DEPARTMENT OF MECHANICAL ENGINEERING

B.e / B.tech –INDUSTRIAL AUTOMATION LABORATORY MANUAL

(Regulation 2017)

Prepared by

M.SARAVANAN

FACULTY OF MECHANICAL ENGINEERING, AVIT

DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

NAME OF THE LAB   :   INDUSTRIAL AUTOMATION LAB

MANUAL REFERENCE NO :   W.I.

PREPARED BY   :

                                    M.SARAVANAN
                          AUTOMATION LAB INCHARGE

APPROVED BY :

                                 PROF.L.PRABHU,
                          HEAD OF THE DEPARTMENT

SYLLABUS

17MECC91	INDUSTRIALAU TOMATIONLAB	Category	L	T	P	Credit
		CC	0	0	4	2

Preamble
Totrainthestudentsinhydraulicandpneumaticcircuitdesignusingdifferentcontroldevices

PrerequisiteNIL

CourseObjective

1	Design HydraulicandPneumaticcircuitsforlowcostautomation
2	Tounderstandtheworkingoflogicalcircuits
3	Tounderstandtheoperationofbasicelectropneumaticcircuits
4	TodesignopenloopandclosedloopcontrolcircuitofACservomotor
5	ApplicationofPLCtodesignasystem.

CourseOutcomes:On thesuccessfulcompletion of thecourse,studentswillbeableto

CO1.	Understandprinciples,strategiesandadvantagesofindustrial automation	Understand
CO2.	Designmaterialhandlingandmaterialstoragesystemsforanautomatedfactory	Analyze
CO3.	Deviseautomatedshopfloorcontrolsandpartidentificationmethods	Understand
CO4.	Outlinethe IoTTechnologies usedinamanufacturingplant andtheir rolein Industry	Understand
CO5.	Understandthebasicsofvehiclecollisionanditseffects.	Understand

MappingwithProgrammeOutcomesandProgrammeSpecificOutcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	S	S	M	L		M							L		
CO2	S	S	S	S	M	S				S			L		
CO3	S	M	L			L							L		
CO4	S	M	L		L	L							L		
CO5	S	S	M	L		M						L	L		

S-Strong;M-Medium; L-Low

LISTOFEXPERIMENTS:

1. TodesignaSpeedcontrolcircuitsfordoubleactingcylinder.

2. Todesign aSynchronizationcircuitfortwocylinders.

3. Todesign aContinuousreciprocationofdoubleactingcylinder.

4. TodesignaSequencingoftwocylindercircuits.

5. Todesign aCascadingcircuitfortrappedsignals-2groups

6. ImplementationofLogicCircuits:AND,OR

7. DesignofBasicElectroPneumaticCircuits:Continuousreciprocationofcylinder(withtimer and counter)

8. Design andtestingof Force,VelocitycalculationsinHydraulic Linearactuation

9. AutomaticbottlefillingMachine

10. DesignandsimulationofPLCControlPneumatic/Hydrauliclinearactuatorcircuits.

11. TodesignaWater LevelControllerusingPLC.

12. Todesign aPLCControlledMaterialHandlingSystem.

TextBooks				
1	**INDUSTRIALAUTOMATIONLABManual**			

CourseDesigners

S.No	FacultyName	Designation	Department/Na meoftheCollege	Emailid
1	M.SARAVANAN	ASST.PROF	MECH./AVIT	saravanan@avit.ac.in

INDEX

INTRODUCTION OF AUTOMATION SYSTEM AND SYMBOLS

AIM:

To study about the important features ,about Automation system and symbols

Introduction to Automation system:

Introduction ELECTRICAL power is one of the most important infrastructure inputs necessary for the rapid economic development of a country. The ever-rising demand of electrical energy has led to the installation and incorporation of a large number of electrical power generation units, with increased capacities in a common power grid, making the operation of the entire system sensitive to the prevailing conditions. Therefore, the extensive and complex power systems have become unmanageable using the conventional instrumentation and control schemes. Intelligent systems based on microprocessors and computers have been employed for online monitoring and control of modern large-scale power systems, in generation, transmission and distribution, thereby overcoming the complexities and drawbacks of the conventional instrumentation schemes.

The term "Automation"

Automation is the use of scientific and technological principles in the manufacture of machines that take over work normally done by humans. This definition has been disputed by professional scientists and engineers, but in any case, the term is derived from the longer term "automatization" or from the phrase "automatic operation". Delmar S. Harder, a plant manager for General Motors, is credited with first having used the term in 1935.

History of Automation Ideas for ways of automating tasks have been in existence since the time of the ancient Greeks. The Greek inventor Hero (fl. about A.D. 50), for example, is credited with having developed an automated system that would open a temple door when a priest lit a fire on the temple altar. The real impetus for the development of automation came, however, during the Industrial Revolution of the early eighteenth century. Many of the steam-powered devices built by James Watt, Richard Trevithick, Richard Arkwright, Thomas Savery, Thomas Newcomen, and their contemporaries were simple examples of machines capable of taking over the work of humans.

One of the most elaborate examples of automated machinery developed during this period was the draw loom designed by the French inventor Basile Bouchon in 1725. The instructions for the operation of the Bouchon loom were recorded on sheets of paper in the form of holes. The needles that carried thread through the loom to make cloth were guided by the presence or absence of those holes. The manual process of weaving a pattern into a piece of cloth through the work of an individual was transformed by the Bouchon process into an operation that could be performed mindlessly by merely stepping on a pedal. Automation Applications Manufacturing companies in virtually every industry are

achieving rapid increases in productivity by taking advantage of automation technologies. When one thinks of automation in manufacturing, robots usually come to mind.

The automotive industry was the early adopter of robotics, using these automated machines for material handling, processing operations, and assembly and inspection. Donald A. Vincent, executive vice president, Robotic Industries Association, predicts a greater use of robots for assembly, paint systems, final trim, and parts transfer will be seen in the near future. One can break down automation in production into basically three categories: fixed automation, programmable automation, and flexible automation. The automotive industry primarily uses fixed automation. Also known as "hard automation," this refers to an automated production facility in which the sequence of processing operations is fixed by the equipment layout. A good example of this would be an automated production line where a series of workstations are connected by a transfer system to move parts between the stations. What starts as a piece of sheet metal in the beginning of the process, becomes a car at the end.

Programmable automation is a form of automation for producing products in batches. The products are made in batch quantities ranging from several dozen to several thousand units at a time. For each new batch, the production equipment must be reprogrammed and changed over to accommodate the new product style. Flexible automation is an extension of programmable automation. Here, the variety of products is sufficiently limited so that the changeover of the equipment can be done very quickly and automatically.

The reprogramming of the equipment in flexible automation is done off-line; that is, the programming is accomplished at a computer terminal without using the production equipment itself. Computer numerical control (CNC) is a form of programmable automation in which a machine is controlled by numbers (and other symbols) that have been coded into a computer. The program is actuated from the computer's memory.

The machine tool industry was the first to use numerical control to control the position of a cutting tool relative to the work part being machined. The CNC part program represents the set of machining instructions for the particular part, while the coded numbers in the sequenced program specifies x-y-z coordinates in a Cartesian axis system, defining the various positions of the cutting tool in relation to the work part.

Automation tools:

- ANN – Artificial neural network

- DCS – Distributed Control System
- HMI – Human Machine Interface
- SCADA – Supervisory Control and Data Acquisition
- PLC – Programmable Logic Controller
- Instrumentation
- Motion control
- Robotics

Advantages and Disadvantages:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.
- Increased consistency of output.
- Reduced direct human labor costs and expenses.
- Installation in operations reduces cycle time.
- Can complete tasks where a high degree of accuracy is required.
- Replaces human operators in tasks that involve hard physical or monotonous work (e.g., using one forklift with a single driver instead of a team of multiple workers to lift a heavy object)[43]
- Reduces some occupational injuries (e.g., fewer strained backs from lifting heavy objects)
- Replaces humans in tasks done in dangerous environments (i.e. fire, space, volcanoes, nuclear facilities, underwater, etc.)
- Performs tasks that are beyond human capabilities of size, weight, speed, endurance, etc.
- Reduces operation time and work handling time significantly.
- Frees up workers to take on other roles.
- Provides higher level jobs in the development, deployment, maintenance and running of the automated processes.

The main disadvantages of automation are:

- Possible security threats/vulnerability due to increased relative susceptibility for committing errors.
- Unpredictable or excessive development costs.
- High initial cost.
- Displaces workers due to job replacement.
- Leads to further environmental damage and could compound climate change.

