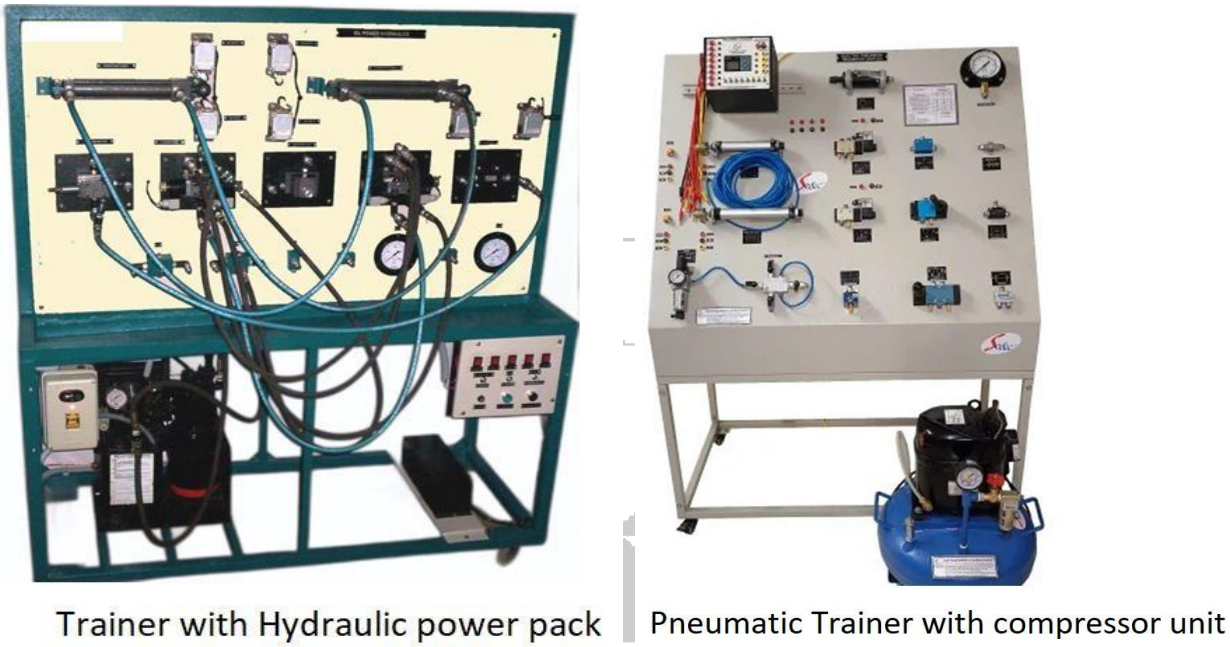


Fig.5.2 Trainer Kits

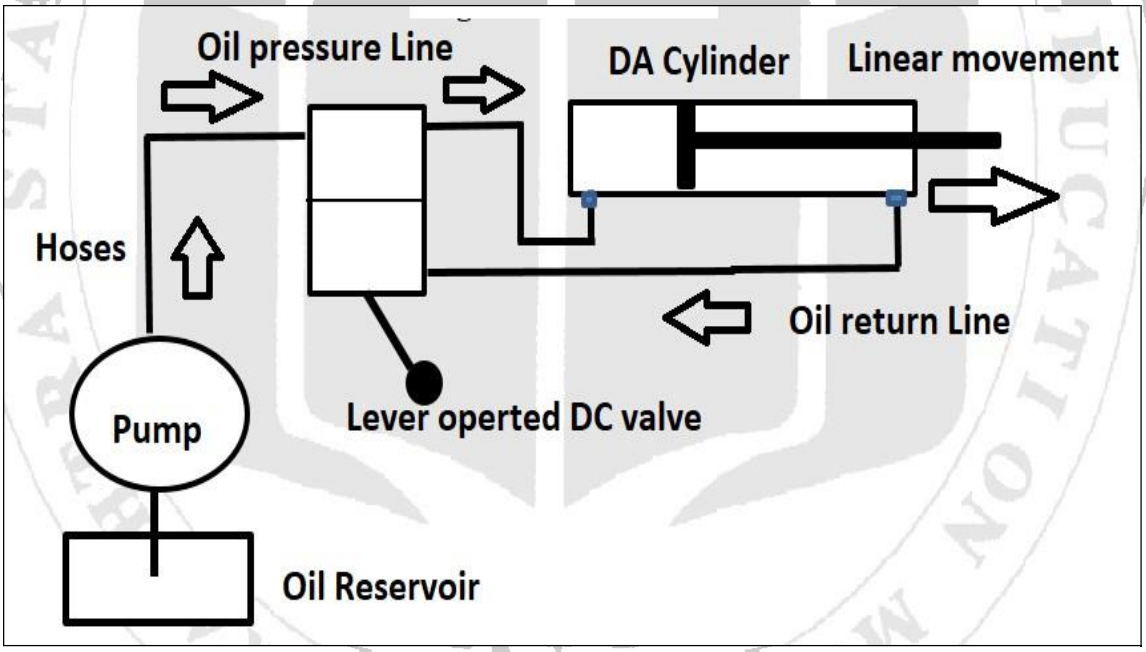


Fig.5.3 Connections for DA Cylinder actuation in oil Hydraulic system

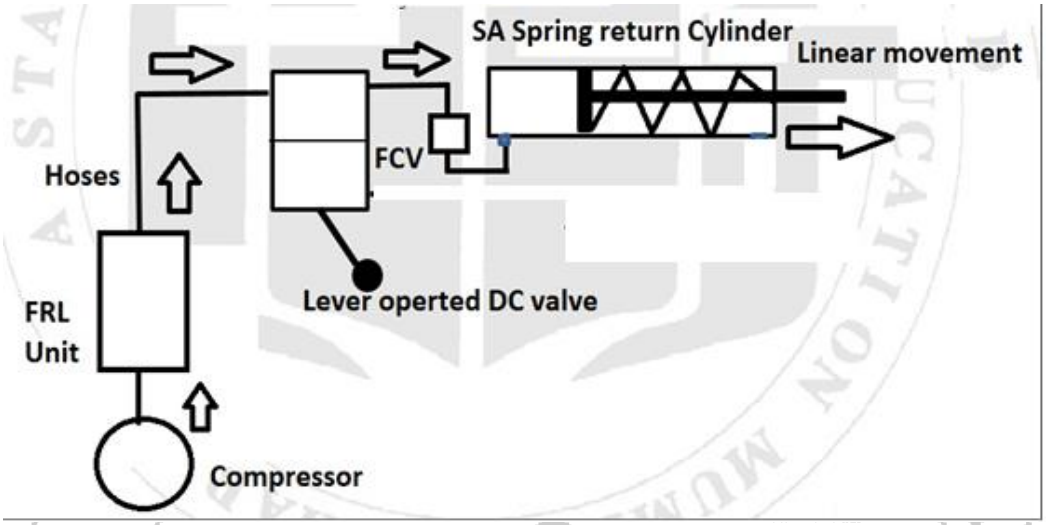


Fig.5.4 Connections for SA Cylinder actuation in Pneumatic system

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hydraulic Trainer	Transparent /Actual working components	01
2	Pneumatic Trainer	Transparent /Actual working components	01
3	Single acting and Double acting oil hydraulic cylinders	Pressure: up to 50 bar Stroke length : 150 to 300 mm	01each
4	Single acting and Double acting pneumatic cylinders	Pressure: up to 10 bar Stroke length : 150 to 300 mm	01 each
5	Stop watch	L.C :1 Sec Smart phone stop watch can be used	01

IX. Precautions to be Followed

- While connection of DC valve and cylinder make sure that connections are firm not loose.
- Perform practical under observation of instructor.

X. Procedure

1. Initially check the level of hydraulic oil to ensure adequate oil in the tank.
2. Make connections of pump discharge to the pressure gauge and flow meter.
3. Allow the trainer in ON position for 5 minutes for initial warm-up.
4. Note down the pressure and flow rate generated by the pump.
5. Make necessary connections to the actuators like S.A.Cylinder, D.A.Cyinder
6. Measure the stroke length and linear velocity using stop watch during forward and return stroke.

7. Calculate the Push and pull force using area of cylinder and pressure of oil/compressed air

XI. Observations and calculations –

1. Hydraulic Cylinder Mounted on oil Hydraulic Trainer

Name of Trainer :		
1	Name of Linear actuator	
2	Mounting Position (Horizontal/vertical)	
3	No of Inlet and outlet ports	
4	Diameter of cylinder bore	
5	Diameter of Piston Rod	
6	Length of stroke	
Measurement and Calculations of Force developed		
1	Oil pressure During forward stroke	
2	Area of cylinder bore	
3	Force generated during forward stroke (Push)	
4	Oil pressure During Return stroke	
5	Area of cylinder bore – Area of piston	
6	Force generated during Retraction (Pull)	
Measurement and Calculations of Liner velocity		
1	Time required for movement of piston (Left to right) during forward stroke	
2	Stroke length	
3	Linear velocity = Stroke length/Time	
4	Time required for movement of piston (Right to left) during Return stroke	
5	Stroke length :	
6	Linear velocity = Stroke length/Time	

2. SA Spring operated Cylinder Mounted on Pneumatic Trainer

Name of Trainer :		
1	Name of Linear actuator	
2	Mounting Position (Horizontal/vertical)	
3	No of Inlet and outlet ports	
4	Diameter of cylinder bore	
5	Diameter of Piston Rod	
6	Length of stroke	
Measurement and Calculations of Force developed		
1	Air pressure During forward stroke	
2	Area of cylinder bore	
3	Force generated during forward stroke (Push)	
4	Air pressure During Return stroke	
5	Area of cylinder bore – Area of piston	
6	Force generated during Retraction (Pull)	

Measurement and Calculations of Liner velocity		
1	Time required for movement of piston (Left to right) during forward stroke	
2	Stroke length	
3	Linear velocity = Stroke length/Time	
4	Time required for movement of piston (Right to left) during Return stroke	
5	Stroke length :	
6	Linear velocity = Stroke length/Time	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Classify linear actuators in details
2. Explain working of Double acting through rod cylinder and tandem cylinder
3. Compare hydraulic cylinders and pneumatic cylinders
4. Select type of cylinder for Dumper trolley and automatic door closing using pneumatics

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.youtube.com/watch?v=O_2BZs3WiQY
- https://www.youtube.com/watch?v=j8ALHGOQTQ0

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the set up	30%
2	Observations of set up	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 06 Hydraulic and pneumatic rotary actuators

I. Practical Significance

The rotary or angular motion is produced by using pressurized oil or compressed air in Hydraulic and pneumatic actuator respectively. Hydraulic motors are useful for large cable winding cables, rotary movement of large concrete mixers while pneumatic or air motors are useful for various hand tools.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

1. Select suitable type of actuator for given fluid operated application/s.

III. Course Level Learning Outcome (CO)

CO2-Select pump, compressor and actuator for given fluid operated system.

IV. Laboratory Learning Outcome(s)

1. Use rotary actuators mounted on hydraulic and Pneumatic trainer
2. Measure RPM of rotary actuators using suitable speed measurement device.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

Before performing this practical student must have knowledge of Working principle of Hydraulic and air motors. The gear, vane motors are commonly used and available as per magnitude of torque, speed with unidirectional or bidirectional rotation facility as per need of the system.

