

# **SRM VALLIAMMAI ENGINEERING COLLEGE**

**(An Autonomous Institution)**

**SRM NAGAR, KATTANKULATHUR – 603 203**



## **1909714 MECHATRONICS AND AUTOMATION LABORATORY MANUAL**

**(Seventh Semester B.E/B.Tech Students for the Academic Year 20222-2023)**

**R2019**

**Prepared By**

**Faculty Members**

**Department of Mechanical Engineering**

**(Private Circulation Only)**

**SRM VALLIAMMAI ENGINEERING COLLEGE, SRM NAGAR,**

**KATTANKULATHUR-603203**

## **Department of Mechanical Engineering**

### **Instructions to the students**

**The following instructions must be followed by the students in their laboratory classes.**

1. Students are expected to be punctual to the lab classes. If they are late, they will be considered absent for that particular session.
2. Students should strictly maintain the dress code (i.e.) they have to wear the lab uniform with black shoes.
3. Students must bring their observation note, record note (completed with previous experiment) and the calculator to every lab class without fail.
4. Students are advised to come with full preparation for their lab sessions by
  - a. Reading the detailed procedure of the experiment from the laboratory manual.
  - b. Completion of observation note book (i.e.) Aim, Apparatus required, Formula (with description), least count calculation, diagrams and the tabular column should be written in the observation note before entering into the laboratory.
5. Data enter in the observation note book must be by pen only.
6. Students must get attestations immediately for their observed readings.
7. Students are advised to get their results evaluated in the observation note book on the same day of that experiment.
8. Class assessment marks for each experiment is based only on their performance in the laboratory.
9. Record note has to be completed then and there and get corrected when the students are coming or the next lab class.
10. Students must strictly maintain silence during lab classes.
11. If any of the students is absent for the lab class for genuine reasons, he/she will be permitted to do the experiment during the repetition class only.
12. Students are advised to perform their experiments under safety care.
13. If any student is found causing damage to the lab equipments, he/she shall replace the same with a new.

**Department of Mechanical Engineering**  
**VII Semester Mechanical Engineering**  
**1909714- MECHATRONICS AND AUTOMATION LABORATORY**

**SYLLABUS**

**Course Objective:** The main learning objective of this course is to prepare the students for:

1. Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits
2. Applying a suitable sensor and image processing technique for Mechatronics systems.
3. Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.
4. Apply PLC, PID and 8085 microcontroller as a control unit Mechatronics system.
5. Developing a model of pneumatic and hydraulic circuits by using simulation software.

**LIST OF EXPERIMENTS**

1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
2. Stepper motor interface
3. Traffic light interface.
4. Speed control of DC motor.
5. Study of various types of transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis basic hydraulic, pneumatic and electrical circuits using software.
8. Study of PLC and its applications.
9. Study of image processing

**Course Outcomes:** Upon completion of this course, the students will be able to:

1. Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits.
2. Applying a suitable sensor and image processing technique for Mechatronics systems.
3. Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.
4. Apply PLC, PID and 8085 microcontroller as a control unit in Mechatronics system.
5. Developing a model of pneumatic and hydraulic circuits by using simulation software.

# Department of Mechanical Engineering

## VII Semester Mechanical Engineering 1909714- MECHATRONICS AND AUTOMATION LABORATORY

### Course Information Sheet

#### **COURSE DESCRIPTION:**

1909714 Mechatronics and automation laboratory is the seventh semester practical subject covering basic pneumatic, hydraulic and various electrical and electronics control functions. This laboratory designed for fourth year Mechanical students with two credits.

#### **PROGRAM SPECIFIC OUTCOMES (PSO):**

1. **PSO1-** Ability to analyze and solve problems related to mechanical engineering
2. **PSO2-** Can be able to apply thermal, fluid, design, electrical & electronics engineering principles to mechanical engineering applications.
3. **PSO3-** Would be able to apply the tools and techniques of quality management of manufacturing service processes.
4. **PSO4-** Ability to use the concept of process planning and cost estimation to manufacture different products.

#### **CONTRIBUTION OF COURSE TO MEETING THE REQUIREMENTS:**

Mathematics and Basic Sciences	Engineering Topics	General Education	Engineering Design
✓	✓	-	✓

#### **PROGRAM SPECIFIC OUTCOMES (PO):**

PO	Description	✓
A	Graduates will demonstrate basic knowledge in mathematics, science and engineering.	✓
B	Graduates will demonstrate the ability to design and conduct experiments, interpret and analyze data, and report results.	✓
C	Graduates will demonstrate the ability to design a mechanical system or a thermal system or a process that meets desired specifications and requirements.	✓
D	Graduates will demonstrate the ability to function on engineering and science laboratory teams, as well as on multidisciplinary design teams.	✓

E	Graduates will demonstrate the ability to identify, formulate and solve mechanical engineering problems.	-
F	Graduates will demonstrate an understanding of their professional and ethical responsibilities.	-
G	Graduates will be able to communicate effectively in both verbal and written forms.	✓
H	Graduates will have the confidence to apply engineering solutions in global and societal contexts.	-
I	Graduates should be capable of self-education and clearly understand the value of lifelong learning.	✓
J	Graduates will be broadly educated and will have an understanding of the impact of engineering on society and demonstrate awareness of contemporary issues.	-
K	Graduates will be familiar with modern engineering software tools and equipment to analyze mechanical engineering problems.	✓
L	Competent enough to succeed in National level competitive examinations in the field of Mechanical Engineering.	-
M	Ability to be a successful Entrepreneur in the fields of Mechanical, Automobile, Mechatronics Engineering and Industrial Automation.	✓

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	2											3			
2	3			3									3			
3	3		3										3			
4	3				3									2		3
5	3	2							2					2		3

## INDEX

EXPT NO	DATE	NAME OF THE EXPERIMENT	SIGN.
-		Introduction to Mechatronics	
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<b>Speed Control of Dc Motor</b>			
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<b>Experiments on Pneumatic Trainer Kit</b>			
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		Design and Testing of Pneumatic Circuits Single cycle automation of double acting cylinder using limit switch	
		Design and Testing of Pneumatic Circuits Single cycle	

		automation of multiple cylinder in sequence (A+B+A·B·)	
<b>Experiments on Electro-Pneumatic Trainer Kit</b>			
<b>7</b>		Design and Testing of Electro-Pneumatic Circuits Operation of single and double acting cylinder using single solenoid valve	
		Design and Testing of Electro-Pneumatic Circuits Operation of double acting cylinder using double solenoid valve.	
<b>Experiments on Electro-Pneumatic with PLC Trainer Kit</b>			
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		Automation of multiple cylinder in sequence (A+B+A·B·) using PLC	
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# INTRODUCTION TO MECHATRONICS