Hydraulic System
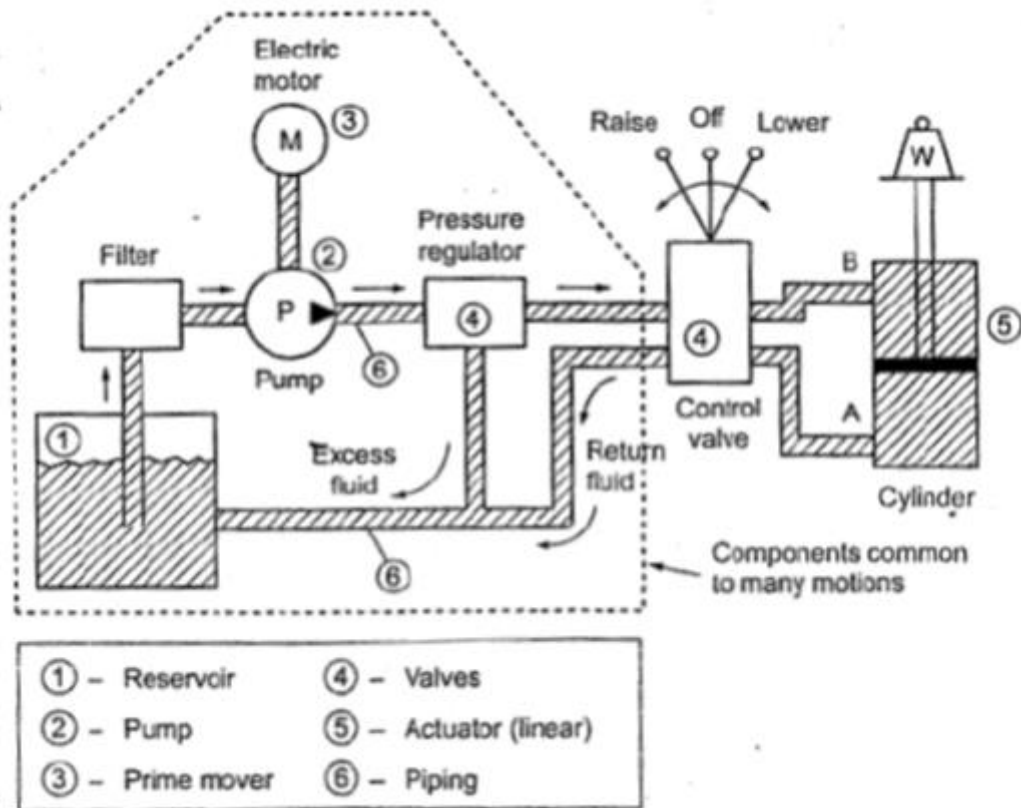
Schematic Layout of Hydraulic System

BASIC COMPONENTS OF A HYDRAULIC SYSTEM:

Reservoir (or air tank):
A reservoir is an oil supply tank. It is provided to hold the hydraulic liquid (usually oil).

Pump:
The pump is used to force the liquid into the system.

Prime mover:
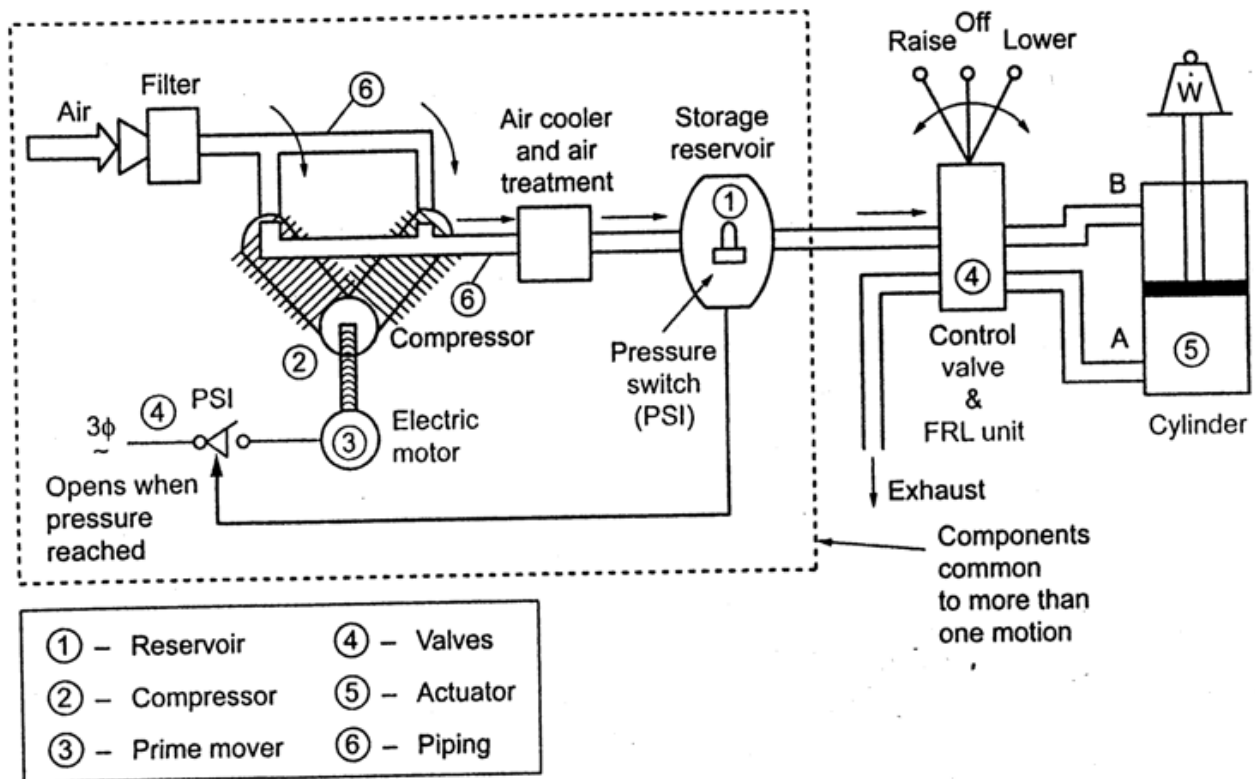A Prime mover, usually an electric motor, is used to drive the pump.

Valves:
Valves are refitted in the system to control liquid direction, pressure, and flow rate.

Actuator:
An actuator is provided to convert the liquid energy into mechanical force or torque to do useful work. The actuator is the actual working element of the system. The actuators can be either cylinders (to provide linear motion) or hydro motors (to provide rotary motion).

Fluid-transfer piping:
The hydraulic Piping is provided to carry the compressed liquid from one place to another.

Schematic Layout of Pneumatic System

Compressor:
The compressor is used to compress the atmospheric air so as to increase the pressure of the air.

Prime mover:
A Prime mover, usually an electric motor, is used to drive the compressor.

Valves:
Valves are refitted in the system to control air direction, pressure, and flow rate.

Actuator:
An actuator is provided to convert the air energy into mechanical force or torque to do useful work.

Fluid-transfer piping:
Piping is provided to carry the compressed air from one place to another.

BASIC COMPONENTS OF A PNEUMATIC SYSTEM:

Reservoir (or air tank):
An air tank is provided to store the compressed air required for the operations.

Compressor:
The compressor is used to compress the atmospheric air so as to increase the pressure of the air.

Prime mover:
A Prime mover, usually an electric motor, is used to drive the compressor.

Valves:
Valves are refitted in the system to control air direction, pressure, and flow rate.
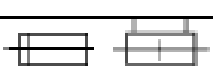
Actuator:
An actuator is provided to convert the air energy into mechanical force or torque to do useful work.
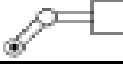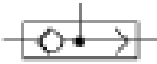
Fluid-transfer piping:
Piping is provided to carry the compressed air from one place to another.

BASIC SYMBOLS USED IN HYDRAULIS AND PNEUMATIC SYSTEM:
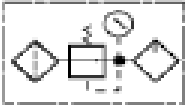
Symbols	Description
LINES	
————————	-continuous line - flow line
— — — — — —	-dashed line - pilot, drain
——— · ——— · ———	-envelope - long and short dashes around two or more component symbols
CIRCULAR	
◯	-large circle - pump, motor
◯	-small circle - Measuring devices
D	-semi-circle - rotary actuator
SQUARE	
□	-one square - pressure control function -two or three adjacent squares - directional control
DIAMOND	
◇	-diamond - Fluid conditioner (filter, separator, lubricator, heat exchanger)
MISCELLANEOUS SYMBOLS	
W	-Spring
⋈	-Flow Restriction
TRIANGLE	
▼	-solid - Direction of Hydraulic Fluid Flow
▽	-open - Direction of Pneumatic flow
PUMPS AND COMPRESSORS	
Fixed Displacement Hydraulic Pump	
⊕	-unidirectional
⊕	-bidirectional
Variable Displacement Hydraulic Pump	
⊘	-unidirectional
Compressor	
⊕	-Compressor