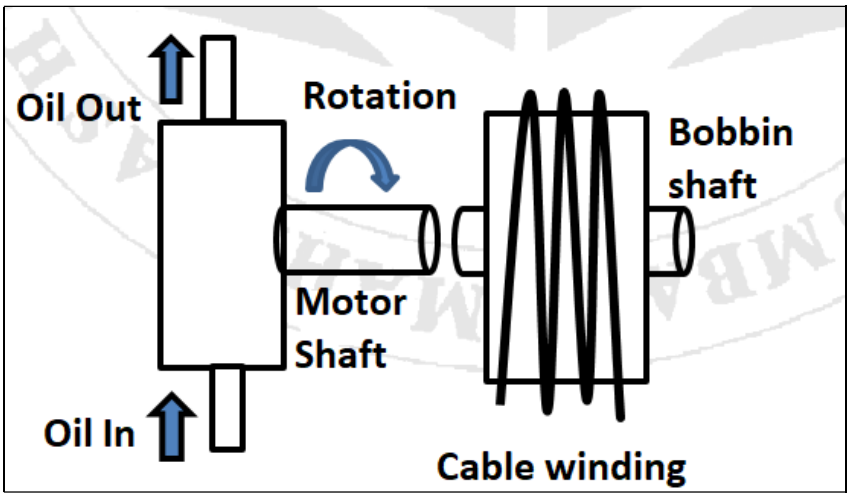


Fig.6.1 Example of Hydraulic motor application

Fig.6.2 Piston type and gear type hydraulic motor

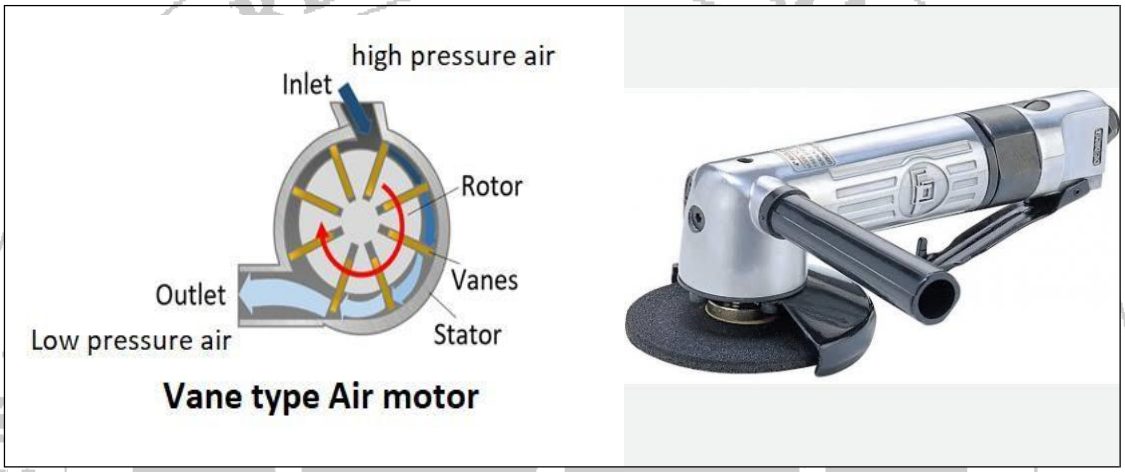


Fig.6.3 Vane type and turbine type Air motor

VII. Experimental setup –

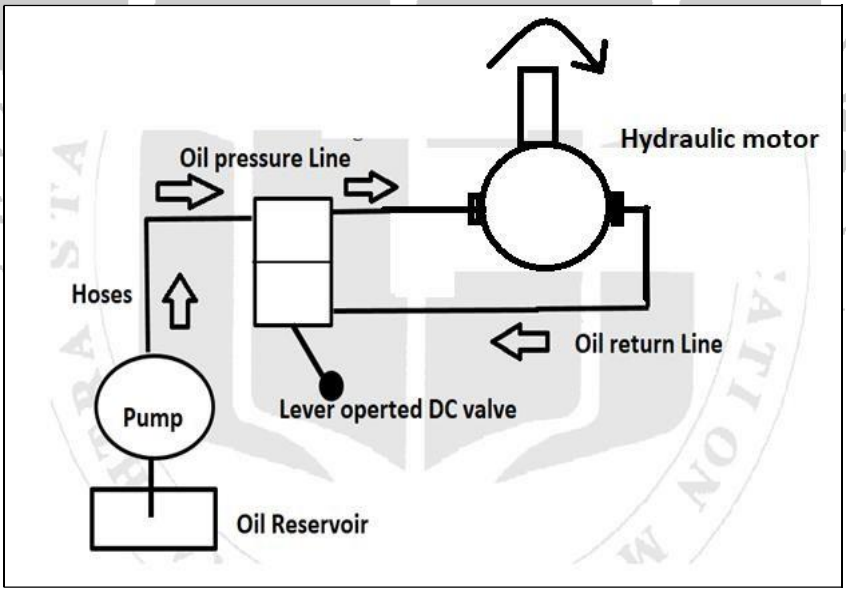


Fig 6.4: Hydraulic motor connections in the circuit

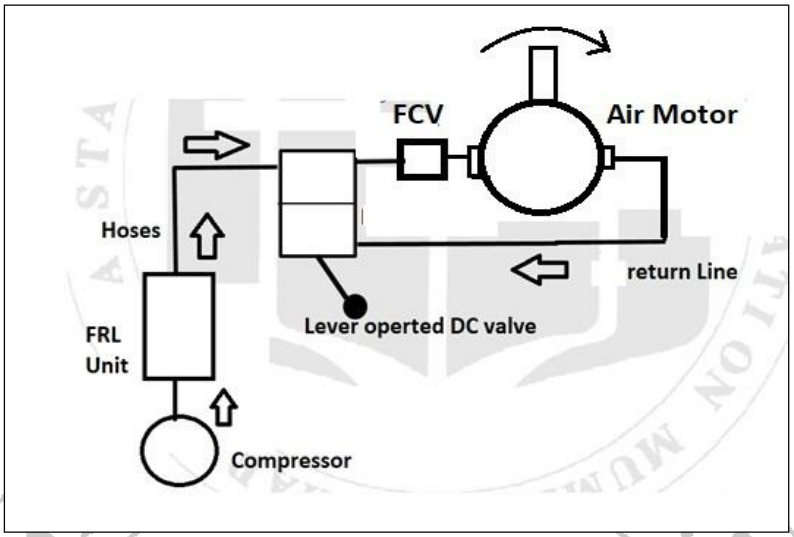


Fig 6.5: Air motor connections in the circuit

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Hydraulic Trainer	Transparent /Actual working components	01
2	Pneumatic Trainer	Transparent /Actual working components	01
3	Hydraulic motor	Pressure: up to 50 bar Unidirectional or bidirectional	01each
4	Pneumatic or Air motor	Pressure: up to 10 bar Unidirectional or bidirectional	01 each
5	Tachometer (Digital)	L.C :1 rpm Range: 0-3000 rpm	01

IX. Precautions to be Followed

- Ensure correct connections of hoses with various ports of DC valve.
- Perform practical under observation of instructor.

X. Procedure

1. Initially check the level of hydraulic oil to ensure adequate oil in the tank.
2. Make connections of pump discharge to the pressure gauge and flow meter.
3. Allow the trainer in ON position for 5 minutes for initial warm-up.
4. Note down the pressure and flow rate generated by the pump.
5. Make necessary connections to the actuators like Oil hydraulic motor, Pneumatic motors
6. Measure the angular velocity using tachometer during Clockwise and counter clockwise rotation
7. record the data in observation table

XI. Observations and calculations –

1. Oil Hydraulic motor

Name of Trainer :		
1	Name of Rotary actuator	
2	Mounting Position (Horizontal/vertical)	
3	No of Inlet and outlet ports	
4	Diameter of inlet of motor	
5	Torque	
6	Oil pressure during clockwise rotation	
7	Rotational speed in rpm and direction	

2. Pneumatic /Air Motor

Name of Trainer :		
1	Name of Rotary actuator	
2	Mounting Position (Horizontal/vertical)	
3	No of Inlet and outlet ports	
4	Diameter of inlet of motor	
5	Torque	
6	Air pressure during clockwise rotation	
7	Rotational speed in rpm and direction	

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Classify air motors in details.
2. Compare air and hydraulic motor on the basis of torque and applications.
3. Enlist various types of pneumatic hand tools
4. Visit to service station to collect information of pneumatic nut runner

[Space for Answer]

XVI. References / Suggestions for Further Reading

- https://www.youtube.com/watch?v=-x7XYLj6Jhg
- https://www.youtube.com/watch?v=Zc13A6xJLKE

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the set up	30%
2	Observations of set up	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.07 Linear and rotary actuators movement by direct method using suitable DC valves

I. Practical Significance

The movement of actuators depends upon the type of task/work to be performed. The selection of appropriate DC valve is required as per the type of actuator selected for given applications. The actuator can be operated by direct method using push button, lever operated manual control valves.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Develop circuits for linear and rotary actuators for simple applications.

III. Course Level Learning Outcome (CO)

CO3 - Select appropriate control valves for given fluid operated system.

CO5 - Develop hydraulic and pneumatic circuits for given applications.

IV. Laboratory Learning Outcome(s)

1. Prepare hydraulic and pneumatic circuits for actuation of linear and rotary actuators by direct triggering using suitable DC valves.
2. Demonstrate hydraulic and pneumatic circuits for actuation of linear and rotary actuators by direct triggering using suitable DC valves following the given procedure.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram (if required)

The students should have knowledge of DC valves like 3/2, 4/2, 4/3, 5/3 DC valves which are manually or direct operated. The 3/2 DC is suitable for SA cylinder/ Unidirectional motors while 4/2 or 5/2 DC valve is suitable for DA cylinder/ Bidirectional motors. The 4/3 or 5/3 DC valve is needed if we wish to control the piston movement during the stroke at any time.