**Aim:** To study about the important features, about Mechatronics system.

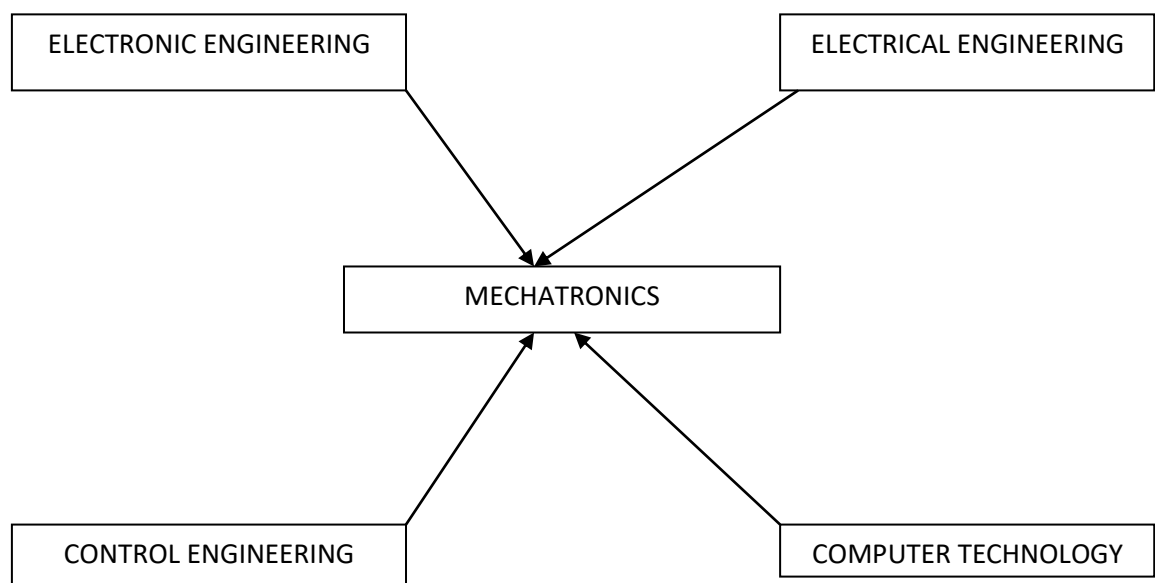
## Introduction to Mechatronics System:

Mechatronics is a word originated in Japan in 1980s to denote the combination of technologies which go together to produce industrial needs. Mechatronics is one of the new and existing fields on the engineering landscape, subsuming parts of traditional engineering fields and requiring a broader approach to the design of system that we can formally call as Mechatronics system.

Today many industries improving their product through automation which is based on the inter connection between the electronics control systems and mechanical engineering. Such control systems generally use microprocessors as controllers and have electrical sensors extracting information from mechanical inputs through electrical actuators to mechanical systems.

It can be considered to be application of computer based digital control techniques through electronic and electric interface to mechanical engineering problems. Successful design of mechatronics can lead to products that are extremely attractive to customer in quality cost-effectiveness.

## GRAPHICAL REPRESENTATION OF MECHATRONICS:





Mechatronics is the synergistic integration of Mechanics and Mechanical Engineering, Electronics, Computer Technology, and IT to produce or enhance products and systems.

Mechatronics brings together areas of technology involving sensors and measurement systems, drive and actuation systems, analysis of the behaviour of systems microprocessor systems. The integration across the traditional boundaries of mechanical engineering, electrical engineering, electronics and control engineering has to occur at earliest stages of the design process if cheaper, more reliable; more flexible systems are to be developed.

#### **ELEMENTS OF MECHATRONICS SYSTEMS:**

- Actuators and sensors
- Signals and conditioning
- Digital logic systems
- Software and data acquisition systems
- Computers and display devices

#### **APPLICATIONS OF MECHATRONICS ENGINEERING:**

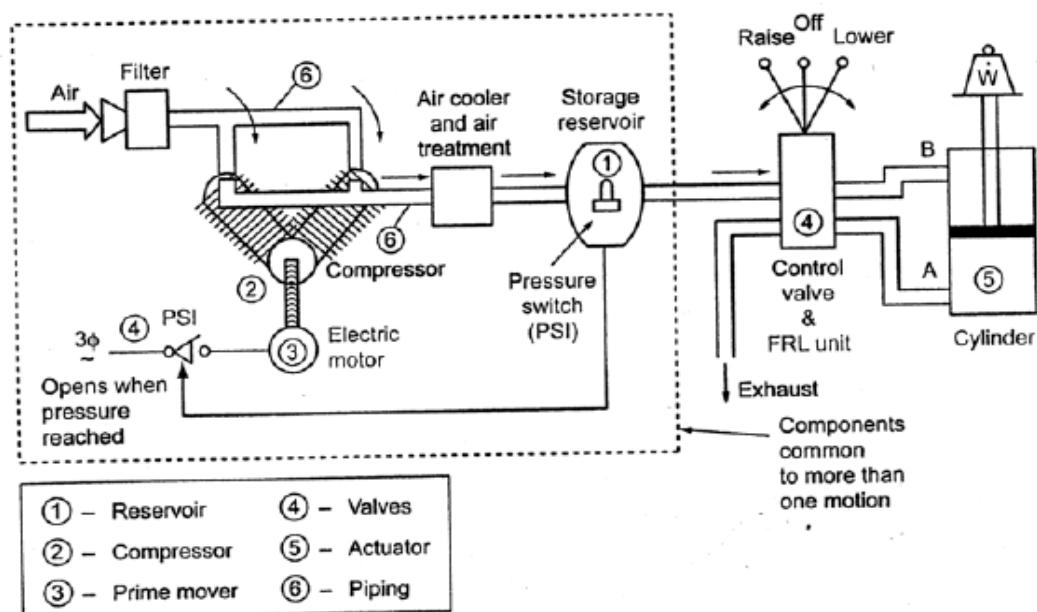
- Electronic home appliances
- Electronic entertainment products
- Engine systems (Cars)
- Large scale applications

#### **PNEUMATICS AND HYDRAULIC SYSTEMS**

Most of mechatronics systems work based on motion or action by means of sort. This motion or actuation caused either by torque or force form which displacement and acceleration can be obtained. To obtain this force or acceleration, actuators are mainly used. Actuator is a device which provides enough force needed to stat the mechatronics systems. At the same, power should be supplied to the actuator to activate it. The power supplied to actuators might be any one of the following forms such as compressed air, pressurized fluid, electric power and mechanical power. If compressed air supplied to the system, it is called as pneumatic system. But if pressurized fluid is supplied to flow the system it is called as hydraulic system.