Symbols	Description
MOTORS	
Fixed Displacement Hydraulic Motor	
(symbol)	-unidirectional
(symbol)	-bidirectional
Variable Displacement Hydraulic Motor	
(symbol)	-unidirectional
(symbol)	-bidirectional
Pneumatic Motor	
(symbol)	-unidirectional
(symbol)	-bidirectional
Rotary Actuator	
(symbol)	- hydraulic
(symbol)	- pneumatic
CYLINDERS	
Single Acting Cylinder	
(symbol)	-returned by external force
(symbol)	-returned by spring or extended by spring force
Double Acting Cylinders	
(symbol)	-single piston rod (fluid required to extend and retract)
(symbol)	-double ended piston rod
Cylinders With Cushions	
(symbol)	- single fixed cushion
(symbol)	- double fixed cushion
(symbol)	- single adjustable cushion
(symbol)	- double adjustable cushion

Symbols	Description
DIRECTIONAL CONTROL VALVES	
Directional Control Valve (2 Ports / 2 Positions)	
	-Normally closed directional control valve with 2 ports and 2 finite positions.
	-Normally open directional control valve with 2 ports and 2 finite positions.
Directional Control Valve (3 Ports / 2 Positions)	
	-Normally closed directional control valve with 3 ports and 2 finite positions.
	-Normally open directional control valve with 3 ports and 2 finite positions.
Directional Control Valve (4 Ports / 2 Positions)	
	-directional control valve with 4 ports and 2 finite positions
Directional Control Valve (4 Ports / 3 Positions)	
	-directional control valve with 4 ports and 3 finite positions *-(center position can have various flow paths)
Directional Control Valve (5 Ports / 2 Positions) Normally A Pneumatic Valve	
	-directional control valve with 5 ports and 2 finite positions
Directional Control Valve (5 Ports / 3 Positions) Normally A Pneumatic Valve	
	-directional control valve with 5 ports and 3 finite positions
CONTROL METHODS	
Manual Control	
	-general symbol (without showing the control type)
	-pushbutton
	-lever
	-foot pedal
Mechanical Control	
	-plunger or tracer
	-spring

Symbols	Description
	-roller
	-roller(one direction only)
Electrical Control	
	-Solenoid (the one winding)
Pilot Operation	
	-pneumatic
	-hydraulic
Pilot Operated Two-Stage Valve	
	-Pneumatic: Sol first stage
	-Pneumatic: Air pilot second stage
	-Hydraulic: Sol first stage
	-Hydraulic: Hyd pilot second stage
CHECK VALVES, SHUTTLE VALVES, RAPID EXHAUST VALVES	
	-check valve -free flow one direction, blocked flow in other direction
	-pilot operated check valve, pilot to close
	-pilot operated check valve, pilot to open
Shuttle Valve	
	-to isolate one part of a system from an alternate part of circuit
Rapid Exhaust Valve/Pneumatic	
	-installed close to an actuator for rapid movement of the actuator
PRESSURE CONTROL VALVES	
Pressure Relief Valve(Safety Valve) Normally Closed	
	- Line pressure is limited to the setting of the valve, secondary part is directed to tank

Symbols	Description
Proportional Pressure Relief	
	- line pressure is limited to and proportional to an electronic signal
Sequence Valve	
	- When the line pressure reaches the setting of the valve, valve opens permitting flow to the secondary port. The pilot must be externally drained to tank.
Pressure Reducing Valve	
	- pressure downstream of valve is limited to the setting of the valve
FLOW CONTROL VALVES	
Throttle valve	
	-adjustable output flow
Flow Control Valve	
	-with fixed output (variations in inlet pressure do not affect rate of flow)
	-with fixed output and relief port to reservoir with relief for excess flow (variations in inlet pressure do not affect rate of flow)
	-with variable output
	-fixed orifice
	-metered flow toward right free flow to left
	-pressure compensated flow control fixed output flow regardless of load
	-pressure and temperature compensated
	-with variable output and relief port to reservoir
Flow Dividing Valve	
	-flow is divided equally to two outputs
SHUT-OFF VALVE	
	-Simplified symbol

Symbols	Description
FILTERS, WATER TRAPS, LUBRICATORS AND MISCELLANEOUS APPARATUS	
Filter or Strainer	
	-filter
Water Trap	
	-with manual drain
	-with automatic drained
Filter With Water Trap	
	-with manual drain
	-automatic drain
Air Dryer	
	- refrigerant, or chemical removal of water from compressed air line
Lubricator	
	-oil vapor is indected into air line
Conditioning unit	
	-compound symbol of filter, regulator, lubricator unit
	-Simplified Symbol

RESULT:

Thus the important feature Automation system was studied.

EX.NO:2   **DATE:**

INTRODUCTION OF PROGRAMMABLE LOGIC CONTROLLER(PLC)

The programmable logic controller (PLC) is a solid state electronic device designed to replace electromechanical relays, timers, counters and sequences, by using a programmable memory for the internal storage of user oriented instructions for implementing specific functions such as logic sequencing timing, country and arithmetic control through digital or analog inputs and outputs, various types of machines or processes.

Major advantages of using PLC are as follows:

1. The PLC is a hardened industrial computer designed to withstand the harsh factoryenvironment.
2. PLCsarereusabletheycontainachangeableprogramthateliminatorsextensiveand component changes and that makes them cost effective
3. PLCs offer easytroubleshooting
4. PLCs feature easy installation and smallsize.
5. Increaseproductivity.
6. Ease ofprogramming.
7. Ability to communicate withcomputer.
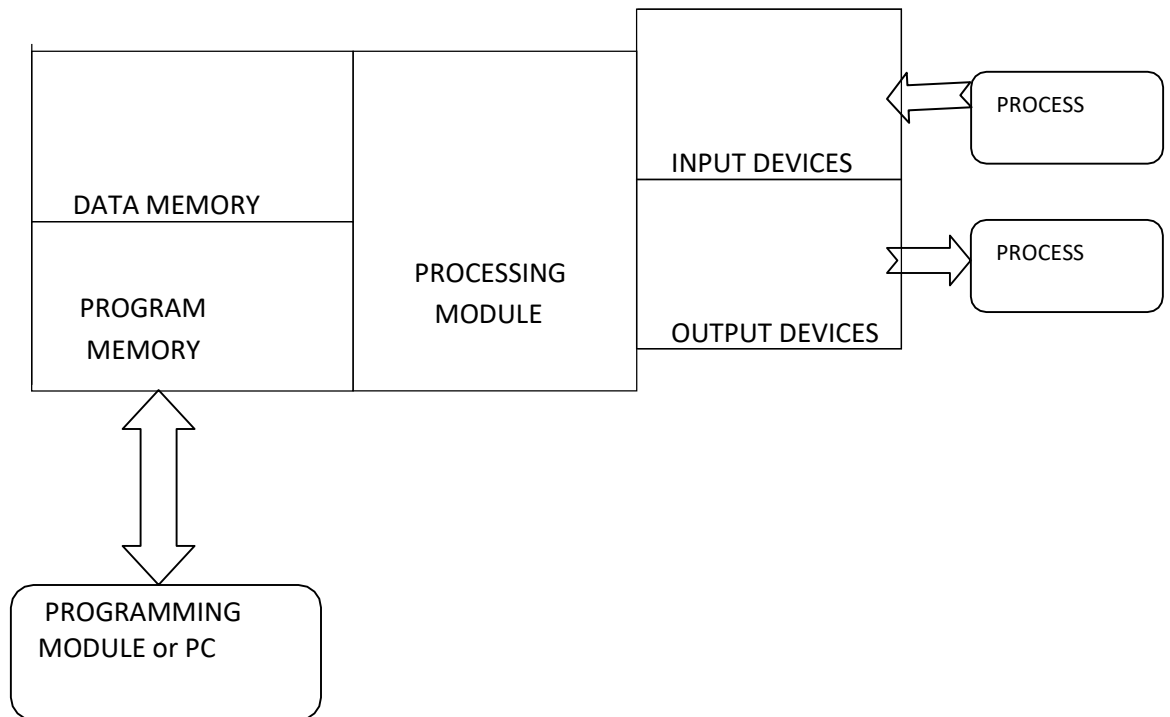
Fig.1.1 ARCHITECHTURE OF PLC
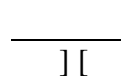
Some of the used Instructions Bit
<u>Instructions</u>
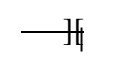
The following instructions are used with fixed, SLC 5/01, SLC 5/02, SLC 5/03, and SLC 5/04 processors.

If you want to:	Use this Instruction:
Examine a bit for an On conditions	XIC
Examine a bit for an Off conditions	XIO
Turn a bit On or Off	OTE
Turn a bit On	OLT
Turn a bit Off	OUT
Trigger a one time event	OSR

Examine if Closed (XIC)

] [Use the XIC instruction in your ladder to determine if a bit is on. Whenthe instruction is executed, if the bit addressed is on (1), then the instruction is evaluated as true. When the instruction is executed, if the bit addressed off (0), then the instruction is evaluated asfalse.