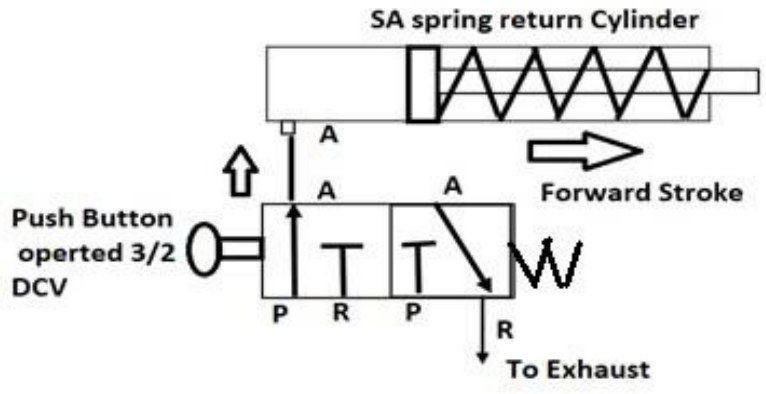


Fig.7.1 SA cylinder and DC valve connections

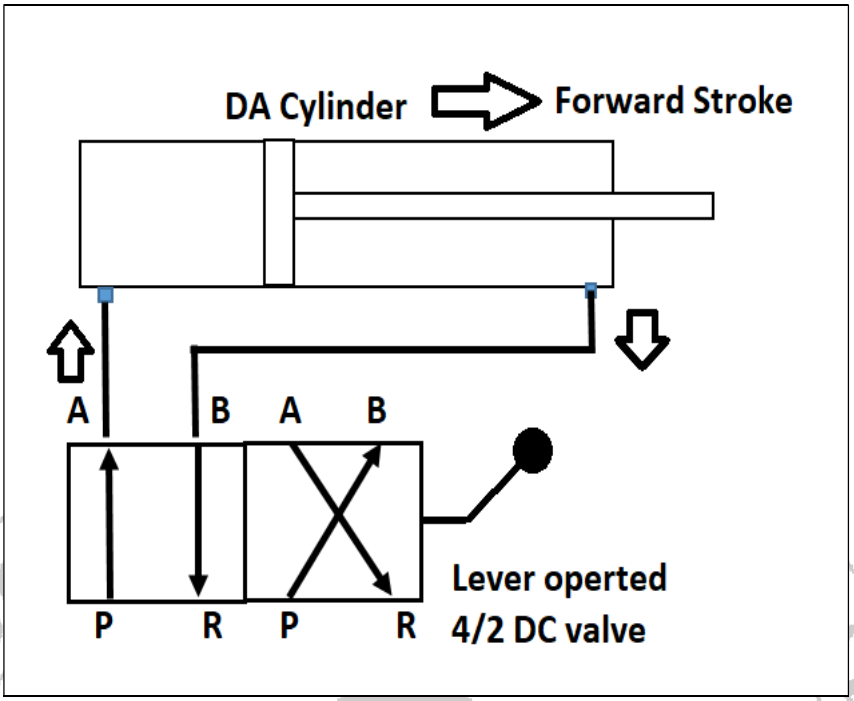


Fig.7.2 DA cylinder and DC valve connections

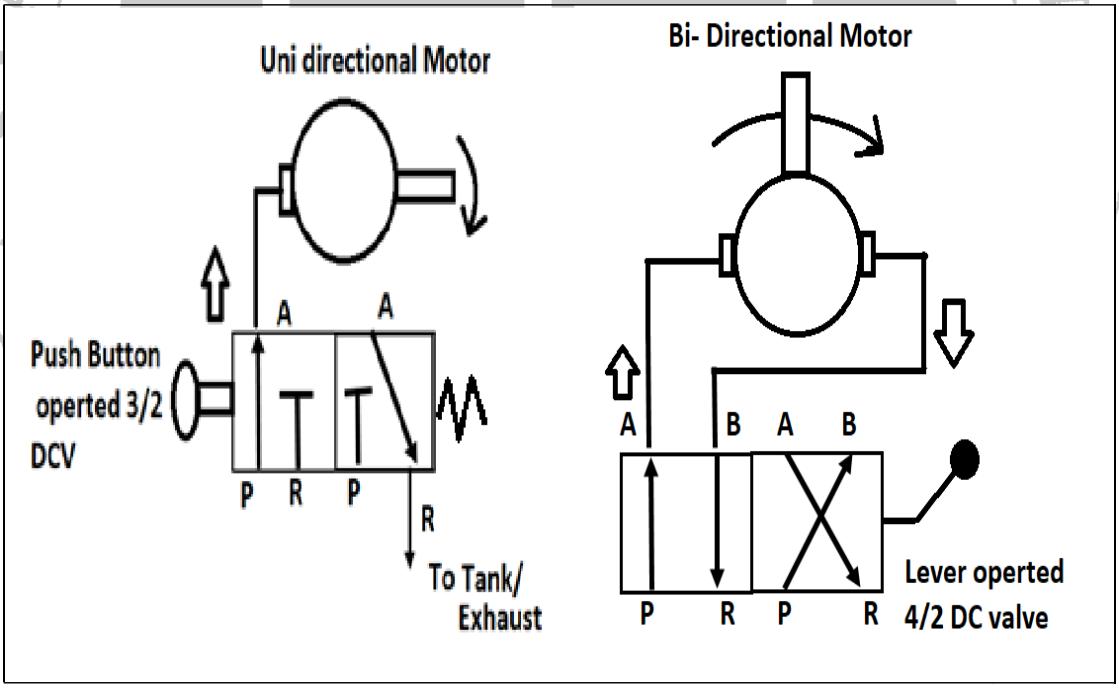


Fig.7.3 Unidirectional and Bi directional motor DC valve connections

VII. Experimental setup

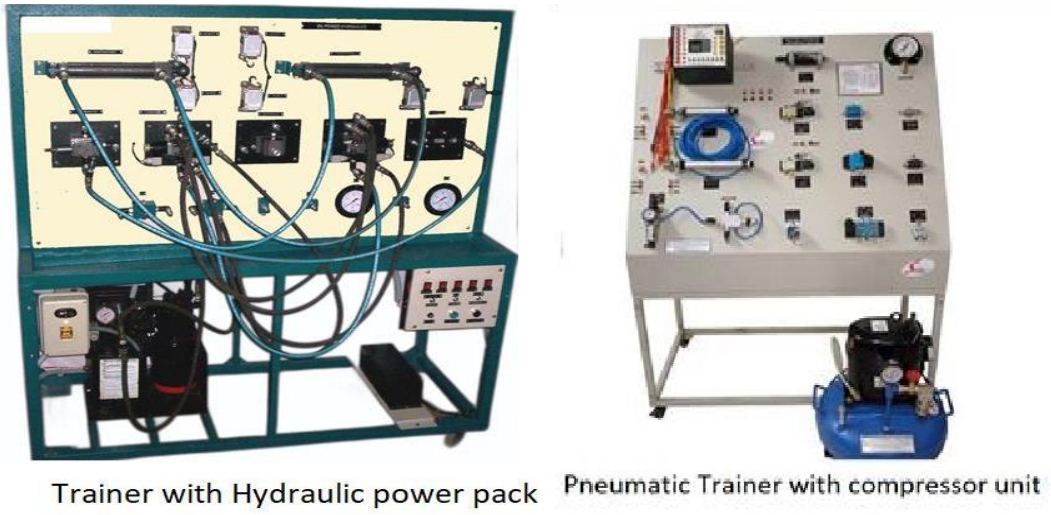


Fig.7.4 Hydraulic and Pneumatic Trainers

Fig 7.5 Circuit components

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic trainer	With 4/2, 5/2,4/3 Lever/push button operated DC Valves and SA/DA Cylinder with stroke length of 300mm, Hydraulic motor (Uni/Bidirectional)	01
2	Pneumatic trainer	With 3/2, 4/2, 5/2,4/3 Lever/Push button operated DC Valves and SA /DA Cylinder with stroke length of 300mm Air motor (Uni/Bidirectional)	01

IX. Precautions to be Followed

- Ensure leak proof connections.
- Any oil spills should be cleaned up immediately.
- Perform practical under observation of instructor.

X. Procedure

1. Initially check the level of hydraulic oil to ensure adequate oil in the tank.
2. Make connections as per circuit diagram.
3. Allow the trainer in ON position for 5 minutes for initial warm-up.
4. Note down the pressure and flow rate generated by the pump.
5. Make necessary connections to the actuators like S.A. Cylinder, D.A.Cylinder, Unidirectional /Bi-directional Hydraulic motor
6. Record the observations.

Similarly, for pneumatic actuators

1. Initially check the pressure of compressed air
2. Make connections as per circuit diagram.
3. Make necessary connections to the actuators like S.A. Cylinder, D.A.Cylinder, Unidirectional /Bi-directional air motor
4. Record the observations.

XI. Observations and calculations

Oil Hydraulic Trainer

Type of actuator selected	
Stroke length in mm	
Diameter in mm	
Symbol of Actuator	
Type of DC valve selected	
No of ports of DC valve	
No.of positions of DC valve	
Symbol of DC valve	

Draw connections for Forward stroke	**Draw connections for Return stroke**

Type of actuator selected	
Stroke length in mm	
Diameter in mm	
Symbol of Actuator	
Type of DC valve selected	
No of ports of DC valve	
No.of positions of DC valve	
Symbol of DC valve	

Draw connections for Forward stroke	**Draw connections for Return stroke**

1. Actuation of SA Cylinder

SR No	Stroke length(mm)	Oil pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Time in sec	Linear velocity (mm/sec)
1						
2						
3						
4						

2. Actuation of DA Cylinder

SR No	Stroke length(mm)	Oil pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Time in sec	Linear velocity (mm/sec)
1						
2						
3						
4						

3. Actuation of Hydraulic motor

SR No	Type	Oil pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Angular Velocity(RPM)
1					
2					
3					
4					

Pneumatic Trainer

Type of actuator selected	
Stroke length in mm	
Diameter in mm	
Symbol of Actuator	
Type of DC valve selected	
No of ports of DC valve	
No.of positions of DC valve	
Symbol of DC valve	
Draw connections for Forward stroke	**Draw connections for Return stroke**

Name of Trainer :_____

Type of actuator selected	
Stroke length in mm	
Diameter in mm	
Symbol of Actuator	
Type of DC valve selected	
No of ports of DC valve	
No.of positions of DC valve	
Symbol of DC valve	
Draw connections for Forward stroke	**Draw connections for Return stroke**

1. Actuation of SA Cylinder

SR No	Stroke length(mm)	Air pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Time in sec	Linear velocity (mm/sec)
1						
2						
3						
4						

2. Actuation of DA Cylinder

SR No	Stroke length(mm)	Air pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Time in sec	Linear velocity (mm/sec)
1						
2						
3						
4						

3. Actuation of Air motor

SR No	Type	Air pressure (Kg/cm²)	Type of DC Valve	Type of Movement	Angular Velocity(RPM)
1					
2					
3					
4					

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Compare 4/2 DC valve and 3/2 Dc Valve.
2. Write practical applications of 3/2 and 5/2 DC Valve.
3. Select DC valve for a. Pneumatic Grinder machine rotates in clock wise direction
   b. Hydraulic table reciprocates manually

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. S A Cylinder circuit: https://www.youtube.com/watch?v=VfqCMqwJJK0
2. D A Cylinder circuit:https://www.youtube.com/watch?v=oCp-PNupoEU
3. Hydraulic motor circuit:https://www.youtube.com/watch?v=-ro_unB-XL4

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the set up	30%
2	Observations of set up	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.08 *Linear and rotary actuators movement by indirect method using suitable DC valves

I. Practical Significance

Linear and rotary actuators can be controlled indirectly using suitable directional control (DC) valves, most commonly by employing pilot-operated valves. This method is practical for operating large actuators with higher power requirements because it only needs a small pilot valve to control a much larger main valve, which then actuates the actuator.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Develop control circuits for both linear and rotary actuators using indirect (pilot) valve techniques

III. Course Level Learning Outcome (CO)

CO1- Develop hydraulic and pneumatic circuits for given applications

IV. Laboratory Learning Outcome(s)

- Demonstrate hydraulic and pneumatic circuits for actuation of linear and rotary actuators by indirect triggering using suitable DC valves following the given procedure.
- Prepare hydraulic and pneumatic circuits for actuation of linear and rotary actuators by indirect triggering using suitable DC valves.

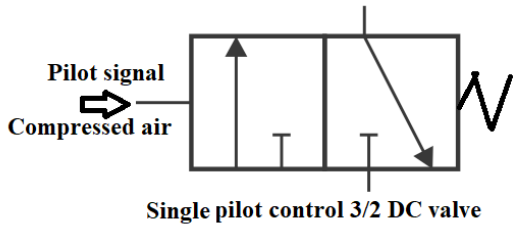
.

V. Relative Affective Domain Related Outcome(s)-

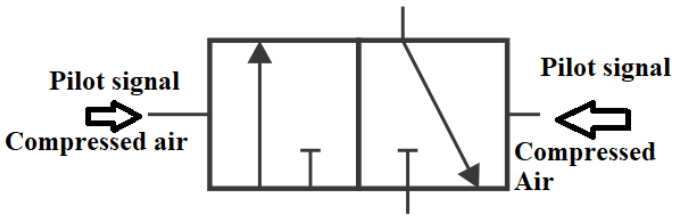
- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

The core idea is that indirect (pilot-operated) actuation uses a small pilot valve to operate a larger main valve, which then controls the actuator from any remote point. A small pilot valve (often electrically actuated) directs fluid to move the spool of a larger DC valve, which is ideal for high-flow or high-pressure circuits. This allows control over large actuators with minimal operator effort.



Single pilot control 3/2 DC valve



Double pilot control 3/2 DC valve

VII. Experimental setup

Fig 9.1: Pilot control DC valve in Pneumatic system

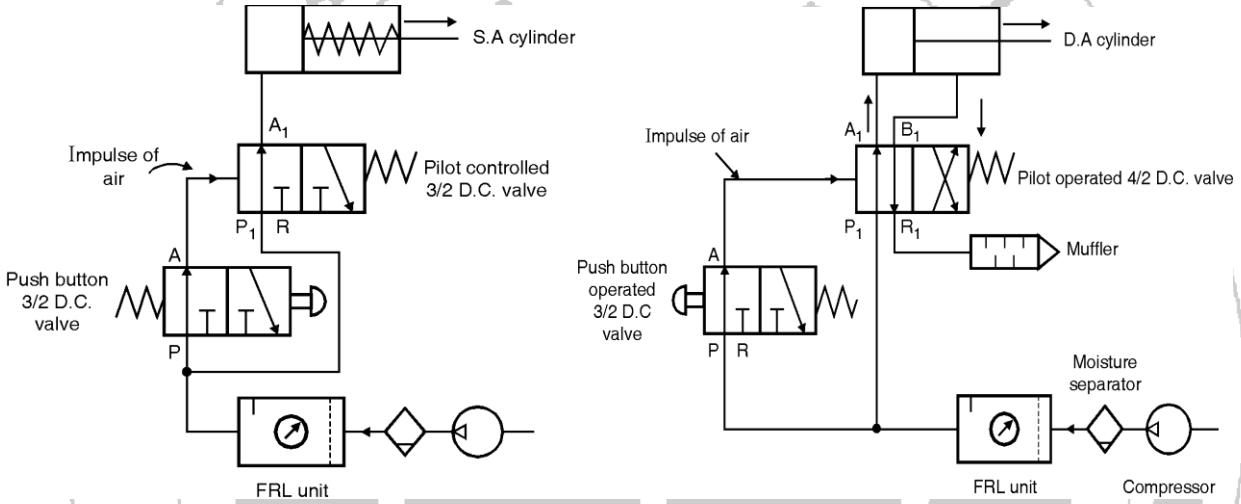


Fig 9.2: Circuit diagram indirect control of SA and DA acting cylinder

Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pneumatic trainer with portable compressor	Transparent/ actual working components Compressor	1
2	Pilot control valves (Single/Double)	Standard 10 bar	Each 1
3	Tool kit	Standard	1

VIII. Precautions to be Followed

- Always ensure the pilot line is free of blockages and contamination,
- Specify the valve correctly for the application, considering pressure, temperature, flow rate, and process fluid properties
- Use proper personal protective equipment if required.