## BASIC ELEMENTS OF PNEUMATIC SYSTEM:

- Compressor and motor
- Pressure relief valve and check valve
- Cooler, filter and water trap
- Air receiver
- Directional control valves
- Actuator or pneumatic cylinder

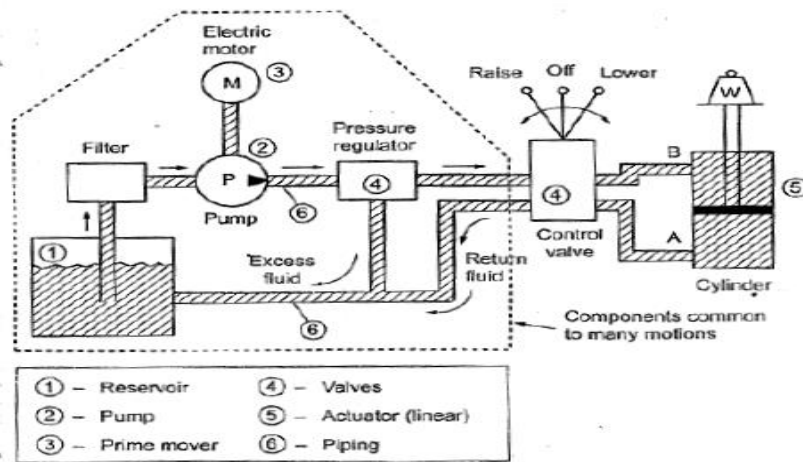


## Schematic Layout of Pneumatic System

## BASIC ELEMENTS OF HYDRAULIC SYSTEM:

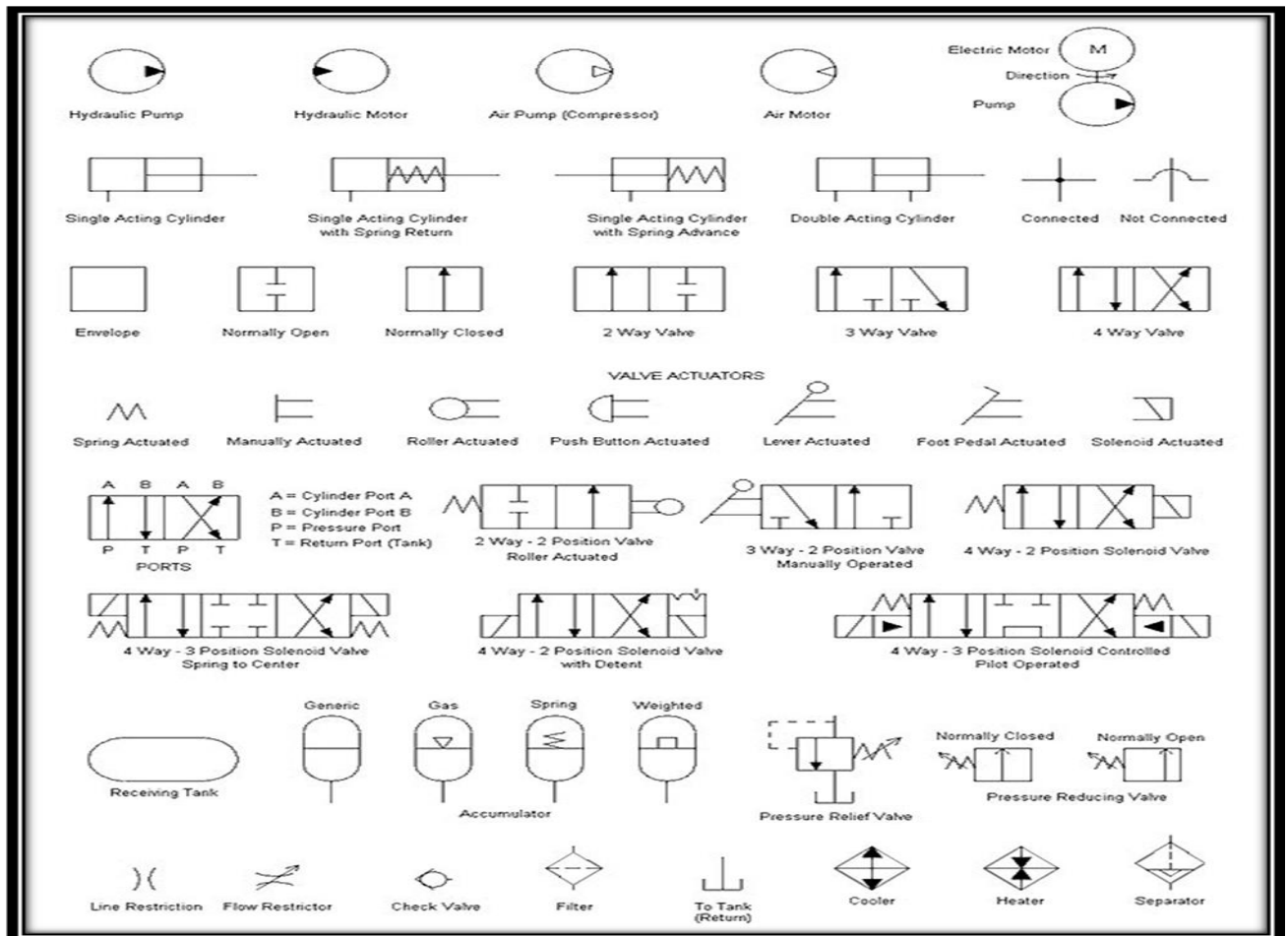
- Reservoir (Or air tank)
- Pump
- Prime mover
- Valves
- Actuator

➤ Fluid-transfer piping



Schematic Layout of Hydraulic System

BASIC PNEUMATIC AND HYDRAULIC SYMBOL



## **ADDITION-SUBTRACTION-MULTIPLICATION-DIVISION-SORTING-CODE CONVERSION**

### **AIM**

To write an assembly language program for Add and Subtract- 8-bit numbers in memory and store the result in memory.

### **APPARATUS REQUIRED:**

- 8085 Micro controller kit

### **THEORY:**

The first data is brought to accumulator A and the second one in any one of the other registers says B. The addition is done using ADD. The result is then stored at 4152. The ADD instruction affects flags depending on result.

### **EXAMPLE ADDITION:**

The two data to be added are at 4150 and 4151. The result is stored at 4152.