Examine if Open (XIO)

]/[Use an XIO instruction in your ladder program to determine if a bit is off. When theinstructionisexecuted,ifthebitaddressedisoff(0),thentheinstructionis evaluated as true. When the instruction is evaluated as false.

Output Energize

( )   Use an OTE instruction in your ladder program to turn on a bit when rung conditions are evaluated astrue.

Output Latch (OTL)

(L)   The OTL instruction is a retentive output instruction that can only turn on a bit. It cannot turn off a bit. This instruction is traditionally used in pairs with an Output Unlatch (OUT) instruction, with both instructions addressing the same bit. You can also use this to initialize data values at the bitlevel.

Output Unlatch (OTU)

(U)   The OTU instruction is a retentive output instruction that can only turn off a bit.If cannotturnonabit.ThisinstructionistraditionallyusedinpairswithanOutput Latch (OTL) instruction, with both instructions addressing the same bit. You can use this to initialize data values at the bit level.

One Short Rising (OSR)

] OSR [The OSR instruction is a retentive input instruction that triggers an event to occur one time. Use the OSR instruction when an event must start based on the change of state of the rung from false to true, not on the resulting status. Applications include starting events triggered by a pushbutton switch. An example is freezing rapidly displayed LEDvalues.

Timer and Counter Instructions

Timers and counters are output instructions. Use the following instructions with fixed, SLC 5/01, SLC 5/02, SLC 5/02, SLC 5/03, and SLC 5/04 processors.

If you want to:	Use this instruction:
Count time base intervals when the instruction is true	TON
Count time base intervals when the Instruction is false	TOF
Count time base intervals when the instruction is true and retain the accumulated value when the instruction goes false	RTO
Increment the count at each false–to–true transition.	CTU
Decrement the count at each false-to-true transition	CTD
Count high-speed pulses from a fixed Controller High-speed input	HSE
Reset the accumulated value and status bits of a timer or counter. Do not use with TOF timers.	RES

Timer On-Delay(TON)

TON	
Timer	T4: 0
Timer Base	0.01

Use the TON instruction to turn an output on or off after the timer has been on for a preset time interval. The TON instruction begins to count time base intervals when rung conditions become true. As long as rung conditions remain true, the timer adjusts its accumulated value (ACC) each evaluation until it reaches thepreset value (PRE). The accumulated value is reset when rung conditions go false, regardless of whether the timer has timedout.

Timer Off-Delay(TOF)

TOF
TIMER OFF DELAY
Timer   T4:1
Time base   0.01

Use the TOF instruction to turn an output on or off after is rung has been off for a preset time interval. The TOF instruction begins to count time base intervals when the rung makes a true-to-false transition. As long as rung conditions remain false, the timer increments its accumulated value (ACC) each scan until it reachesthe preset value (PRE). The accumulated value is reset when rung conditions go true the timer has timed out.

Retentive Timer (RTO)

RTO
RETENTIVE TIMER ON
Timer   T4: 2
Time base   0.01

Use the RTO instruction to turn an output on or off after its timer has been on for a preset time interval. The RTO instruction is a retentive instruction that begins to count time base intervals when rung conditions become true. As long as rung conditions remain true, the timer increments its accumulated value (ACC) until it reaches the preset value (PRE).

Using counters

Counter instructions have three word data file elements. Word 0 is the control word, containing the status bits of the instructions. Word 1 is the preset value; word 2 is the accumulatedvalue.

How Counters Work: The figure below demonstrates how a counter works. The count value must remain in the range of –32768, a counter status overflow (OV) or underflow (UN) bit isset.

Count Up (CTU)

```
CTU

COUNT UP




Prese        120
```

The CTU is a retentive output instruction that counts false-to-true rungtransitions.Rungtransitionscanbecausedbyeventsoccurring in the program such as parts traveling past a detector or actuating a limitswitch.

Count Down (CTD)

```
CTD

COUNT DOWN

Counter       C5:1

Preset        120
```

The CTD is a retentive output instruction that counts false-to-true rung transitions Rung transitions can be caused by events occurring in the program such as parts traveling past a detector or actuating a limit switch.

High-Speed Counter (HSC)

```
HSC

HIGH SPEED
COUNTER

Counter

      C5:0

Preset        120
```

The High-Speed Counter is a variation of the CTU counter. The HSC instruction is enabled when the rung logic is true and disabled when the rung logic is false.

Reset (RES)

Use a RES instruction to reset a timer or counter. When the RES instruction is enabled, it resets the retentive on-delay timer, count up, or countdown instruction having the same address as the RES instruction.

Math Instruction

The following output instruction allows you to perform computation and math operations on individual words. Use these instructions with fixed. SLC 5/01, SLC 5/02, SLC 5/03, and SLC 5/04 processors, except where noted.

If you want to:	Use this instruction
Add two values	ADD
Subtract two values	SUB
Multiply one value from another	MUL
Divide one value by another	DIV
Perform a double divide	DDV
Change the sign of the source value and place it in the destination	NEG
Set all bits of a world to zero	CLR
Convert an integer to BCD	TOD
Convert a BCD value to an integer value	FRD
Multiplex data	DCD
Find the square roof of a value	SQR
Scale a value	SCL

Add (ADD)

```
ADD

Source  A

Source B

```

Use the ADD instruction to add one value (source A) to another value (source B) and place the result in the destination.

Subtract (SUB)

SUB
Subtract
SourceA
SourceB

Use the SUB instruction to subtract one value (Source B) from another (Source A) and place the result in the destination.

Multiply (MUL)

MUL
Multiply
Source A
SourceB
Dest

Use the MUL instruction to multiply one value (source A) by another (source B) and place the result in the destination.

Divide (DIV)

DIV
Divide
Source A
SourceB
Dest

Use the DIV instruction to divide one value (source A) by another (source B). The rounded quotient is then placed in the destination. If the remainder is 0.5 or greater, round up occurs in the destination. The unrounded quotient is stored in the most significant word of the math register. The remainder is placed in the least significant word of the math register.

Scale Data (SCL)

SCL
Scale
Rate [/10000]
Offset

When this instruction is true, the value at the source address is multiplied by the rate value. The rounded result is added to the offset value and placed in the destination. Use this instruction with SLC 5/02, SLC 5/03, and SLC 5/04processors.

Comparison Instructions

Following input instructions allow you to compare values of data, Use these instructions with fixed, SLC 5/01, SLC 5/02, SLC 5/03, and SLC 5/04 processors.

If you want to:	**this instruction:**
Test whether two value is not equal	EQU
Test whether one value is not equal to	EQ
Test whether one value is less than a second value	LES
Test whether one value is less than or equal to a second value	LEQ
Test whether one equal to second value is greater than another	GRT
Test whether one value is greater than or equal to a second value	GEQ
Test portions of twovaluesto see whether they areequal	MEQ
Test whether one value is within the limit range of two other values	LIM

Equal (EQU)

EQU
EQUAL
Source A
Source B

Use the EQU instruction to test whether two values are equal. If source A and source B are equal, the instruction is logically true. If these values are not equal, the instruction is logically false.

Not Equal (NEQ)

NEQ
NOT EQUAL
Source A
Source B

Use the NEQ instruction to test whether two values are not equal. If source A and source B are not equal, the instruction is logically true. If the two values are equal, the instruction is logically false.

Less Than (LES)

LES
LESS THAN
Source A
Source B

Use the LES instruction to test whether one value (source A) is less than another (source B). If source A is less than the value at source B the instruction is logically true. If the value at source A is greater than or equal to the value at source B, the instruction is logically false.

Less Than or Equal (LEQ)

LEQ
LESS THAN OR EQUAL
SourceA
SourceB

Use the LEQ instruction to test whether one value (source A) is less than or equal to another (source B). If the value at source A is less than or equal to the value at source B, the instruction is logically

true. If the value at source A is greater than the value at source B, the instruction is logically false.

Greater Than (GRT)

GRT
GREATER THAN
Source A
Source B

Use the GRT instruction to test whether one value (source A) is greaterthananother(sourceB).IfthevalueatsourceAisgreaterthan   the value at source B. The instruction is logically true. If the value at source A is less than or equal to the value at source B, the instruction is logicallyfalse.

Greater Than or Equal (GEQ)

GEQ
GREATER THAN OR EQUAL
Source A
Source B

Use the GEQ instruction to test whether one value (source A) is greater than or equal to another (source B). If the value at source A is greater than or equal to the value at source B, the instruction is logically true. If the value at source A is less than the value at source B, the instruction is logically false.

Masked Comparison for Equal MEQ)

MEQ
MASKED EQUAL
Source
Mask

 Use the MEQ instruction to compare data at a source address with data at a reference address. Use of this instruction allows portions of the data to be masked by a separate word.