- Tighten all fittings securely before pressurizing the system.

XIV Procedure

- Prepare the circuit diagram and ensure all components match the specifications.
- Mount the pilot valve and main directional control valve in the correct locations on the test rig or machine frame.
- Connect pilot lines from the pilot valve outlets to the pilot control ports of the main valve.
- Verify cylinder lines are attached to the correct ports on the main valve.(for Linear or rotary actuator).
- Power on but do not pressurize; check all electrical and signal connections to pilot valves (if solenoid-actuated).
- Pressurize the system slowly while monitoring for leaks and irregular pressure readings.
- Actuate the pilot valve and observe the main valve and actuator response, ensuring smooth operation without chattering or delayed action.
- After testing, depressurize the system before disconnecting any lines or performing further adjustments.

IX. Observations and calculations

Sr.No	Name of actuator	Type of pilot DC valve	Movement observed

Draw actual circuit diagram of (Pneumatic or Hydraulic)

X. Results

XI. Interpretation of Results

XII. Conclusions and Recommendation

XIII. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State indirect movement of a linear actuator using a pilot-operated directional control (DC) valve
2. Write the specifications of pilot operated DC and Direct operated DC valve.
3. Explain function of rotary actuator and linear actuator.
4. Write advantages of indirect method used to control the actuators.

[Space for Answer]

XIV. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/shorts/87TTOW47CH8

XV. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60%)**
1	Handling of the Instruments	30%
2	Observation and readings	30%
Product Related (10 Marks)		**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.09 *Pressure relief and sequence valve circuits

I. Practical Significance

By relieving excess pressure instead of allowing it to build up, the valve enhances efficiency and prolongs component life. Common applications Used in all hydraulic and pneumatic systems—such as presses, injection molding machines, and power steering units—to limit maximum system pressure.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. To select relief valve for safety of hydraulic system
2. To select suitable valves for sequential operations for simple automation

III. Course Level Learning Outcome (CO)

CO3- Select appropriate control valves for given fluid operated system.
CO5- Develop hydraulic and pneumatic circuits for given applications.

IV. Laboratory Learning Outcome(s)

- Prepare circuits using pressure relief and sequence valve.
- Demonstrate circuits using pressure relief and sequence valve following the given procedure.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

The pressure relief valve is a safety component designed to limit the maximum pressure within a hydraulic system. It operates by opening a passage to divert excess fluid back to the reservoir (tank) when the system pressure exceeds a preset limit.

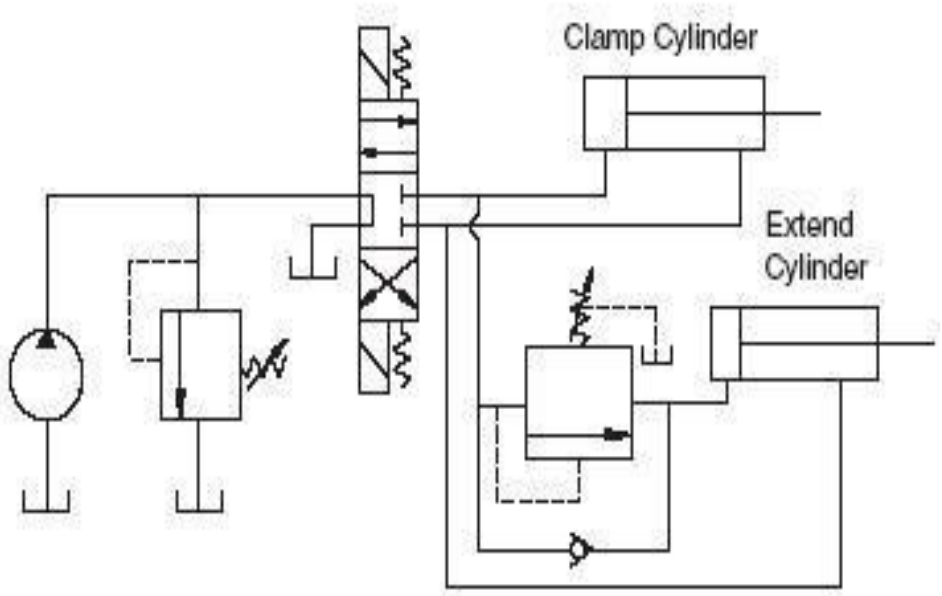


Fig. 9.1 Sequencing Circuit using PRV and Sequence valve

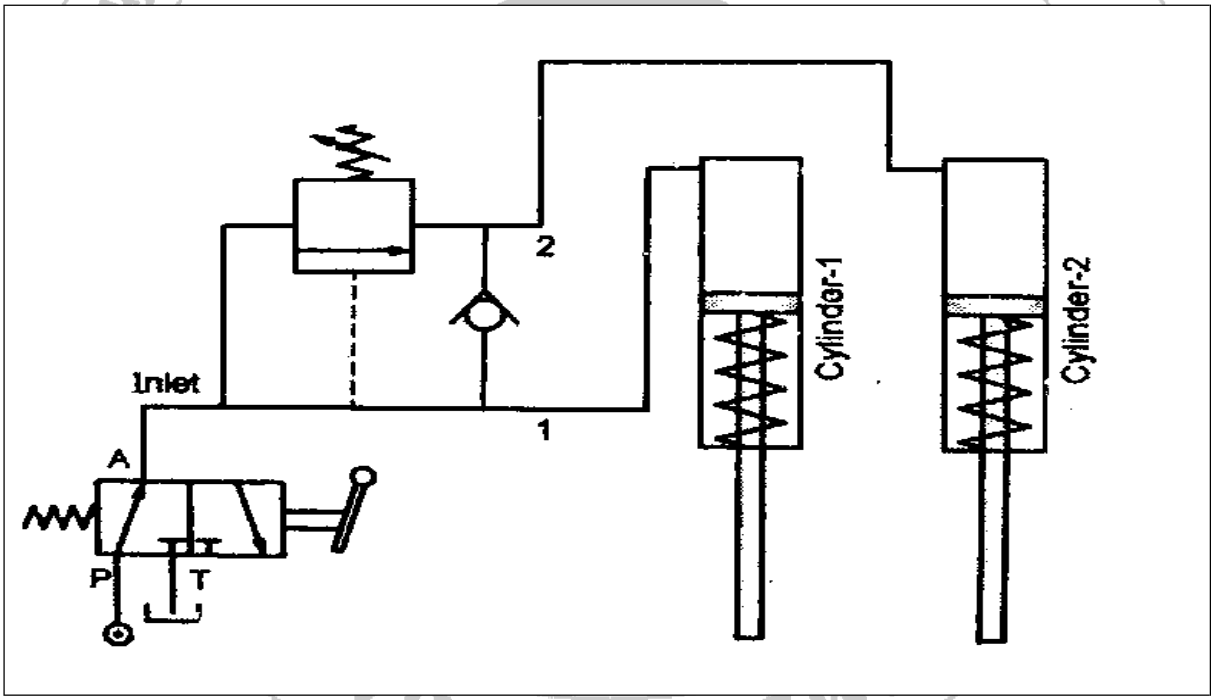


Fig 9.2: Sequencing Circuit using PRV and Sequence valve

VII. Experimental setup

Students are suggested to visit Industrial fluid power laboratory to identify various components of Oil hydraulic and Pneumatic trainers.

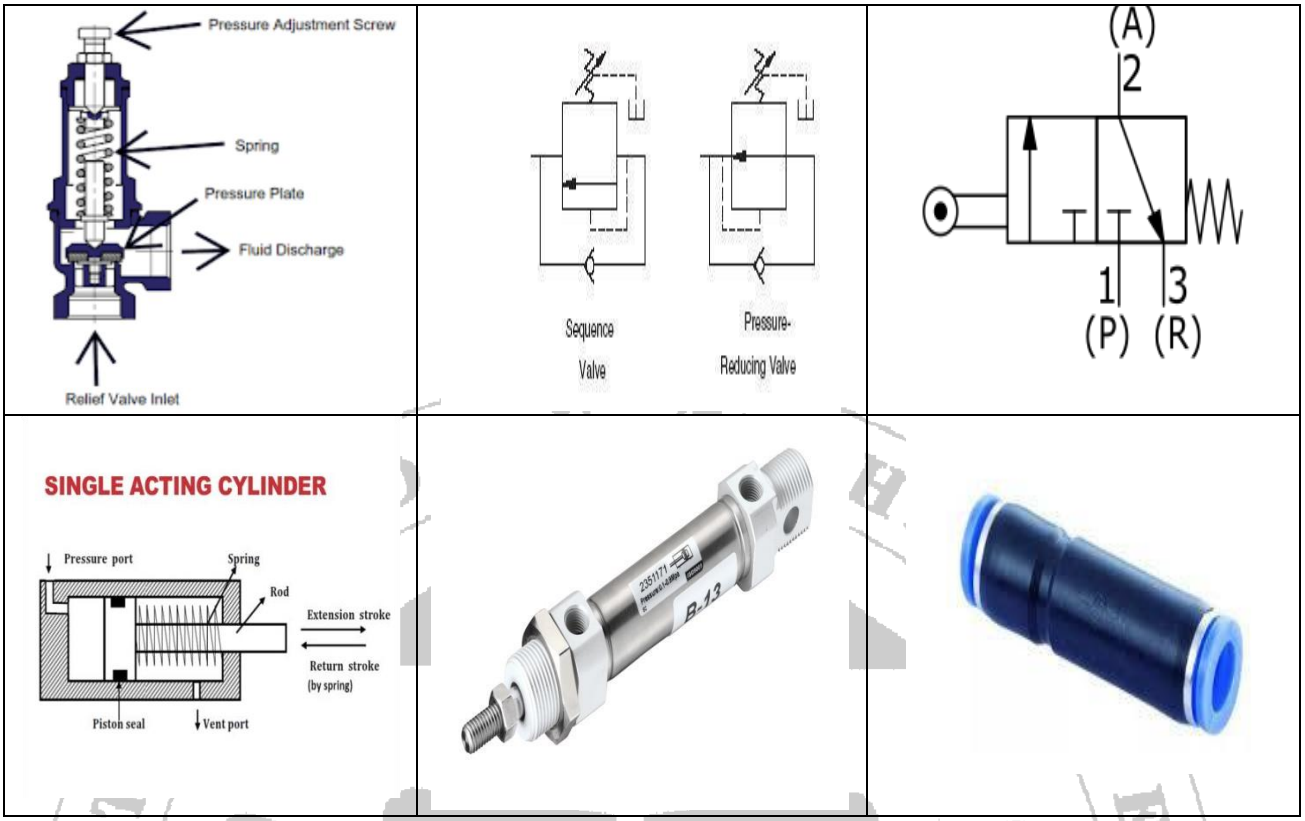


Fig 9.3: Components of Hydraulics/Pneumatic system

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic trainer with various components	Transparent /actual working components	1
2	Pneumatic trainer with portable compressor	Transparent/ actual working components Compressor: Pressure 0-10 bar	1
3	Demonstration Models of pumps, cylinders, valves, other components	Working / actual/Cut section	Each 1
3	Tool kit	Standard	1

IX. Precautions to be Followed

- Do not forcefully connect to ports/connectors to avoid the damage.
- Perform practical under observation of instructor.
- Avoid improper/loose connections of components.