Data (4150) = 23

(4151) = 35

Result = 58

### **PROGRAM:**

```
LDA 4150 ;
```

```
4150 (A) = 23
```

```
MOV B, A;
```

```
LDA 4151;
```

```
4151 A = 35
```

```
ADD B;
```

```
(A) + (B) = (A)
```

```
STA 4152;
```

(A) 4152 = 58

HLT

**OBJECT CODES FOR ADD:**

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	3A	LDA@4150
4101	50	
4102	41	
4103	47	MOV B, A
4104	3A	LDA@4151
4105	51	
4106	41	
4107	80	ADD B
4108	32	STA@4152
4109	52	
410A	41	
410B	76	HLT

**Procedure:**

- Key in the opcodes from the address specified
- Enter data at 4150 and 4151 as specified in the Example
- Execute the program and check for the result at 4152
- Change data at 4150 and execute each time and check for result

**EXAMPLE SUBTRACT:**

The two data to be added are at 4150 and 4151. The result is stored at 4152.

Data (4150) = 49

(4152) = 24

Result = 25

**OBJECT CODES FOR SUBTRACT:**

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	21	LXI H, 4150
4101	50	
4102	41	
4103	7E	MOV A, M
4104	23	INX H
4105	96	SUB M
4106	23	INX H
4107	77	MOV K, A
4108	76	HLT

**Procedure:**

- Key in the opcodes from the address specified
- Enter data at 4150 and 4151 as specified in the Example
- Execute the program and check for the result at 4152
- Change data at 4150 and execute each time and check for result

**OBJECT CODES FOR MULTIPLICATION :**

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	3A	LDA 4152
4101	52	
4102	41	
4103	47	MOV B,A
4104	11	LXI D, 0000
4105	00	
4106	00	
4107	2A	LHLD 4150
4108	50	
4109	41	
410A	EB	XCHG
410B	19	LOOP DAD D
410C	05	DCR B
410D	C2	JNZ LOOP
410E	0B	
410F	41	
4110	22	SHLD 4154
4111	54	
4112	41	
4113	76	HLT

**PROCEDURE:**

- Key in the opcodes from the address specified.
- Enter data at 4150 and 4153 for execution
- Execute the program and check for the result at 4154 and 4155
- Change data at 4250 and 4151 and execute each time and check result
- **OBJECT CODES FOR DIVISION :**

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	3A	LDA 4150
4101	50	
4102	41	
4103	47	MOV B,A
4104	3A	LDA 4151
4105	51	
4106	41	
4107	0E	MVI C, 00
4108	00	
4109	B8	CMP B
410A	DA	JC LOOP
410B	13	
410C	41	
410D	90	LOOP1 : SUB B
410E	0C	INR C
410F	B8	CMP B



4110	D2	JNC LOOP1
4111	09	
4112	41	
4113	32	LOOP:STA 4152
4114	52	
4115	41	
4116	79	MOV A,C
4117	32	STA 4153
4118	53	
4119	41	
411A	411A	HLT

**PROCEDURE:**

- Key in the opcodes from the address specified.
- Enter data at 4150 and 4151 for execution
- Execute the program and check for the result at 4152 and 4153

**PROGRAM FOR CODE CONVERSION**

Objective: To convert the ASCII number in memory to its equivalent decimal number

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	21	LXI H 4140
4101	50	
4102	41	
4103	7E	MOV A, M
4104	DE	SUI 30

4105	30	
4106	FE	CPI 0A
4107	0A	
4108	DA	JC LOOP
4109	0D	
410A	41	
410B	3E	MVI A,FF
410C	FF	
410D	23	LOOP INX H
410E	77	MOV M, A
410F	76	HLT

**RESULT:**

Thus the Add ,Subtract, multiplication, Division and code convection- 8-bit numbers in memory and store the result in memory are verified.

## **VIVA QUESTIONS AND ANSWERS**

### **1. What is a Microprocessor?**

Microprocessor is a CPU fabricated on a single chip, program-controlled device, which fetches the instructions from memory, decodes and executes the instructions.

### **2. What is Instruction Set?**

It is the set of the instructions that the Microprocessor can execute.

### **3. What is Band width?**

The number of bits processed by the processor in a single instruction.

### **4. What is clock speed?**

Clock speed is measured in the MHz and it determines that how many instructions a processor can processed. The speed of the microprocessor is measured in the MHz or GHz.

### **5. Define Interpreter.**

An interpreter may be a program that either :-executes the source code directly; translates source code into some efficient intermediate representation (code) and immediately executes this; explicitly executes stored precompiled code[1] made by a compiler which is part of the interpreter system.

### **6. Define Assembler.**

An assembler is a program that takes basic computer instructions and converts them into a pattern of bits that the computer's processor can use to perform its basic operations.

### **7. What is Assembly level language?**

An assembly language is a low-level programming language for microprocessors. It implements a symbolic representation of the binary machine codes and other constants needed to program a particular CPU architecture. This representation is usually defined by the hardware manufacturer, and is based on mnemonics that symbolize processing steps (instructions), processor registers, memory locations, and other language features.

## **8. What are Mnemonics?**

Mnemonics are instructions or commands to perform a particular operation given by user to microprocessor e.g MOV MIV ADD SUB IMUL.

## **9. What is a bus?**

Information is transferred between units of the microcomputer by collections of conductors called buses.

There will be one conductor for each bit of information to be passed, e.g., 16 lines for a 16 bit address bus. There will be address, control, and data buses.

## **10. Distinguish between Microprocessor & Microcontroller.**

- The microprocessor is a digital integrated circuit device that can be programmed with a series of instructions to perform specified functions on data.
- But micro controller is a computer on a chip which has memory, input, output on the chip itself.
- So, micro processor can perform only few functions but micro controller can perform so many functions.

## STEPPER MOTOR INTERFACING WITH 8051 MICRO CONTROLLER FOR CLOCKWISE ROTATION

### AIM

To write an assembly language program for driving the stepper motor in clockwise direction.