Limit Test (LIM)

LIM
LIMIT TEST
Test
HighLim

Use the LIM instruction to test for value within or outside a specified range, depending on how you set the limits. Use this instruction with 5/02 and 5/03 processors.

Move and Logical Instructions

The following output instructions allow you to perform move and logical operations on individual words. Use these instructions with fixed. SLC 5/01, SLC 5/02, SLC 5/03, and SLC 5/04processors.

If you want to:	Use this instruction:
Move the source value to the destination	MOV
Move data from a source location to a selected portion of the destination	MVM
Perform an AND operation	AND
Perform an inclusive OR operation	OR
Perform an Exclusive Or operation	XOR
Perform a NOT operation	NOT

Move (MOV)

```
MOV

MOVE

Source
```

This output instruction moves the source value to the destination location.

Masked Move (MVM)

```
MVM

MASKED MOVE

Source
```

The masked move instruction is a word instruction that moves data from a source location to a destination, and allows portions of the destination data to be masked by a separate word.

RESULT:

Thus the important feature Programmable Logic Controller was studied.

28

EX.NO:3   **DATE:**

DESIGN OF CIRCUITS WITH LOGICAL SEQUENCE (AND GATE) USING ELECTRO PNEUMATIC TRAINER KITS

Aim

To construct a pneumatic circuit to control the single acting cylinder control by Two-way pressure valve using electro pneumatic trainer kits.

Apparatus Required

- ➢ Compressor air
- ➢ FRL
- ➢ Two-way pressure valve
- ➢ Single acting cylinder

Component Description	
Number	**Description**
1	Compressed air supply
1	Air service unit, simplified representation
1	Single acting cylinder
1	Two pressure valve
2	3/2 Push button valve
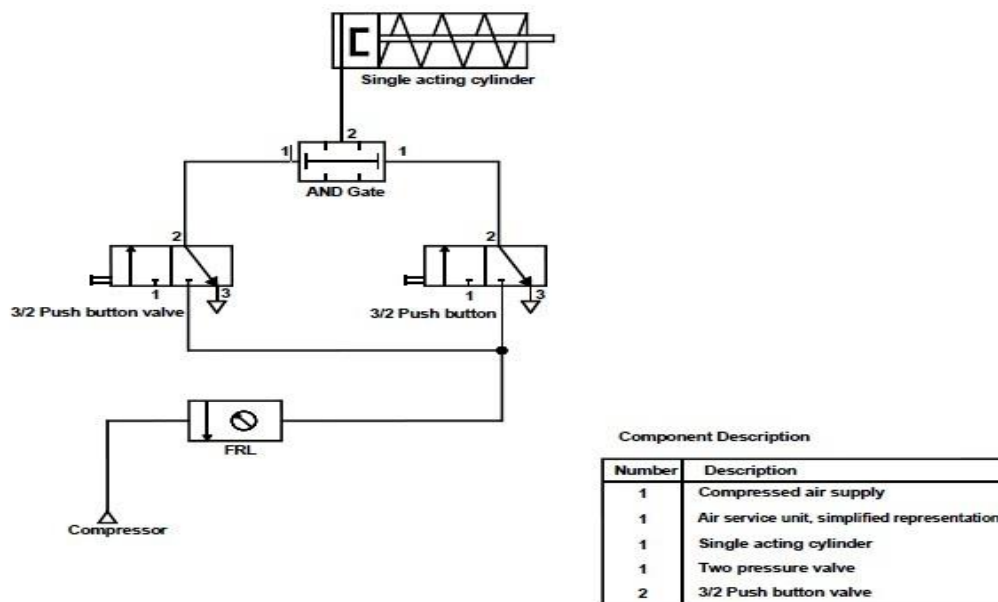
Figure. 1. Circuit Diagram of the AND Logic in the Single Acting Cylinder

Procedure

1. Draw the circuit diagram.

2. Connect the compressor air supply to FRL unit.

3. Any two of the outputs of FRL unit directly connected to **3/2 push button valve** inlet first and second.

4. Both 3/2 push button valves outputs to give **AND Gate input.**

5. Check the all circuit.

6. Open the hand slide valve. The air passes in both 3/2 pushbutton valves input port.

7. When both push buttons is press the cylinder should be activated.

Truth table

Input 1	Input 2	Output
ON	ON	ON
OFF	OFF	OFF
OFF	ON	OFF
ON	OFF	OFF

Result

The pneumatic circuit of two way pressure valve was simulated

EX.NO:4   **DATE:**

DESIGN OF CIRCUITS WITH LOGICAL SEQUENCE (OR GATE) USING ELECTRO PNEUMATIC TRAINER KITS

Aim

To construct a pneumatic circuit to control the single acting cylinder using electro pneumatic trainer kits.

Apparatus Required

- ➢ Compressor air
- ➢ Tube
- ➢ 3/2 push button valve
- ➢ Shuttle valve
- ➢ Single acting cylinder

Component Description

Number	Description
1	Compressed air supply
1	Air service unit, simplified representation
1	Single acting cylinder
2	3/2 Push button valve
1	Shuttle valve
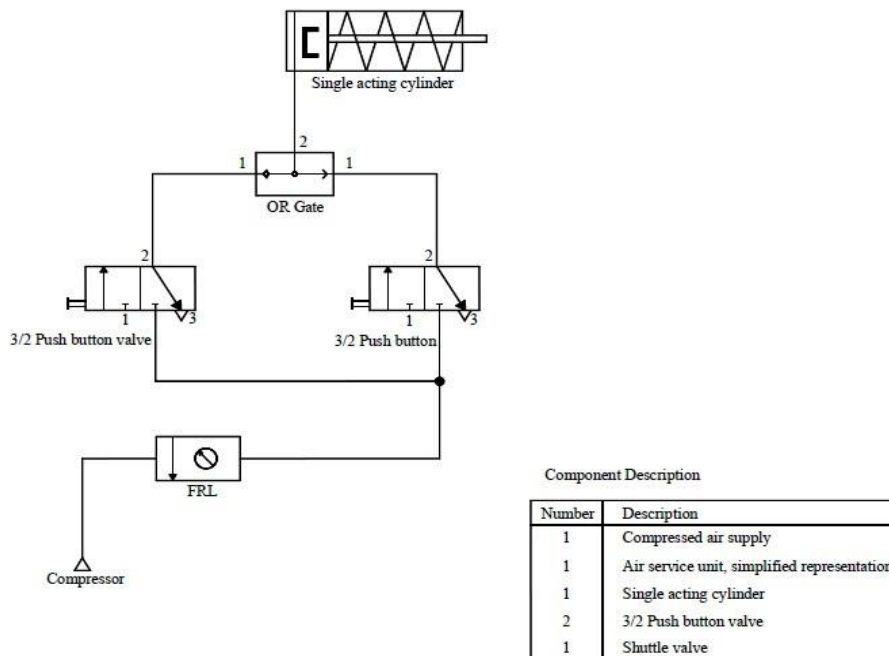
Figure. 2. Circuit Diagram of the OR Logic in the Single Acting Cylinder.

Procedure

1. Draw the circuit diagram (Refer Fig. 2)
2. Connect the compressor air supply to FRL unit.
3. Any two of the output of FRL unit to first **3/2 push button valve inlet and second 3/2 push button valve inlet.**
4. Both 3/2 push button valves outputs to give shut the valve inlet ports.
5. Check the all circuits.
6. Open the hand slide valve. The air passes in both 3/2 push button valve inlets.
7. Press any one push button valve. The cylinder will be activated.

Truth table

Input 1	Input 2	Output
OFF	OFF	OFF
ON	OFF	ON
OFF	ON	ON
ON	ON	ON

Result

Thus the single acting cylinder controlled by OR Gate.

EX.NO:5   **DATE:**

AUTOMATION OF MULTIPLE CYLINDERS IN SEQUENCE (A+B+B-A-) USING PLC

Aim:

 To perform sequencing of two pneumatic cylinders (A and B) in the order of $A^+B^+\,B^-A^-$ using PLC.