X. Procedure

A sequence valve ensures that actuators operate in a predetermined order — typically one cylinder moves fully before the next begins. The hydraulic sequencing circuit is used for automation in operations like clamping and machining. The common procedure is as follow.

- Set DCV to the neutral position.
- Start the pump and adjust the pressure relief valve between
- Move the DCV lever to the right (forward direction).
- Observe that Cylinder A extends first (primary actuator).
- As pressure builds, the sequence valve opens and allows Cylinder B to extend.
- Shift the DCV to the left (reverse direction) and observe both cylinders retract simultaneously.

Circuit Setup

- Assemble the circuit as shown in the sequencing diagram.
- Connect the DCV output to both cylinders through the sequencing valve.
- Ensure proper connection of hoses and return lines to the reservoir

XI. Observations and calculations

Sr.No	Relief Valve setting Pressure (Bar)	Pressure of oil from pump (Bar)	Remark

Sr.No	Sequence valve location	Name of actuators operated in sequence	Write Sequence of operations

Draw Actual Circuit diagram

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Differentiate between a pressure relief valve and a sequence valve in terms of their purpose and response in a hydraulic system.
2. Describe the sequence of operations in a hydraulic circuit using two cylinders and a sequence valve.
3. State if the pressure relief valve is set too low or fails to operate properly

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60**%)
1	Handling of the Instruments	30%
2	Observation and readings	30%
Product Related (10 Marks)		**(40**%)
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.10 *Speed control circuit for hydraulic (meter in and meter out circuits

I. Practical Significance

In hydraulic systems, the practical significance of speed control circuits—specifically meter-in and meter-out circuits—lies in their ability to regulate actuator (cylinder or motor) motion for optimal stability, control, and efficiency across varying load conditions.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer.

a) To design and analyse meter-in and meter-out circuits for controlling actuator speed based on specific industrial application requirements.

b) To select proper configurations (meter-in for resistive, meter-out for overrunning loads) to ensure operational efficiency.

III. Course Level Learning Outcome (CO)

CO5- Develop hydraulic and pneumatic circuits for given applications

IV. Laboratory Learning Outcome(s)

- Prepare speed control circuits for hydraulic actuators (meter in and meter out circuits)
- Demonstrate speed control circuits for hydraulic actuators (meter in and meter out circuits) following the given procedure

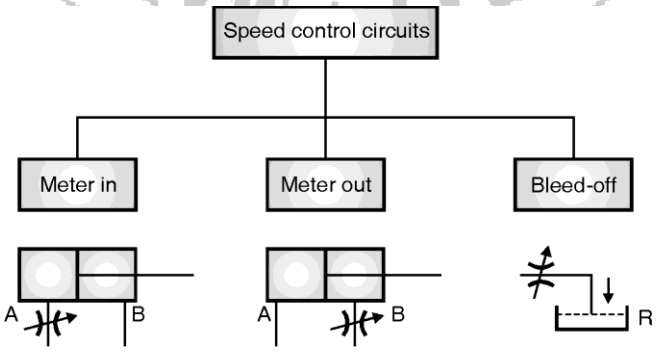
V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

Meter-In Circuit: In the Meter-In circuit, a flow control valve (FCV) is installed before the actuator (cylinder) in the pressure line. It regulates the amount of oil entering the cylinder, directly controlling the speed of actuator.

Meter-Out Circuit: In the Meter-Out circuit, the flow control valve is installed after the actuator, in the line between the cylinder and tank. It controls how fast fluid leaves the cylinder, thus regulating the retracting or extending motion.



VII. Experimental setup

Fig 10.1: Oil Hydraulic and Pneumatic Trainer

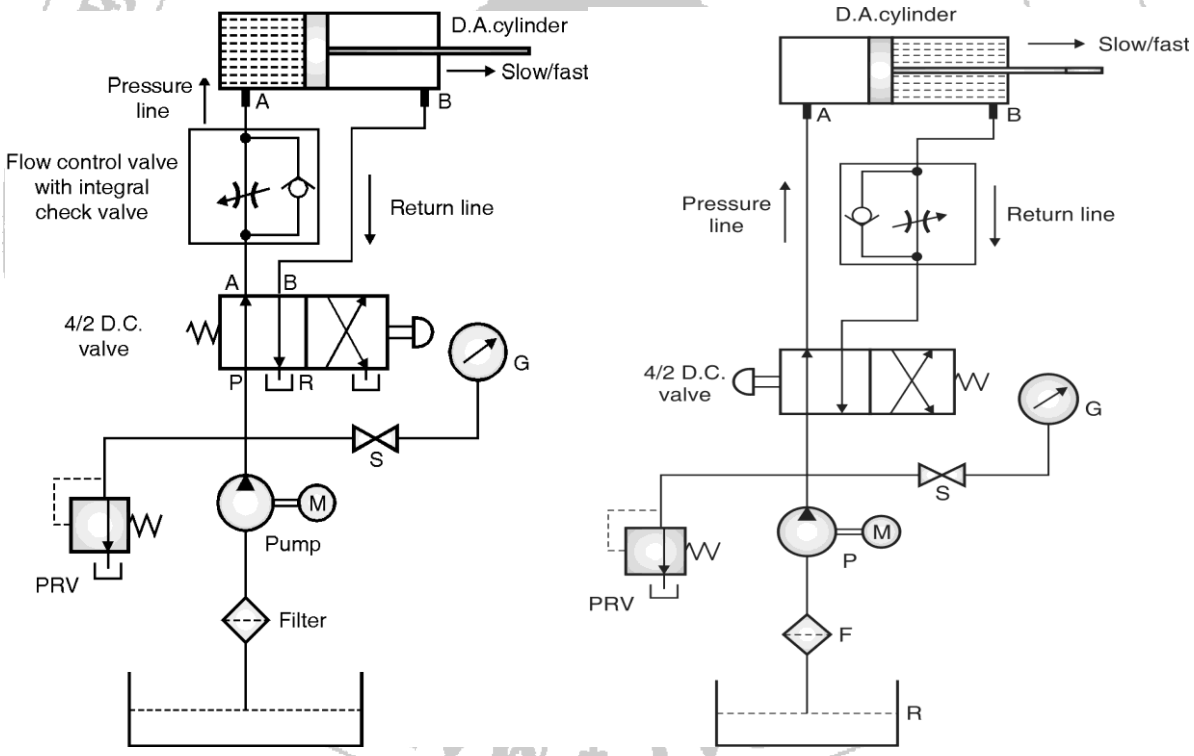


Fig 10.2 : Meter-in and Meter-out circuits

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic trainer	Transparent /actual working components	1
2	Tool kit	Standard	1

IX. Precautions to be Followed

1. Avoid improper/loose connections of components.
2. Do not forcefully connect to connectors to avoid the damage.
3. Connections should never be made while the machine is running.
4. If difficulty is encountered while attempting to make a connection, make sure that
5. the machine is off and that the lines are not under pressure.
6. Any oil spills should be cleaned up immediately.

X. Procedure

1. Ensure the proper connections of all components.
2. Adjust the pressure relief valve to desired setting to protect against overpressure.
3. Open or close flow control and needle/globe valves as required
4. Place the flow control valve in the pressure line before the actuator.
5. For meter-out: Place the flow control valve in the return line after the actuator.
6. Ensure the actuator (cylinder) remains at rest before starting.
7. Fully open the flow control valve to allow maximum initial flow for testing.
8. Energize the pump and allow hydraulic oil to circulate.
9. Gradually adjust the flow control valve to achieve the desired actuator speed.
10. In meter-in, adjust for the speed of extension.
11. In meter-out, adjust for the speed of retraction, especially with overrunning or vertical load.

XI. Observations and calculations

1. Meter-in circuit

SR No	Setting level of FCV	Pressure before throttling	Pressure after throttling	Flow (LPM) After throttling	Time for piston movement (T) Sec	Actuator speed observed (L/T) mm/sec	Remark (Slow/fast)
1	Fully open						
2	50% closed						

2. Meter-Out circuit

SR No	Setting level of FCV	Pressure before throttling	Pressure after throttling	Flow (LPM) After throttling	Time for piston movement (T) Sec	Actuator speed observed (L/T) mm/sec	Remark (Slow/fast)
1	Fully open						
2	50% closed						

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the purpose of a speed control circuit in a hydraulic system.
2. Compare meter-in and a meter-out circuit
3. Write the function of a check valve in a hydraulic circuit.
4. Suggest speed control circuit for vertical or overrunning loads.
5. Draw the circuit diagram of meter out circuit for bidirectional motor.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
2 1	Handling of the Instruments	30%
2	Observation and readings	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.11 *Speed control circuit for pneumatic actuators

I. Significance

The speed control circuit for pneumatic actuators is highly significant in ensuring precise, safe, and efficient motion in pneumatic systems. It allows users to regulate how fast a pneumatic cylinder or actuator extends or retracts by controlling the airflow using flow control valves.

II. Industry/Employer Expected Outcome (s)

- To develop speed control pneumatic circuits for desired applications as per task.

III. Course Level Learning Outcome (CO)

CO2- Select pump, compressor and actuator for given fluid operated system.

CO5-Develop hydraulic and pneumatic circuits for given applications.

IV. Laboratory Learning Outcome(s)

- Prepare speed control circuits for pneumatic actuators.
- Demonstrate speed control circuits for pneumatic actuators.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

- Pneumatic actuators (cylinders) move when compressed air fills their internal chamber. The speed of the piston depends directly on how fast the air is supplied or exhausted.
- By controlling airflow, the actuator's movement can be made faster or slower Flow control valves are the main devices used for this regulation. Speed regulation increases versatility of the machines / equipment.

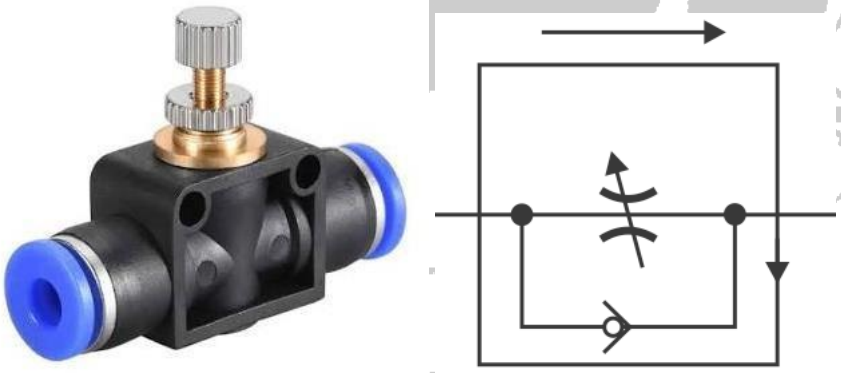


Fig.11.1 Flow control Valve and its symbol

VII. Experimental setup

Pneumatic Trainer with compressor unit

Fig 11.2: Pneumatic Trainer

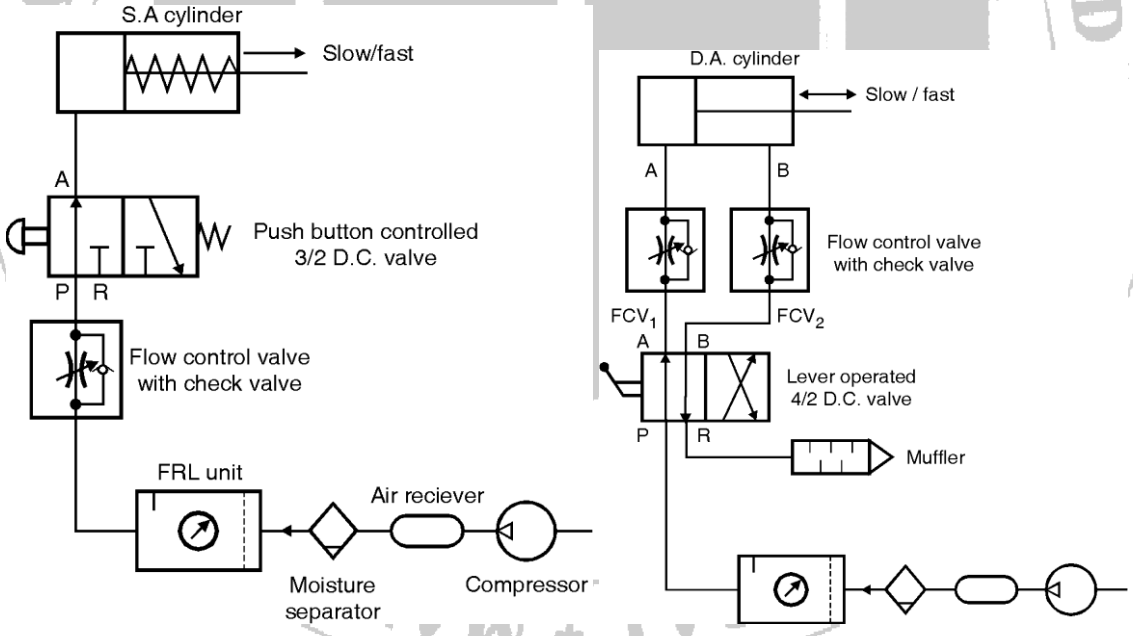


Fig 11.3: Speed control circuits

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pneumatic trainer with portable compressor	Transparent/ actual working components	1
2	FCV /FCV with check valve	Standard	1

IX. Precautions to be Followed

- Avoid loose or improper connections to prevent leaks and accidental detachment.
- Do not forcefully connect fittings; this can damage connectors and result in air loss.
- Ensure all lock nuts, adjuster screws, and valves are securely fastened
- Keep clear of the actuator's moving parts during initial testing to avoid injury
- Never exceed maximum rated pressure for the actuator, valve, or tubing.
- Regularly clean and inspect filters, seals, and hoses for dust or leaks.