### APPARATUS REQUIRED:

- Stepper motor
- 8051 Micro controller kit #SD 4100 - Enter

### PROGRAM:

MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	7C	MOV R4, #FF
4101	FF	
4102	90	START: MOV DPTR, #LOOK UP
4103	41	
4104	14	
4105	78	MOV R0, #04
4106	04	
4107	E0	JO: MOVX A, @DPTR
4108	C0	PUSH DPH
4109	83	
410A	C0	PUSH DPH
410B	82	
410C	90	MOV DPTR #FFCOH
410D	FF	

410E	C0	
410F	F0	MOVX @ DPTR, A
4110	DC	DJNZ R4, CALL
4111	06	
4112	80	HLT: SJMP HLT
4113	FE	
4114	09	LOOK UP: DB 09H, 05H, 06H, 0AH
4115	05	
4116	06	
4117	0A	
4118	7A	
4119	03	
411A	79	DLY2: MOV R1, #FFH
411B	FF	
411C	7B	DLY1: MOV R1, #FFH
411D	FF	
411E	DB	DLY: DJNZ R3, DLY
411F	FE	
4120	D9	DJNZ R1, DLY1
4121	FA	
4122	DA	DJNZ R2, DLY2
4123	F6	
4124	D0	POP DPL

4125	82	
4126	D0	POP DPH
412	83	
4128	A3	INC DPTR
4129	D8	DJNZ R0, J0
412A	DC	
412B	80	SJMP START
412C	D5	
412D		END

**RESULT:**

Thus the stepper motor was driven in clockwise direction.

## **VIVA QUESTIONS AND ANSWERS**

### **1. What is zener voltage?**

In the reverse direction, the diode conducts very little when the voltage is below the breakdown value. This critical limiting value of reverse voltage is known as zener voltage.

### **2. Name three output characteristics of transistor configuration.**

a. Saturation region b. Active region c. Cut-off region.

### **3. What is a microprocessor?**

A microprocessor is a multipurpose, programmable, clock driven, registers – based electronic device that reads binary instructions from a storage device called memory, accepts binary data as input and processes data according to those instructions, and provides results as output.

### **4. What are the four components of a programmable machine?**

A typical programmable machine can be represented with four components. a. Microprocessor b. Memory c. Input d. Output.

### **5. Define the terms. a) Bus b) RAM c) ROM.**

BUS – A group of lines used to transfer bits between the microprocessor and other components of the computer system. RAM – Random Access Memory. Data is stored in a read / write memory. ROM – Read only Memory. A memory that stores binary information permanently. The information can be read from this memory but cannot be altered.

### **6. What the types of languages used?**

The types of languages used are, a. Machine language b. Assembly language c. Low – level language d. High – level language.

### **7. What is a machine language?**

The binary medium of communication with a computer through a designed set of instructions specific to each computer.

### **8. What is a assembly language?**

A medium of communication with a computer in which programs are written in mnemonics. An assembly language is specific to a given computer.



**9. What is low – level language?**

A medium of communication that is machine – dependent or specific to a given computer. The machine and the assembly language of a computer are considered low – level languages. Programs written in these languages are not transferable to different types of machines.

**10. What is a high – level language?**

A medium of communication that is independent of a given computer. Programs are written in English – like words, and they can be executed on a machine using a translator (a compiler or an interpreter).

## TRAFFIC LIGHT CONTROLLER INTERFACING WITH 8051/8085 MICRO CONTROLLER

### AIM

To write an assembly language program for Microcontroller based traffic light system.

### APPARATUS REQUIRED:

- Traffic Light Controller
- 8051 Micro controller kit

### PROGRAM:

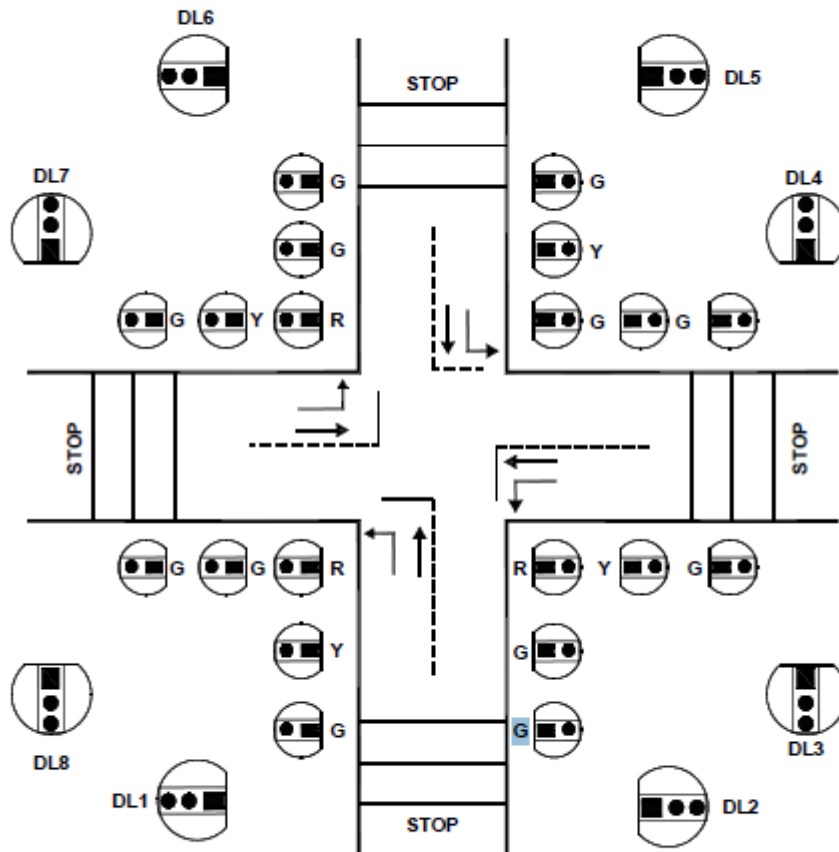
MEMORY ADDRESS	OBJECT CODES	MNEMONICS
4100	74 80	MOV
4102	90 FF OF	MOV
4105	FO	MOVX
4106	7C 04	MOV
4108	90 41 9B	MOV
410B	AA 83	MOV
410D	AB 82	MOV
410F	90 41 8F	MOV
4112	A8 83	MOV
4114	A9 82	MOV
4116	EO	MOVX
4117	A8 83	MOV
4119	A9 82	MOV
411B	90 FF OC	MOV

411E	F0	MOVX
411F	09	INC
4120	88, 83	MOV
4122	89 82	MOV
4124	EO	MOVX
4125	A8 83	MOV
4127	A9 82	MOV
4129	90 FF OD	MOV
412C	FO	MOVX
412E	88 83	MOV
4130	89 82	MOV
4132	EO	MOVX
4133	A8 83	MOV
4135	A9 82	MOV
4137	90 FF OE	MOV
413A	FO	MOVX
413B	O9	INC
413C	12 41 75	LCALL
413F	8A83	MOV
4141	8B 82	MOV
4143	E0	MOVX
4144	AA 83	MOV
4146	AB 82	MOV