Apparatus Required:

1. FRL Unit
2. Flow Control valve
3. 5/3 solenoid operated directional control Valve
4. 5/2 solenoid directional control Valve
5. PLC pneumatic trainer
6. Double Acting Pneumatic Cylinder
7. Polyurethane Tubes and Electrical wires

ACTUATED POSITION
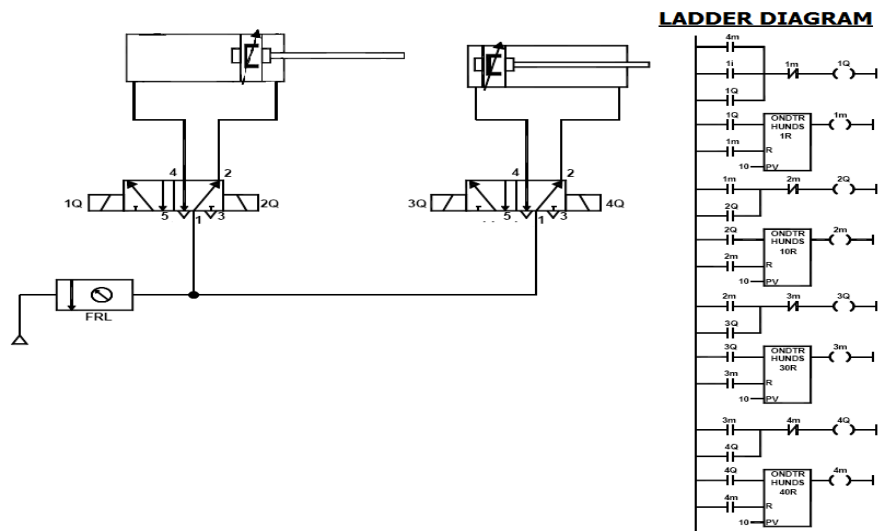
Figure.3

Procedure:

1. Connect the FRL unit, Control valves, directional control valves and cylinders as shown in the circuit.
2. Draw the functional block diagram using PLC software and save it in the computer.
3. Give connections between PLC and PC using USB port and download the program to the PLC.
4. Give connections from the reed switches to the PLC input and from the PLC output to the respective solenoid valves.
5. Adjust the FRL and set the pressure as 6 bars.
6. Switch on the electric supply.
7. Execute the program from the PLC and observe the sequencing of cylinders being carried out automatically.

RESULT:

Thus the single cycle automation of multiple cylinders is operated in sequence (A+B+B-A-) using PLC.

ACTUATION OF HYDRAULIC CYLINDER TO FIND OUT FORCE Vs PRESSURE

Aim

To actuate the hydraulic cylinder and find out the force vs. pressure

Apparatus required

Oil tank, single-phase motor, gear pump, pressure relief valve, 4/3 double solenoid valve, double acting cylinder, load cell, and data actuation card than lab view software.

Procedure

1. Switch on the electrical power supply with motor.

2. Switch on the power supply to the control unit.

3. Open the lab view software in the system.

4. Inter face hydraulic trainer with system using RS-232.

5. Open the force. Go to operate, click the run. Than power on (below).

6. Now extend the system by pressing the up button.

7. Load cell indicate the force value in the monitor.

8. Now adjust the pressure regulator and set the maximum pressure as 25kg/cm2.

9. Retract the cylinder.

10. Once again forward the cylinder; you have adjusted the pressure in pressure regulator.

11. You have seen the force value in monitoring.

12. Repeat the force value for different pressure.
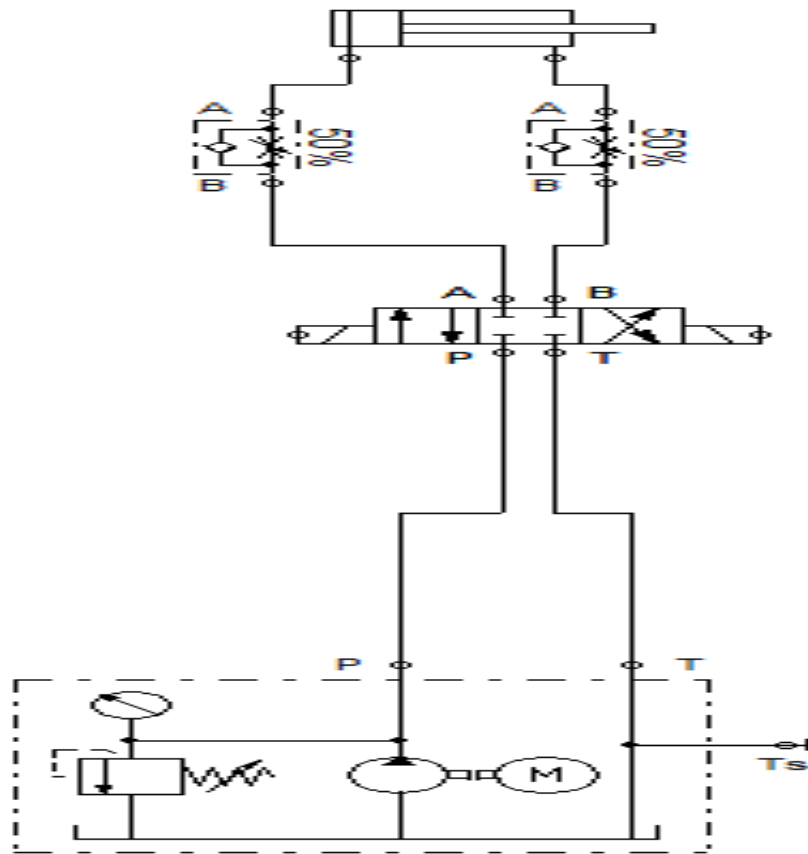
Figure.4

HYDRAULIC LINEAR ACTUATION TRAINER

Tabulation

S. No	Pressure (kg/m²)	Force (displayed) (kg)	Calculated force (kg)	% of Errors

Calculation

W. K. T.

> **Pressure** $= \dfrac{\textbf{Force}}{\textbf{Area}}$

- PRESSURE in '**kg/m²**'
- FORCE in '**kg**'
- AREA in '**m²**'

> **Area** $= \dfrac{\boldsymbol{\pi}}{\textbf{4}} \ \textbf{D}^{\textbf{2}}$

> **D = Cylinder diameter**

- Cylinder diameter = **50mm.**
- Cylinder rod diameter = **28mm.**
- Cylinder stroke length = **150mm.**
- **Error = Displayed Force – Calculated Force / Displayed Force**

$$\textbf{\% Error} = \dfrac{\textbf{Display forces} - \textbf{Calculated Forces}}{\textbf{Displayed Forces}} \times \textbf{100}$$

37

MODEL CALCULATION:

GRAPH:

Pressure VS Force

MODEL GRAPH:
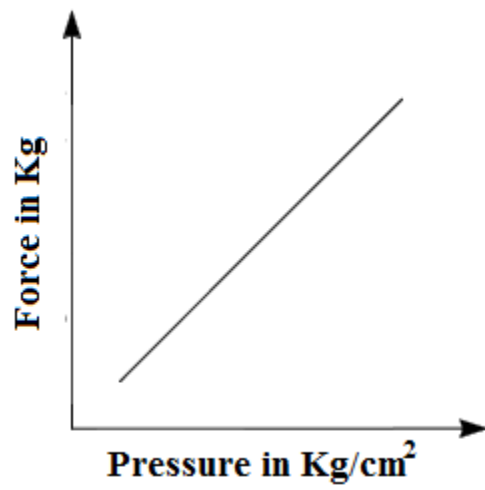
Result

The actuation of double acting cylinder was carried out

EX.NO:7   **DATE:**

ACTUATION OF HYDRAULIC CYLINDER TO FIND OUT SPEED VS. DISCHARGE

Aim

To actuate the double acting hydraulic cylinder to find out speed vs. discharge

Apparatus required

Oil tank, single-phase motor, gear pump, pressure relief valve, 4/3 double solenoid valve, flow control valve, double acting cylinder, load cell, and data actuation card than lab view software.
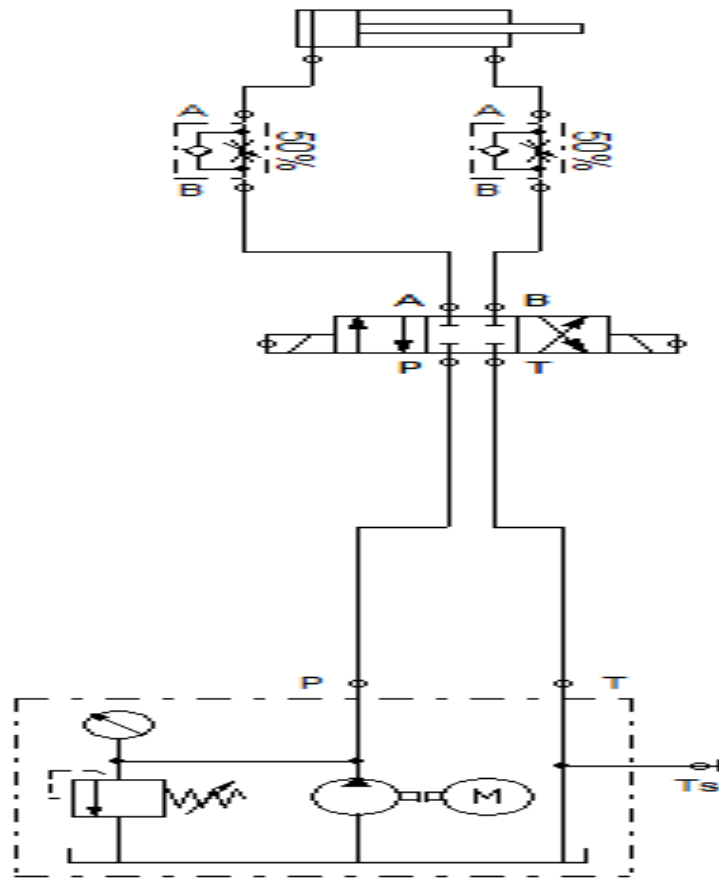
Procedure

1. Switch on the electrical power supply with motor.

2. Switch on the power supply to the control unit.

3. Open the lab view software in the system.

4. Inter face hydraulic trainer with system using RS-232.

5. Open the speed. Go to operate, click the run then power on (below).

6. Now extend the system by pressing the up button.

7. Now regulate the flow control valve, contract the system by pressing down position after seen monitor in velocity cm/sec.