X. Procedure

- Securely mount all components according to the pneumatic circuit diagram
- Verify all parts are properly and snugly connected; ensure there are no loose
- Adjust the pressure regulator to the required setting for system operation.
- Install the flow control valve (typically one-way) on the desired port of the cylinder
- Adjust the needle valve gradually—open it slowly to avoid sudden piston movement.
- Switch on the service unit to begin supplying compressed air.
- Actuate the circuit using the push button or electrical control for the directional valve.
- Observe piston stroke and adjust the speed as needed using the flow control valve.

XI. Observations and calculations

Name of Actuator	FCV Position	Speed of actuator	Remark
SA Cylinder	Fully open	Fast	
	50 % open		
	25 % open		
DA Cylinder	Fully open		
	50 % open		
	25 % open		

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State air supply quantity on the speed of a pneumatic actuator.
2. Describe the construction and operation of a meter-in circuit for controlling the speed of a pneumatic motor
3. Draw meter out circuit of Pneumatic system for Bidirectional motor.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
3 1	Handling of the Instruments	30%
2	Observation and readings	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.12 *Pneumatic circuits involving use of Quick exhaust valve, logic OR, AND functions

I. Practical Significance

Quick exhaust valves, logic OR, and AND functions are essential elements in pneumatic circuits with significant practical uses in industrial automation for enhancing system control, increasing actuator speed, and enabling advanced machine sequencing. Quick exhaust valves allow rapid venting of air directly from a pneumatic actuator to the atmosphere, bypassing the control valve and long tubing.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

Use of suitable logic gate valve as per task to be performed for given applications

III. Course Level Learning Outcome (CO)

CO 4- Select appropriate special components for advanced fluid operated system.

CO 5- Develop hydraulic and pneumatic circuits for given applications

IV. Laboratory Learning Outcome(s)

- Prepare pneumatic circuits using quick exhaust valve, logic OR, AND, NOT functions.
- Demonstrate pneumatic circuits using quick exhaust valve, logic OR, AND, NOT functions following the given procedure.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices

VI. Minimum Theoretical Background with diagram

Quick Exhaust Valve Principle: This valve allows air from the actuator to bypass the control valve and exhaust directly, enabling rapid actuator retraction or extension crucial for high-speed operations.

Logic OR Function in Pneumatics: An OR circuit (shuttle valve) enables an output if either of its two inputs receives a signal. The output is energized when at least one input pressure is present, allowing control from multiple sources or inputs

Logic AND Function in Pneumatics: An AND circuit (two-pressure valve) outputs a signal only when both input pressures are present simultaneously. This is vital for interlocking functions or when safety requires two conditions to be met for operation.

VII. Experimental setup

Quick Exhaust Valve

Shuttle Valve

Twin Pressure Valve

Fig 12.1: Components of Pneumatic system

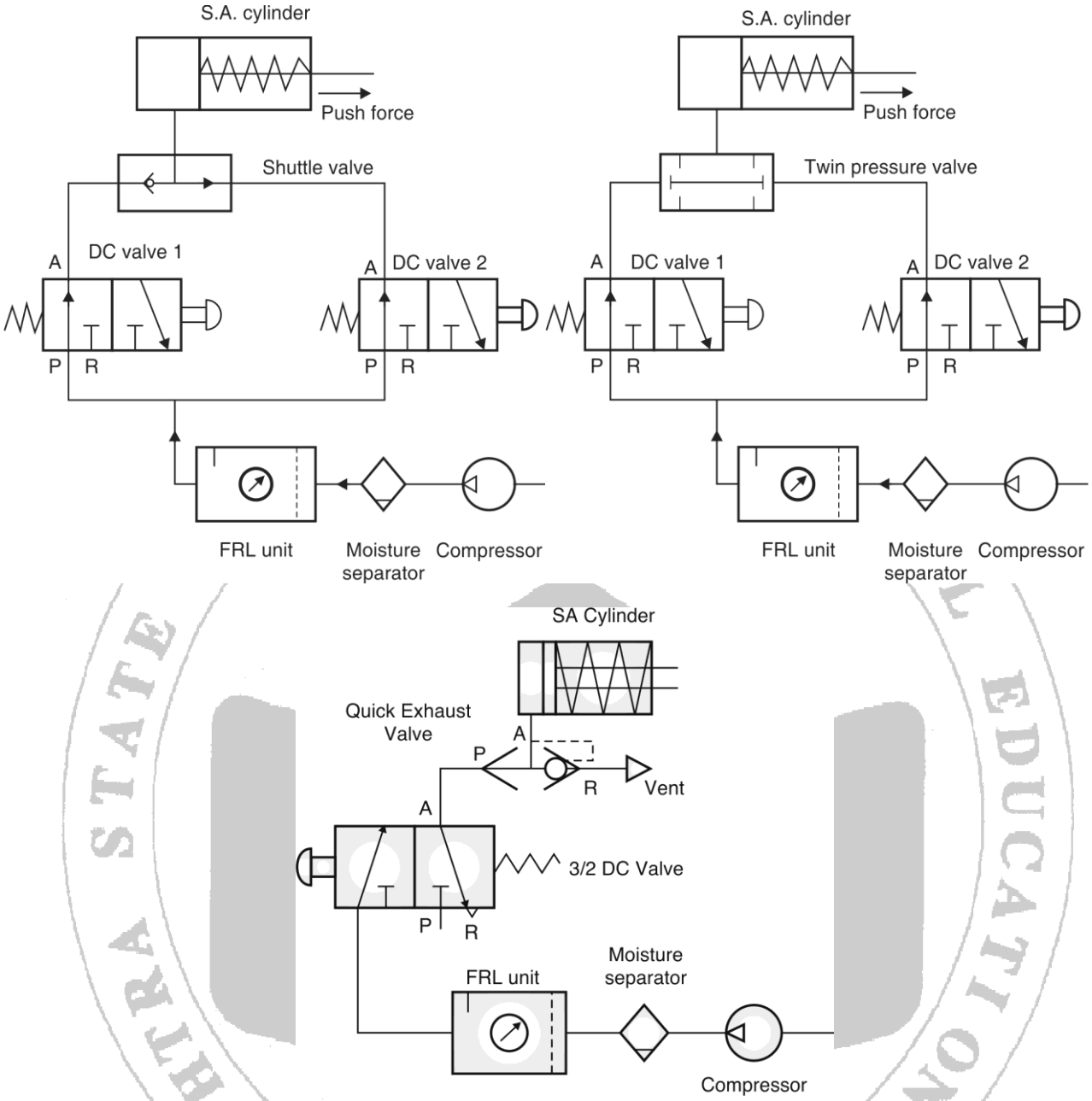


Fig 12.2: OR,AND Logic and Quick Exhaust valve circuit

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Pneumatic trainer with portable compressor	Transparent/ actual working components Compressor: Pressure 0-10 bar	1
2	AND,OR, Quick Exhaust valve	Standard	1

IX. Precautions to be Followed

- Make proper connections of hoses and avoid loose fittings of connectors
- Handle electrical connections carefully

X. Procedure

- Check that an air supply, FRL (filter, regulator, lubricator) unit, and silencer (for the exhaust port)
- Ensure coordination of OR,AND and Quick exhaust valves in circuits to meet logical conditions
- Connect the circuit with safety in mind to manage residual pressure and emergency stops
- Actuate the circuit using the push button or electrical control for the directional valve.
- Observe piston stroke and speed as per type of valve used.

XI. Observations

Type of Valve	Type of DC valve	Positions of DC valve	Remark
OR Gate Valve	3/2 DCV 3/2 DCV	DCV 1 – operated DCV 2 –Not operated	Cylinder operated
		DCV 1 - DCV 2 -	
AND Gate valve	3/2 DCV 3/2 DCV	DCV 1 – operated DCV 2 –Not operated	
		DCV 1 - DCV 2 -	
Quick Exhaust Valve	Location of Quick exhaust valve:	Actuator movement Without Quick exhaust valve :	Actuator movement With Quick exhaust valve:

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the function of a quick exhaust valve in a pneumatic circuit
2. Design a pneumatic circuit where a double-acting cylinder uses a quick exhaust valve to achieve rapid forward motion and adjustable retracting speed.
3. In a circuit with two separate valves used to control a cylinder, state the use of shuttle valve to implement the OR logic function to allow either input to operate the actuator.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=-iwttJ3ahFo
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the Instruments	30%
2	Observation and readings	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.13 Special purpose actuators pneumatic circuits

I. Practical Significance

Pneumatic circuits using double rod end cylinders and telescopic cylinders are valued in industrial automation for their ability to enable specialized motion control and efficient use of space in various applications. Telescopic cylinders offer an extended stroke from a compact, collapsed length, making them ideal for applications with limited installation space but requiring long travel, such as dump trucks, packing machinery, or lifting platforms.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Select special type of cylinders for longer stroke length, uniform velocity for given application
2. Develop circuits for through rod, telescopic cylinders

III Course Level Learning Outcome (CO)

CO 4- Select appropriate special components for advanced fluid operated system.
CO5 - Develop hydraulic and pneumatic circuits for given applications.

IV. Laboratory Learning Outcome(s)

- Prepare pneumatic circuits using double rod end cylinder /telescopic cylinder.
- Demonstrate pneumatic circuits using double rod end cylinder/ telescopic cylinder following the given procedure.

V. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

VI. Minimum Theoretical Background with diagram

A double rod end cylinder has a piston with rods protruding from both ends, allowing controlled movement and force application in both directions. It has same velocity in both the strokes as area is same on both sides.

A telescopic cylinder provides a long stroke in a short retracted length by using nested tubes that extend sequentially. It is suitable for tractor trolley, dumper trolley lifting mechanism.