4148	90 FF OC	MOV
414B	FO	MOVX
414C	OB	INC
414D	8A 83	MOV
414F	8B 82	MOV
4151	EO	MOVX
4152	AA 83	MOV
4154	AB 82	MOV
4156	90 FF OD	MOV
4159	FO	MOVX
415A	OB	INC
415B	8A 83	MOV
815D	8B 82	MOV
415 F	EO	MOVX
4160	AA 83	MOV
4162	AB 82	MOV
4164	90 FF 0E	MOV
4167	FO	MOVX
4168	OB	INC
4169	12 41 82	LCALL
416C	88 83	MOV
416E	89 82	MOV
4170	DC A4	DJNZ

4172	12 41 06	LCALL
4175	7D 12	MOV
4177	7E FF	MOV
4179	7F FF	MOV
417B	DF FE	MOV
417D	DE FA	DJNZ
417F	DD F6	DJNZ
4181	22	RET
4182	7D 12	MOV
4184	7E FF	MOV
4186	7F FF	MOV
4188	DF FE	DJNZ
418A	DE FA	DJNZ
418C	DD F6	DJNZ
418E	22	RET
418F	44 27 12	DB
4192	92 2B 10	DB
4195	84 9D 10	DB
4198	84 2E 48	DB
419B	48 27 12	DB
419E	92 4B 10	DB
41A1	84 9D 20	DB
41A4	04 2E 49	END

## TRAFFIC LIGHT CONTROLLER



### RESULT:

Thus the based traffic light system studied.

## VIVA QUESTIONS AND ANSWERS

### **1. Differentiate a compiler and an interpreter?**

Compiler – A program that translates English – like words of a high level language into the machine language of a computer. A compiler reads a given program, called a source code, in its entirety and then translated the program into the machine language, which is called an object code. Interpreter – A program that translates the English – like statements of a high – level language in to the machine language of a computer. An interpreter translates one statement at a time from a source code to an object code.

### **2. What are the types of bus?**

The types of bus are, a. Address bus b. Data bus c. Control bus.

### **3. Define the term , Data Bus, Address bus, Control Bus.**

**a. Address Bus** A group of lines that are used to send a memory address or a device address from the MPU to the memory location or the peripheral and is unidirectional. The 8085 microprocessor has 16 address lines. **b. Data bus** A group of bi-directional lines used to transfer data between the MPU and peripherals and is bi-directional. The 8085 microprocessor has eight data lines. **c. Control bus** Single lines that are generated by the MPU to provide timing of various operations.

### **4. Write about the 16 – bit register of a 8085 microprocessor?**

The 8085 has two 16 – bit register. a. The program counter b. Stack pointer The program counter is used to sequence the execution of a program. The stack pointer is used as a memory pointer for the stack memory.

### **5. What are the two types of memories?**

The two types of memories are, a. Static memory (SRAM) b. Dynamic memory (DRAM)

### **6. Write about the SRAM?**

a. This memory is made up of flip – flops, and it stores the bit as a voltage. b. Each memory cell requires six transistors. c. The memory chip has low density, but high speed. d. More expensive, and consumes more power. e. Also known as cache memory.

**7. What is flash memory?**

The flash memory must be erased either in its entirety or at the sector level. The memory chips can be erased and programmed at least a million times. The power supply requirement for programming these chips was around 12V, but now chips are available that can be programmed using a power supply as low as 1.8 V. Hence, this memory is ideally suited for low – power systems.

**8. What are the interfacing devices?**

The bus drivers increase the current driving capacity of the buses, the decoder decodes the address to identify the output port, and the latch holds data output for display. These devices are called interfacing devices. The interfacing devices are semiconductor chips that are needed to connect peripherals to the bus system.

**9. Write about buffer?**

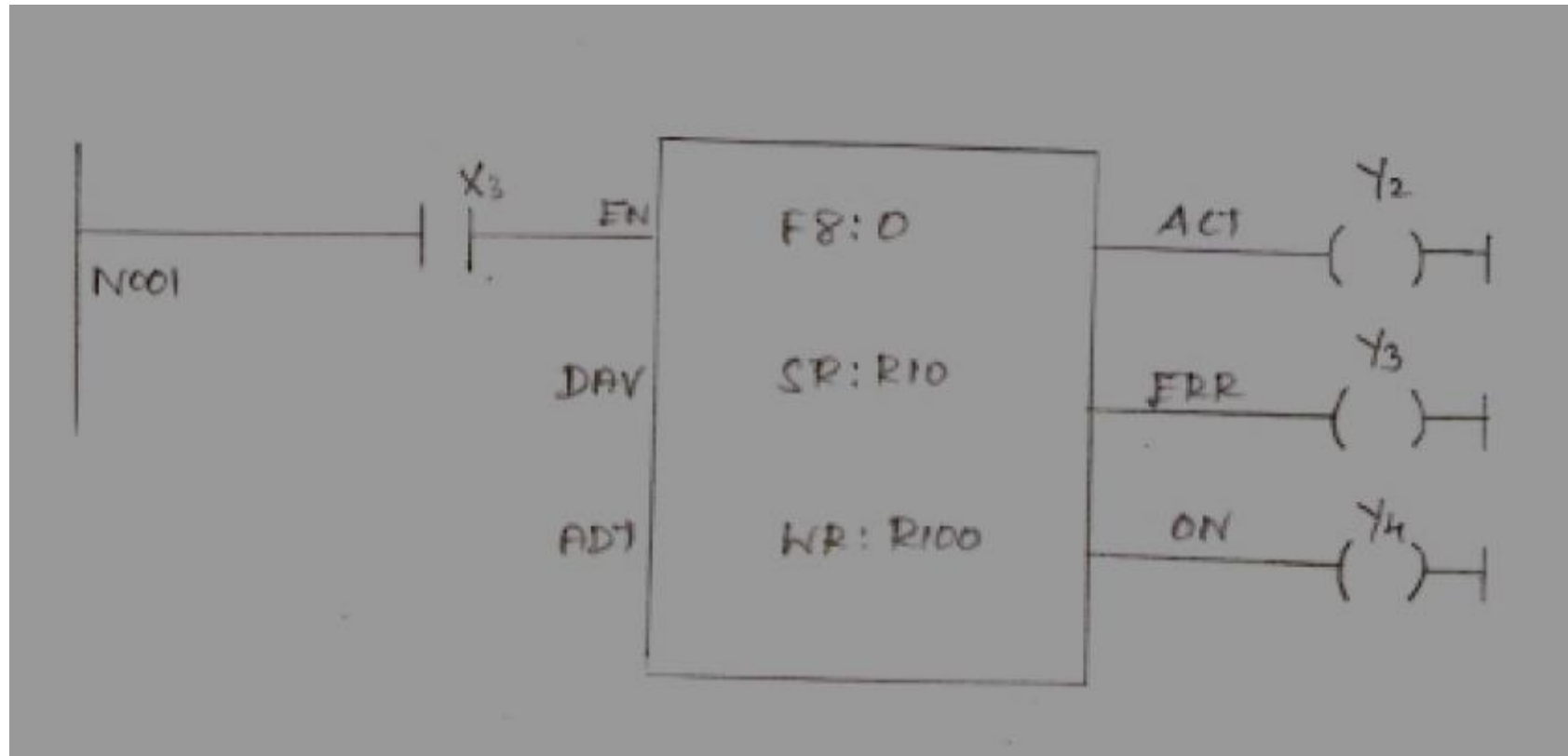
The buffer is a logic circuit that amplifies the current or power. It has one input line and one output line. The logic level of the output is the same as that of the input, logic 1 input provides 1 output. The buffer is used primarily to increase the driving capability of a logic circuit. It is also known as driver.