8. Now adjust the flow control valves and set the maximum flow, to find the up and velocity.

9. Repeat the velocity values for different flows

HYDRAULIC LINEAR ACTUATION TRAINER

Tabulation

S. No	Velocity in UP (cm/sec)	Velocity in DOWN (cm/sec)	Discharge in UP FLOW (L/sec)	Discharge in DOWN FLOW (L/sec)

Calculation

W. K. T.

> $$\text{Velocity Speed} = \frac{\textbf{Flow}}{\textbf{Area}}$$

- SPEED in '**cm/sec**'
- FLOW(DISCHARGE) in **'L/sec'**
- AREA in '$\textbf{m}^2$'

➢ **Area** $= \dfrac{\pi}{4} \ D^2$

➢ **Flow = velocity × Area**

MODEL CALCULATION:

D Diameter of Cylinder cm

Cylinder diameter = 50mm

Cylinder rod diameter = 30mm

Cylinder stroke length = 150mm

GRAPH:

Speed VS Discharge

MODEL GRAPH:
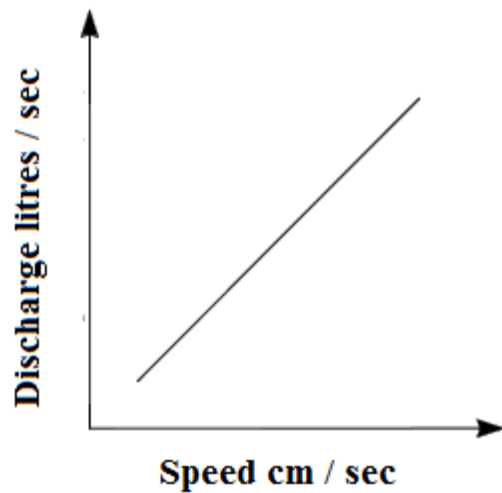
Result

The actuation of hydraulic cylinder was carried out.

EX.NO:8   **DATE:**

SIMULATION OF SINGLE ACTING CYLINDER BY USING

AUTOMATION SOFTWARE

Aim

To perform the simulation of single acting cylinder with use of automation software.

Apparatus required

1.Automation software

2.Computer

Procedure

1. Open the file automation software and open a new file.

2. Then the select the required circuit using the library tool bar.

3. Then pick the required cylinder and valves required.

4. Then drag it and place it is the file.

5. Then give the connections as given in the circuit.

6. Then save the circuit and then select the simulation option.

Diagram:

SINGLE ACTING CYLINDER USING LIVER OPERTED DCV

SINGLE ACTING CYLINDER

LIVER OPERTED DCV

EXHAUST

FRL UNIT

COMPRESSOR

Result:

Thus the simulation operation of a single acting cylinder was done.

EX.NO:9   **DATE:**

SIMULATION OF DOUBLE ACTING CYLINDER BY USING

AUTOMATION SOFTWARE

Aim

To perform the simulation of Double acting cylinder with use of automation software.
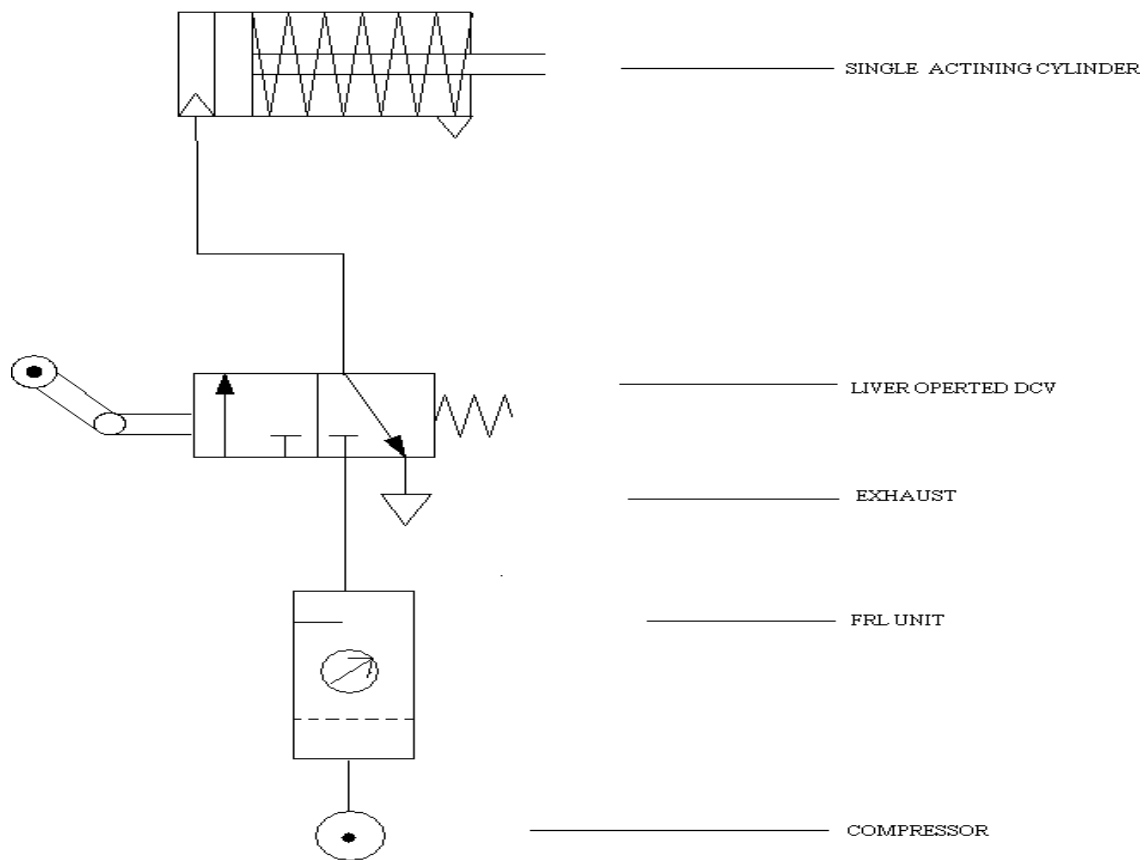
Apparatus required

1.Automation software

2.Computer

Procedure

1. Open the file automation software and open a new file.

2. Then the select the required circuit using the library tool bar.

3. Then pick the required cylinder and valves required.

4. Then drag it and place it is the file.

5. Then give the connections as given in the circuit.

6. Then save the circuit and then select the simulation option.

Diagram:

DOUBLE ACTING CYLINDER USING LEVER OPERTED DCV

DOUBLE ACTING CYLINDER

5/2 LEVER OPERTED DCV

EXHAUST

FRL UNIT

COMPRESSOR
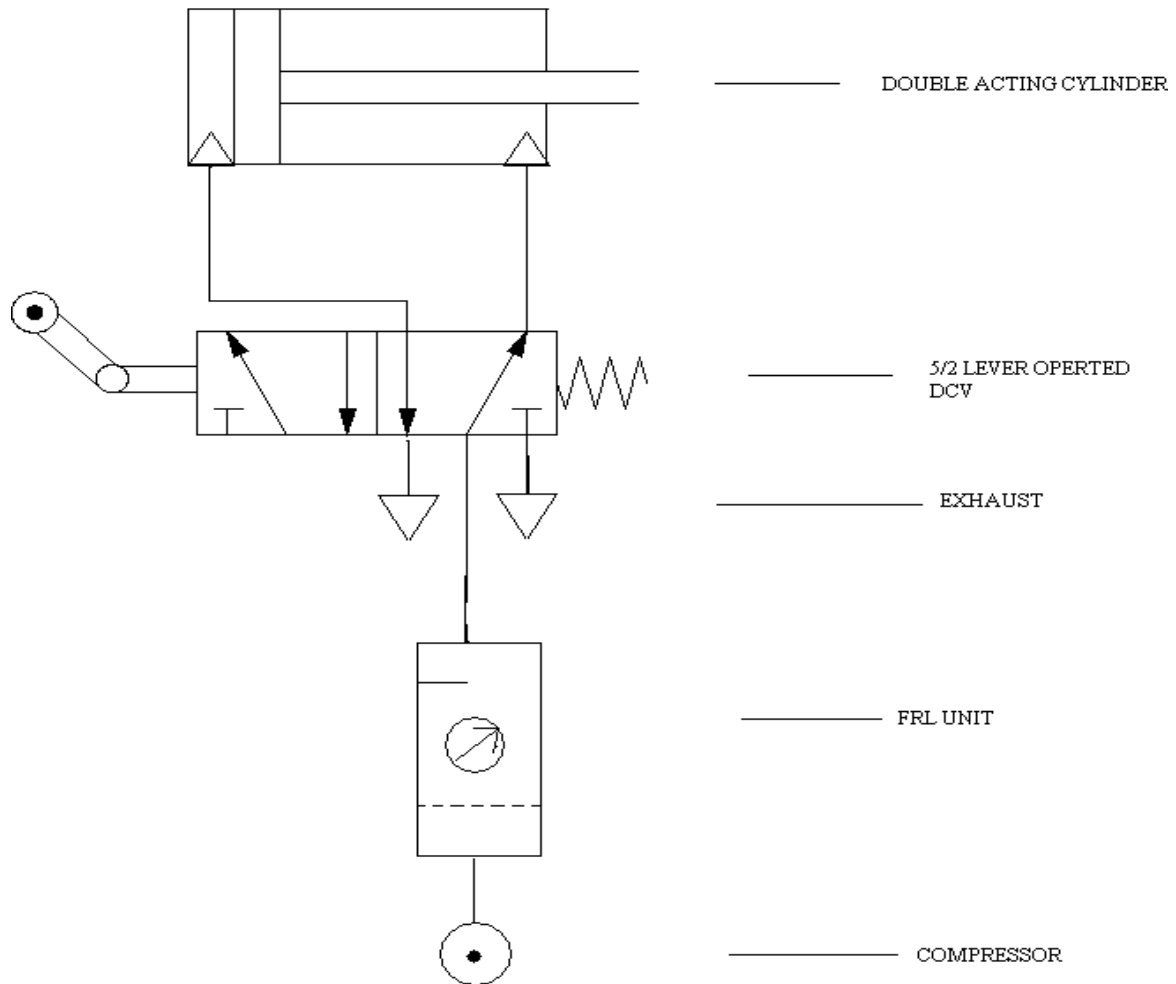
Result:

Thus the simulation operation of a single acting cylinder was done.

EX.NO:10 DATE:

AUTOMATIC BOTTLE FILLING MACHINE USING PLC.

AIM

To execute a PLC program for a conveyor system.

APPARATUS REQUIRED

1. PLC Trainer kit.

2. PC with Siemens LOGO! Software.

3. Ethernet cable.

4. Patch chords.

5. Power supply.

6. Conveyor system setup.

PROCEDURE

STEP 1: Switch ON the power supply to PC and PLC Trainer kit.

STEP 2: Patch the power chords. (24v Positive to inputs and 24v

Positive to outputs)

STEP 3: Click File >Click Open>**Conveyor Program.**

STEP 4: Download and Run the program. (Refer **CREATE NEW A**

PROGRAM STEP 4 in **PROGRAMMING METHODS**).

STEP 5: Connect the patch as per the connections given below.

STEP 6: Enable the Start input **I2;** conveyor starts to move in forward

direction if Direction input is not enabled in the conveyor

setup.

STEP 7: When the specified count is reached from detection of metal

piece by sensor, the conveyor will come to stop.

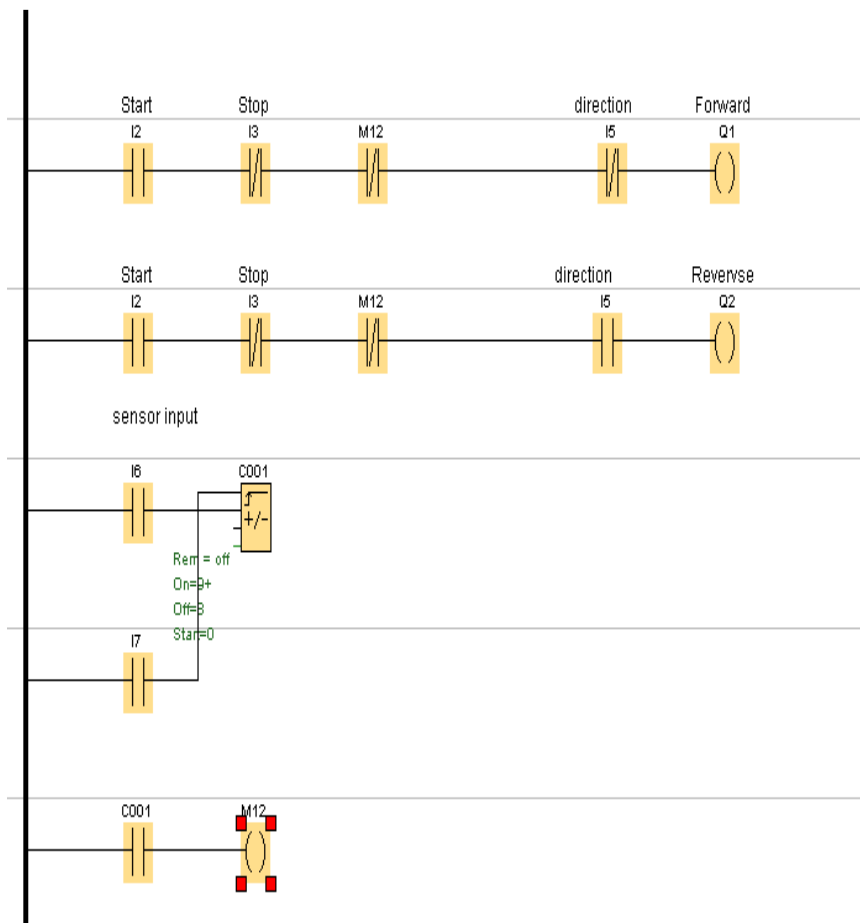STEP 8: If direction input is enabled, the conveyor will start to run inreverse direction.

STEP 9: If stop input **I3** is enabled, conveyor comes to stop.

CONNECTIONS:

SUPPLY	PLC TRAINER KIT	CONVEYOR SETUP
24V	INPUT	24V
	Q1 PORT 1	
	Q2 PORT 2	
GND		GND
	I5	DIRECTION SWITCH
	I6	SENSOR INPUT
	Q1 PORT 2	FORWARD
	Q2 PORT 2	REVERSE

PROGRAM

DESCRIPTION

INPUTS/OUTPUTS	DESCRIPTION
I2	START
I3	STOP
I5	DIRECTION
I6	SENSOR INPUT
I7	COUNTER RESET
Q1	FORWARD
Q2	REVERSE

RESULT:

Thus PLC program for conveyor system is executed

VIVA – VOCE QUESTIONS

1. What is meant by sensor?
2. What are the various types of control system?
3. Distinguish between closed loop system and open loop system.
4. What are the types of strain gauges?
5. Define -LVDT
6. What is meant by fluid power?
7. What is a check valve?
8. What is a solenoid valve?
9. Define – FRL unit
10. Define –DCV
11. Differentiate between meter-in and meter-out controls.
12. What is the function of an unloading valve?
13. What is the function of a sequence valve?
14. What is the function of a shuttle valve?
15. What is the function of a spool valve?
16. What is the function of a process control valve?
17. What is the function of a 2-way pressure valve?
18. Why hydraulic power is especially used in heavy works?
19. Where are pneumatic system spreferred?
20. Name the basic components of a hydraulic system.
21. What is the function of a relief valve in a hydraulic system?
22. Draw the symbols for a pressure relief valve and a pressure reducing valve.
23. What is meant by NC and NO contacts?
24. What is meant by an actuator?
25. What are the types of actuators?
26. What is a control valve?
27. What are the types of control valves?
28. What is a circuit control valve?
29. What is the function of flow control valve?
30. Distinguish between flow control and needle valve.

31. What is the function of time delay valve?

32. What is the function of pilot operated valve?

33. What is a quick exhaust valve?

34. What is the difference between a strainer and a filter?

35. Distinguish between hydraulics and pneumatics?

36. What is the purpose of a pressure regulator?

37. Why lubricator is used in pneumatic systems?

38. What are the advantages of hydro-pneumatics?

39. What is meant by logic control?

40. Name the different pneumatic position sensors.

41. How do you rate a compressor?

42. What is a programmable logic controller?

43. What are the basic elements of a PLC?

44. What are the various approaches for entering the program for PLC?

45. What is a ladder diagram?

46. What is the purpose of an electrical timer?

47. Draw the general ladder rungs to represent a latch circuit.

48. How does a PLC differ from relay logic?

49. What are the features of a PLC?

50. What is the function of proximity switch?

s