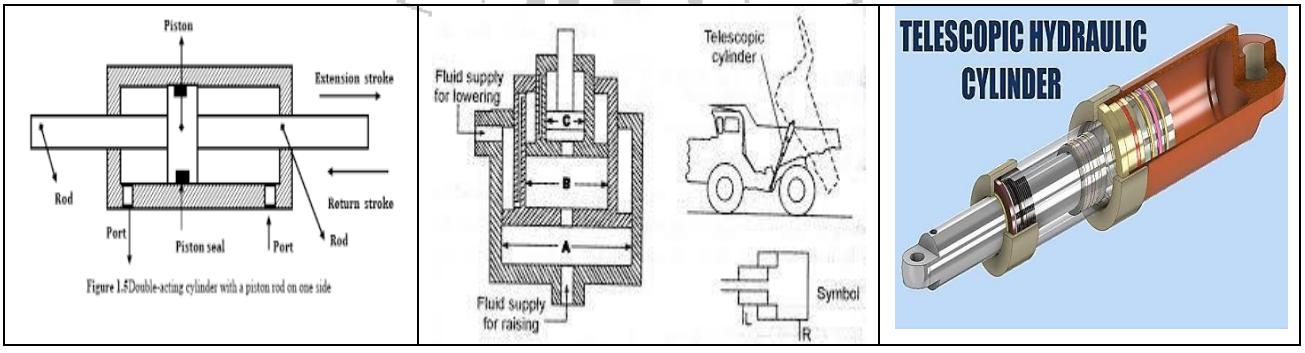


Fig 13.1 Double rod and telescopic cylinder

VII .Experimental setup

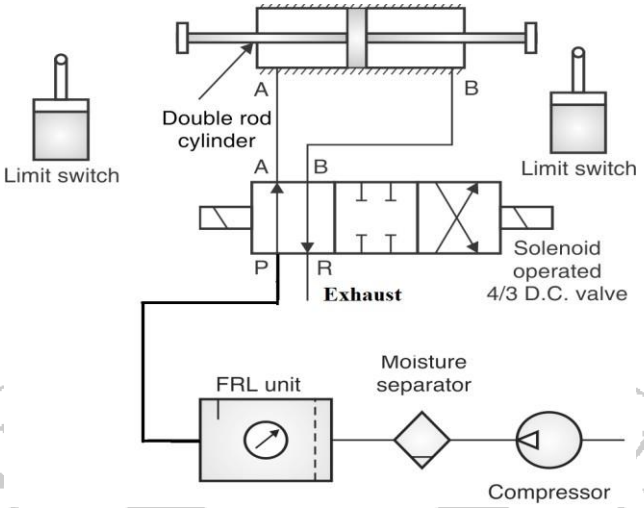


Fig 13.2 Double rod circuit

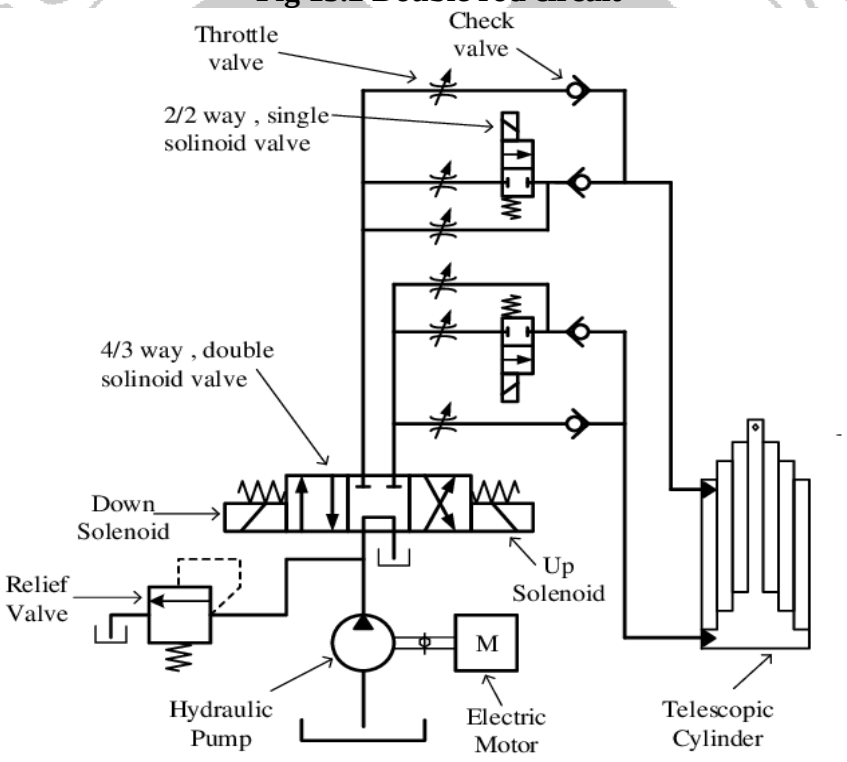


Fig 13.3 Telescopic cylinder circuit

VIII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Advanced Pneumatic trainer with portable compressor	Transparent/ actual working components	1
2	Double rod , telescopic cylinder	Working / actual/Cut section	Each 1

IX. Precautions to be Followed

- Do not forcefully connect to ports/connectors to avoid the damage.
- Perform practical under observation of instructor.
- Avoid improper/loose connections of components.

X. Procedure

1. Check that an air supply, FRL (filter, regulator, lubricator) unit, and silencer (for the exhaust port)
2. Select double acting cylinder and make connections as per circuit.
3. Connect the circuit with safety in mind to manage residual pressure and emergency stops
4. Actuate the circuit using the push button or electrical control for the directional valve.
5. Observe piston stroke movement and speed for both strokes of cylinder
6. Similarly, for telescopic cylinder make connections as per circuit.
7. On site field visit may be suggested if not possible to conduct practical
8. Observe piston stroke movement and measure total movement of cylinder

XI. Observations and calculations

Through rod (Double acting cylinder:

Diameter:
Piston rod Diameter:
Stroke length:

S. No.	Input Pressure (bar)	Time for forward stroke	Time for Return stroke	Remark
1				
2				

Telescopic cylinder (On site field visit may be suggested)

Diameter:
Piston rod Diameter:
Stroke length: Stage 1 Stage 2: Stage 3:
Total stroke length:

S. No.	Input Pressure (bar)	Time for Step 1 stroke	Time for Step 2 stroke	Time for Step 2 stroke
1				
2				

XII. Results

XIII. Interpretation of Results

XIV. Conclusions and Recommendation

XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Write applications of Double rod cylinder.
2. Compare double rod and telescopic cylinder.
3. Select type of cylinder (double rod end or telescopic) is better suited for compact space with larger stroke length for crane operation.

[Space for Answer]

XVI. References / Suggestions for Further Reading

1. https://mech.poriyaan.in/topic/hydraulic-circuit-for-a-milling-machine-31641/
2. https://www.youtube.com/watch?v=kzqkPx8F3D8

XVII. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60**%)
1	Handling of the Instruments	30%
2	Observation and readings	30%
Product Related (10 Marks)		**(40**%)
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.14 Ladder diagram for simple circuits

I. Practical Significance

The practical significance of ladder diagrams for simple circuits makes them essential tools in industrial automation and electrical engineering for designing, documenting, troubleshooting, and maintaining circuits.

Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

- Develop ladder diagrams for simple hydraulic and pneumatic circuits.

II. Course Level Learning Outcome (CO)

CO4 - Select appropriate special components for advanced fluid operated system.

CO5 - Develop hydraulic and pneumatic circuits for given applications.

III. Laboratory Learning Outcome(s)

- Develop ladder diagram for simple circuits.

IV. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices Follow ethical Practices.

V. Minimum Theoretical Background with diagram

- **Structure of Ladder Diagram:** Ladder diagrams visually resemble a ladder, with two vertical rails representing power supply lines and horizontal rungs representing control logic circuits
- **Logic Flow:** The control logic is evaluated from left to right and top to bottom. Inputs are evaluated, conditions checked, and if all conditions in a rung are true, the coil (output) is activated.
- **Logic Functions:** Ladder logic incorporates simple logical functions like AND (series contacts) and OR (parallel contacts) to control output Two vertical rails: L1 (Live) and L2 (Neutral)A rung connecting L1 to L2 through two series contacts (push button and limit switch). The coil represents the output motor energized when both contacts close the circuit.

VI. Experimental setup

AND logic of push buttons

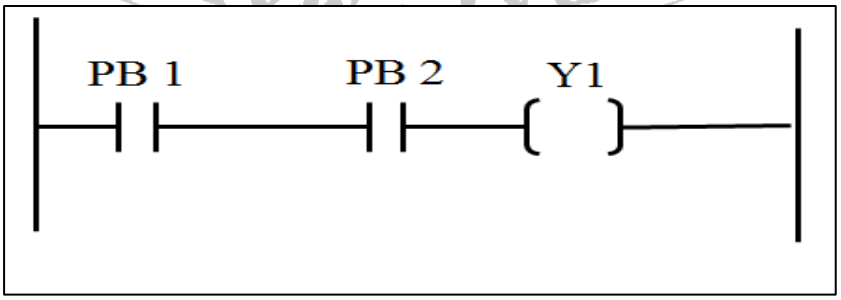


Fig.14.1 AND logic ladder diagram

The AND logic function is achieved by connecting two push buttons in series, as shown in Figure. The configuration ensures that both push button is pressed to actuate the double-acting cylinder. When the one push button is pressed, the relay coil K1 is not energized and K1 contact/switch remains open. This cause the solenoid to remain at initial state.

OR logic of push buttons or switches

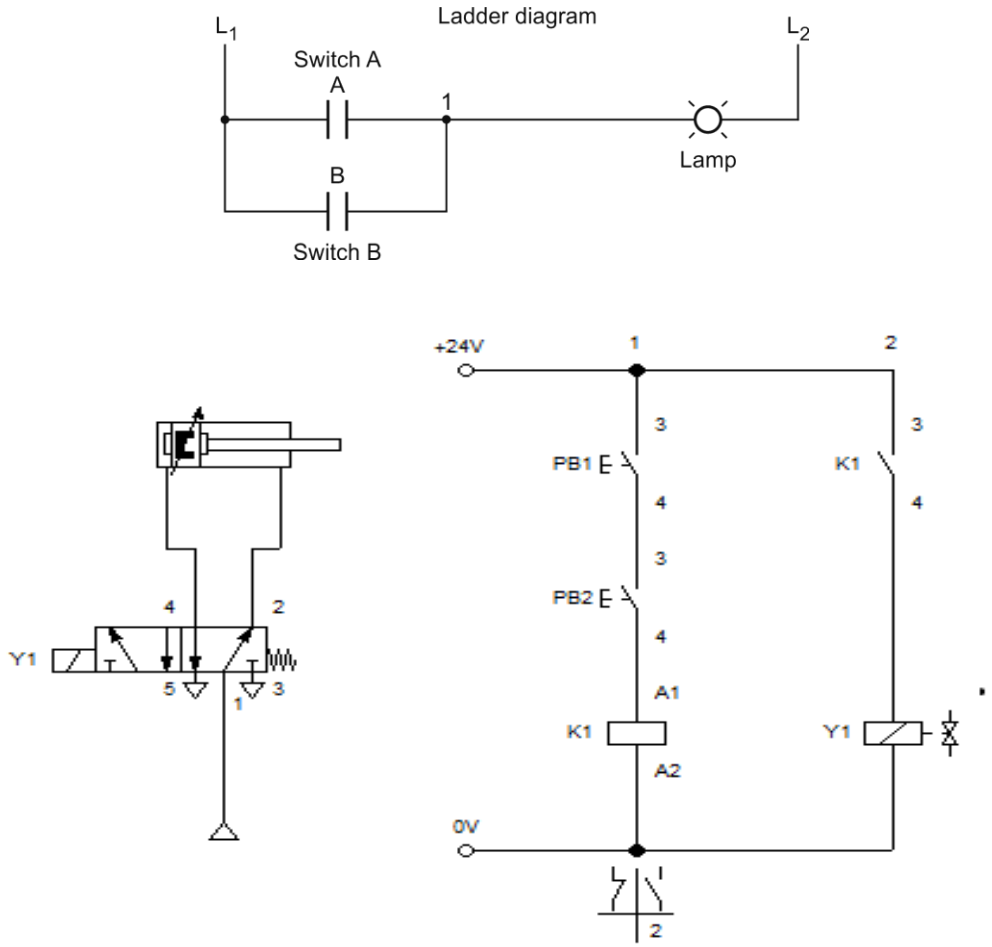


Fig 14.2 PLC based logic gate circuit

VII. Required Resources /Apparatus/Equipment with specification

Sr.No.	Name of Resource	Suggested Broad Specification	Quantity
1	PLC Trainer Or Virtual lab of automation	As per availability	1
2	Student learning software	Freely availability on net	1

VIII. Precautions to be Followed

- Use PLC trainer or software by technically correct procedure.

- Perform practical under observation of instructor.
- Avoid improper/loose connections of components.