**10. Define looping?**

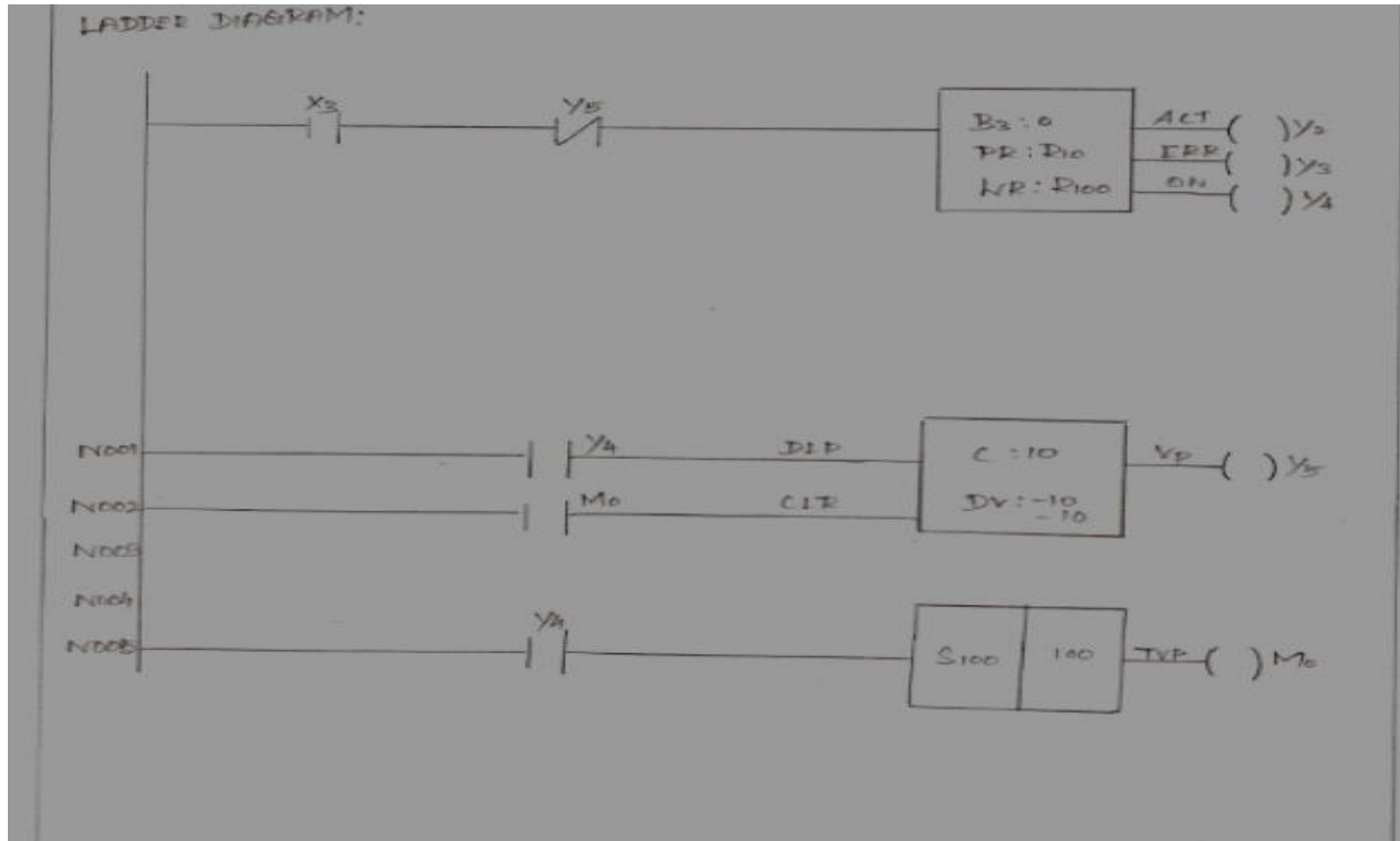
The programming technique used to instruct the microprocessor to repeat tasks is called looping. A loop is set up by instructing the microprocessor to change the sequence of execution and perform the task again. This process is accomplished by using Jump instructions.