IX. Procedure: -

1. **Identify the Control Components**: Define inputs like push buttons or limit switches (e.g., extend button, retract button). Define outputs that control the solenoid valves (e.g., solenoid valve for extension and solenoid valve for retraction)
2. **Understand the Operational Logic**: The cylinder should extend when the extend push button is pressed. The cylinder should retract when the retract push button is pressed. Assume safety or interlock conditions such as the cylinder cannot extend and retract simultaneously.
3. **Draw the Power Rails:** Draw two vertical lines representing live (L1) and neutral (L2) power rails on the left and right sides.
4. **Create the Extension Control Rung:** Place a Normally Open (NO) contact representing the "Extend" push button in series with a coil for the solenoid valve that extends the cylinder. Include any interlocking contact to prevent simultaneous operations (e.g., NC contact of the retract solenoid coil contact in series).
5. **Add Holding Contacts (Seal-in Circuit):**For each solenoid output coil, add a parallel NO holding contact in the rung to maintain the solenoid energized even after the push button is released.
6. **Incorporate Limit Switches (Optional):**Use limit switches to detect cylinder end positions for automatic control. Include their contacts as inputs in the ladder logic for advanced control sequences like auto stop or transition.

X. Observations and calculations

Sr. No	Observation Description	Input/Output/Component	Status (ON/OFF)	Function/Result
1	Press Extend Push Button	Input (PB1)	ON	
2	Retract Push Button Not Pressed	Input (PB2)	OFF	
3	Cylinder Extension Solenoid Energized	Output (Y1 Coil)	ON	

Sr. No	Observation Description	Input/Output/Component	Status (ON/OFF)	Function/Result
4	Cylinder Fully Extended (Limit Switch Activated)	Input (S2)	ON	
5	Retract Solenoid Coil Energized (After S2)	Output (Y2 Coil)	ON	
6	Both Extend and Retract buttons released	Input (PB1, PB2)	OFF, OFF	

XI. Results

XII. Interpretation of Results

XIII. Conclusions and Recommendation

XIV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Explain the working of a ladder diagram that controls the reciprocation of a double-acting cylinder.
2. In a ladder diagram, state the application of solenoid valves for pneumatic cylinders extension and retraction
3. Describe a practical application of a pneumatic ladder diagram in manufacturing automation.

[Space for Answer]

XV. References / Suggestions for Further Reading

1. PLC sequence control: https://youtu.be/CW8AvotzN68
2. Logic elements: https://youtu.be/ng2FkYqitT8

XVI. Rubrics for Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**(60**%)
1	Handling of the Instruments	30%
2	Observation and readings	30%
Product Related (10 Marks)		**(40**%)
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.15 *Simple maintenance of hydraulics/pneumatics

I. Practical Significance

Maintenance is the activity to upkeep hydraulic/pneumatic system protects it from failure and it will increase reliability, availability of the hydraulic system. Routine checks and maintenance prevent expensive breakdowns and the need for major repairs or equipment replacement, effectively cutting long-term costs.

II. Industry/Employer Expected Outcome (s)

This practical is expected to develop the following skills for the industry/Employer

1. Demonstrate knowledge of maintenance of hydraulic/pneumatic system components.
2. Maintain simple parts of hydraulic/pneumatic system components.

I. Course Level Learning Outcome (CO)

CO-5 Develop hydraulic and pneumatic circuits for given applications.

II. Laboratory Learning Outcome(s)

1. Diagnose the common faults in hydraulics/pneumatics systems
2. List the corrective measures for identified faults in hydraulics/pneumatics systems.

III. Relative Affective Domain Related Outcome(s)-

- Follow safety practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- Follow ethical Practices

IV. Minimum Theoretical Background with diagram

Principles of preventive maintenance: Regular inspection of tubing and hoses for wear or damage, checking and replacing hydraulic fluid or lubricants, cleaning/replacing filters, checking for leaks, and monitoring component performance metrics like pressure and cycle time .

Instructions to handle the Components

- Handling valves and actuators in a pneumatic circuit involves careful operation and regular maintenance to ensure reliability and safety.
- Operating valves smoothly without forcing to prevent damage, using manual overrides where applicable for start-up or fine-tuning.
- Ensuring the pneumatic system is depressurized before performing any maintenance or adjustments on valves or actuators to avoid accidents.
- Regular inspection for leaks, corrosion, wears on seals, and proper actuator function. Replace worn seals or damaged parts promptly to maintain sealing and performance.
- Lubricating valve stems and moving parts to reduce friction and wear, following manufacturer recommendations.
- Cleaning valves to remove dust, dirt, or debris that might obstruct air flow or valve movement.

Fig.15.1 Common faults observed in oil hydraulics

V. Common faults and remedies for Oil hydraulic system

Hydraulic Component	Common Faults	Remedy/Maintenance Required
Hydraulic Pump	Contamination, cavitation, overheating	Use clean fluid; prevent air entry; control temperature; proper installation and alignment
Hydraulic Hoses	Abrasion, improper routing, incorrect pressure rating	Inspect regularly; route correctly; use correct hose rating
Seals	Wear, contamination, heat, rod damage	Inspect/replace seals; maintain clean fluid; protect rods
Valves	Blocked by contaminants, improper adjustment, corrosion	Clean fluid; adjust valves; protect from moisture/corrosion
Hydraulic Cylinder	Seal leakage, overheating, misalignment	Replace seals; proper alignment; maintain cooling system
Fluid Quality	Thinning, thickening, oxidation, water contamination	Use correct fluid; replace fluid/filters as scheduled; monitor condition
System (General)	Noisy operation, jerky movement, pressure issues	Inspect for air/leaks; clean/replace filters; check settings and alignment

VI. Common faults and remedies for Pneumatic components

Pneumatic Component	Common Faults	Remedy/Maintenance Required
Air Filter	Clogging, pressure drop	Regular cleaning or replacement every 4-6 months; daily drain of water separator if present

Pneumatic Component	Common Faults	Remedy/Maintenance Required
Pressure Regulator	Inaccurate pressure, leaks	Inspect and adjust pressure settings; check seals for leaks; replace worn parts
Lubricator	Dry operation, insufficient lubrication	Regularly check oil level and refill; clean to avoid clogging
Pneumatic Hoses & Tubing	Cracks, leaks, blockage	Routine inspection for damage; replace damaged hoses, tighten fittings
Pneumatic Valves	Leakage, sluggish operation, stuck valves	Clean valve components; lubricate moving parts; replace seals; test operation regularly
Pneumatic Cylinders/Actuators	Leakage, sticking piston, slow movement	Inspect seals and rods; lubricate moving surfaces; clean to prevent contamination; replace worn seals
FRL Unit (Filter-Regulator-Lubricator)	Filter saturation, regulator failure	Replace filter elements regularly; inspect and maintain all sub-components; drain trapped water daily

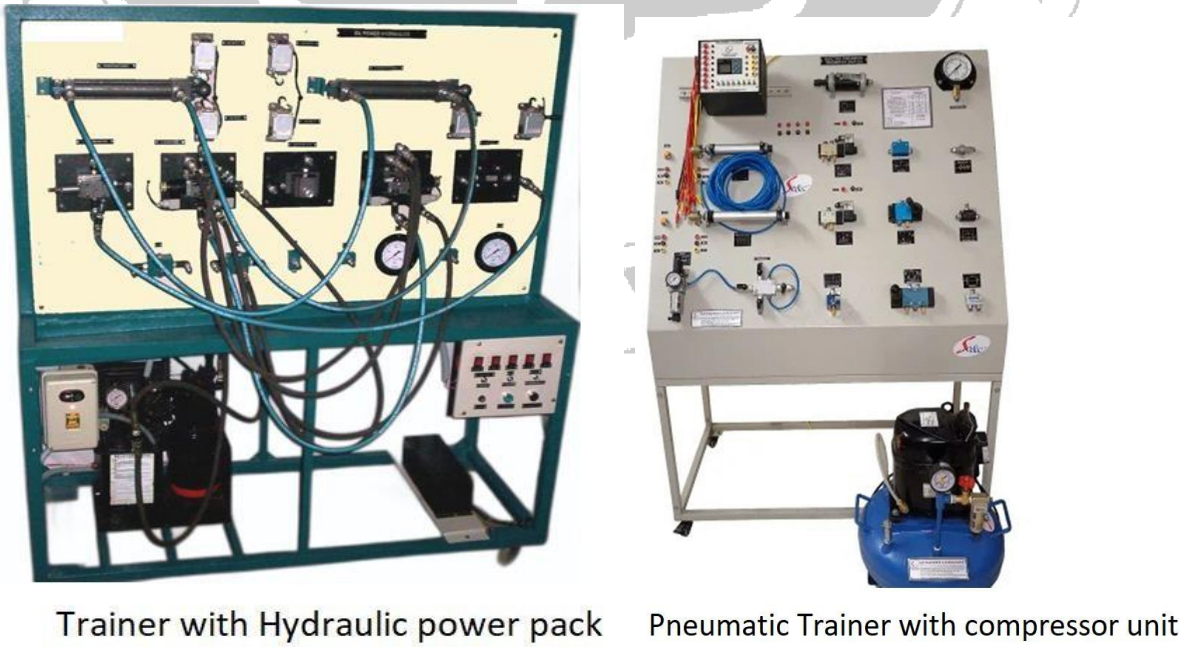


Fig.15.2 Oil Hydraulic and Pneumatic Trainer

Fig.15.3 Tool kit for maintenance

VII. Required Resources /Apparatus/Equipment with specification

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Oil Hydraulic trainer with various components	Transparent /actual working components	1
2	Pneumatic trainer with portable compressor	Transparent/ actual working components Compressor: Pressure 0-10 bar	1
3	Tool kit	Standard	1

VIII. Precautions to be Followed

- Do not forcefully connect to ports/connectors to avoid the damage.
- Perform practical under observation of instructor.
- Avoid improper/loose connections of components.

IX. Procedure

1 Go through the instruction and operating manual supplied by the manufacturers and also follow the instructions given by teacher.
2 Go through the safety precautions, guidelines given for maintenance in lab manual.
3 Run the system for at least 10 min. and observe working of various components and fill up the information in the inspection format for each component.
4 Go through the fault, cause and remedial actions table from book. Search out remedial action for observed fault.
5 By following instructions, safety takes the appropriate remedial actions using tool kit under the teacher's guidance.
6 Maintain a log of all maintenance activities, repairs, and replacements to track system condition and schedule future maintenance.

X. Observations and calculations

Observation for Oil hydraulic system:
(Hydraulic trainer / Hydraulic system at nearby service station

Hydraulic Component	Observation	Remark
Reservoir	1. Tank with adequate level of hydraulic oil **2.** No leakage observed	**OK**

Observation for Pneumatic system:
(Pneumatic trainer / Pneumatic system at nearby service station like hand tools/pneumatic jack)

Pneumatic Parts Name	Observation	Remark
Compressor	Belt drive – belt is in ok condition Pressure gauge: operates properly and shows proper readings of air pressure	Satisfactory , regular inspection required
Air Filter		

Pneumatic Parts Name	Observation	Remark
Pressure Regulator		
Pneumatic Cylinder (Actuator)		
Directional Control Valve		
Lubricator		
Quick Exhaust Valve		
Flow Control Valve		

XI. Results

XII. Interpretation of Results

XIII. Conclusions and Recommendation

XIV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List maintenance tasks required for pneumatic valves.
2. Explain the necessity of regular lubrication is essential for hydraulic cylinder performance.
3. State the process to troubleshoot and fix a leak in a pneumatic hose.
4. Cylinder is not operating with required speed in oil hydraulic system, state the faults and remedies to solve this fault.
5. The pressure relief valve is diverting oil flow without pressure control of oil, state the fault in pressure relief valve.

[Space for Answer]

XV. References / Suggestions for Further Reading

1. https://www.youtube.com/watch?v=W82T7ez1mMk&t=13s
2. https://www.youtube.com/watch?v=tm5cfjcf9YA&t=223s

XVI. Rubrics for Assessment Scheme

	Performance Indicators	Weightage
	Process Related (15 Marks)	**(60%)**
1	Handling of the Instruments/tool kit	30%
2	Observation and readings	30%
	Product Related (10 Marks)	**(40%)**
3	Interpretation of result	10%
4	Conclusions	10%
5	Practical related questions	20%
	Total	100 %

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	