## Open Loop Systems



Ex. No: Closed Loop Systems



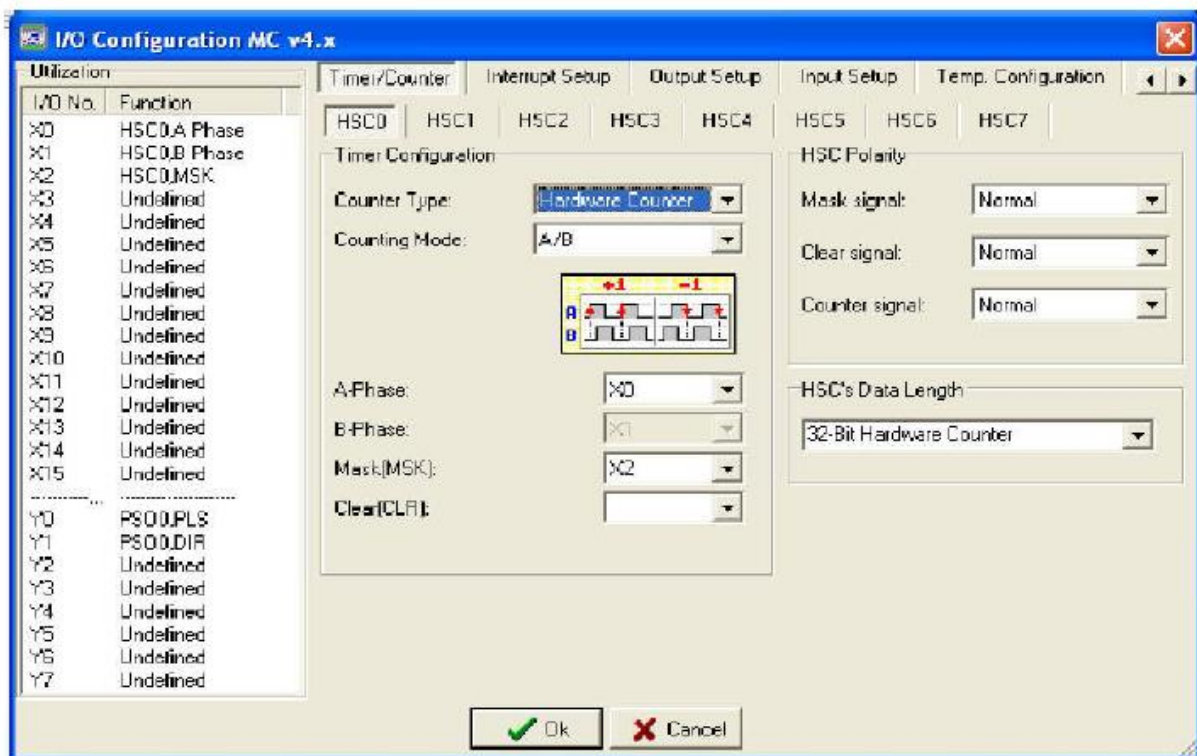
## SERVO CONTROLLER INTERFACING FOR DC MOTOR USING PLC

### AIM:

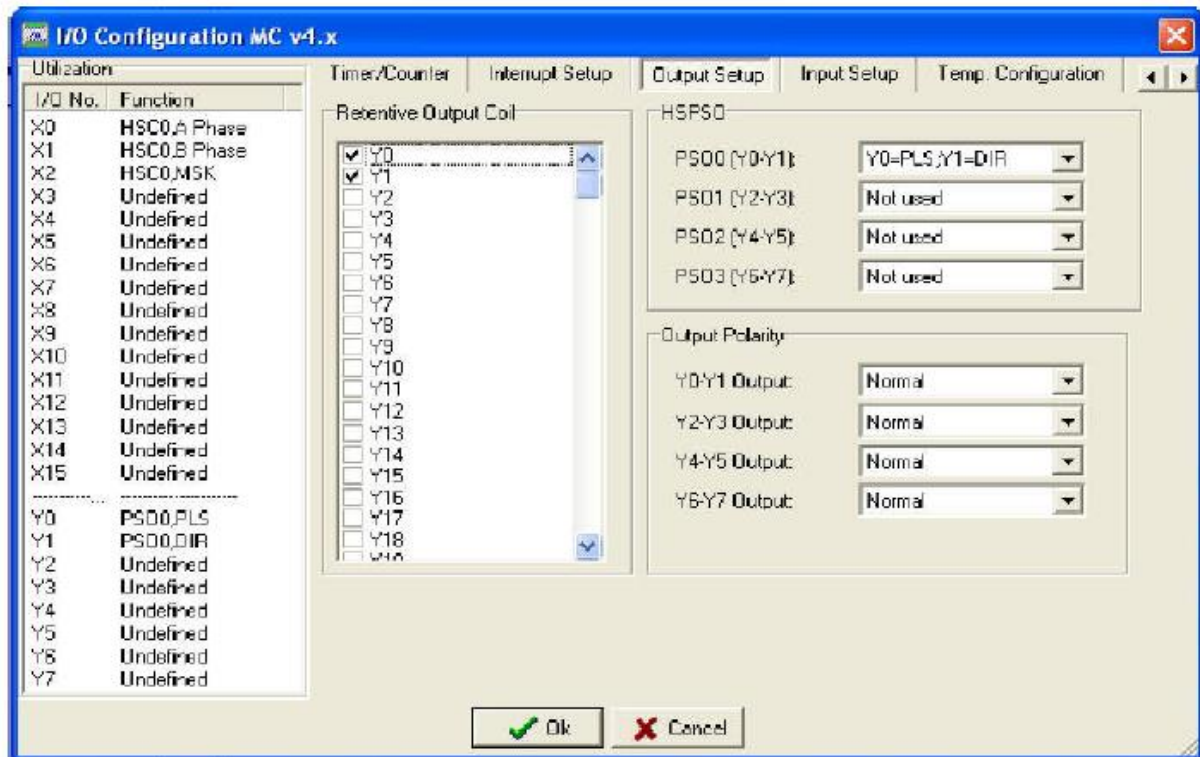
To study the performance of servomotor control for open & closed loop system.

### PROCEDURE:

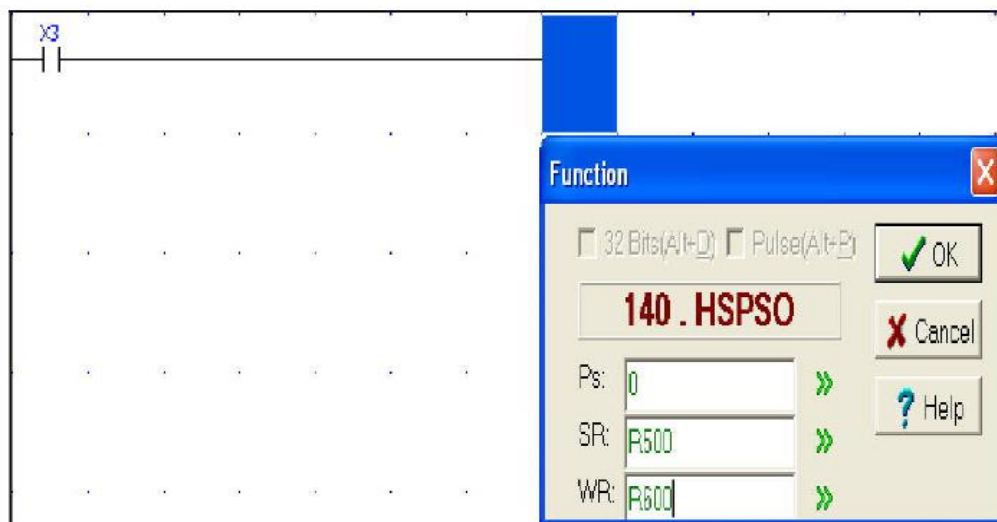
- Install the winpro ladder and panatrem software to PC.
- Open the winpro ladder software.
- Switch on the PLC trainer.
- Connect the PLC and servo controller kit.
- Click file button then click new project.
- Give a project name then click OK.
- Now double click system configuration then double click I/O configuration.
- A new window will open as shown below.



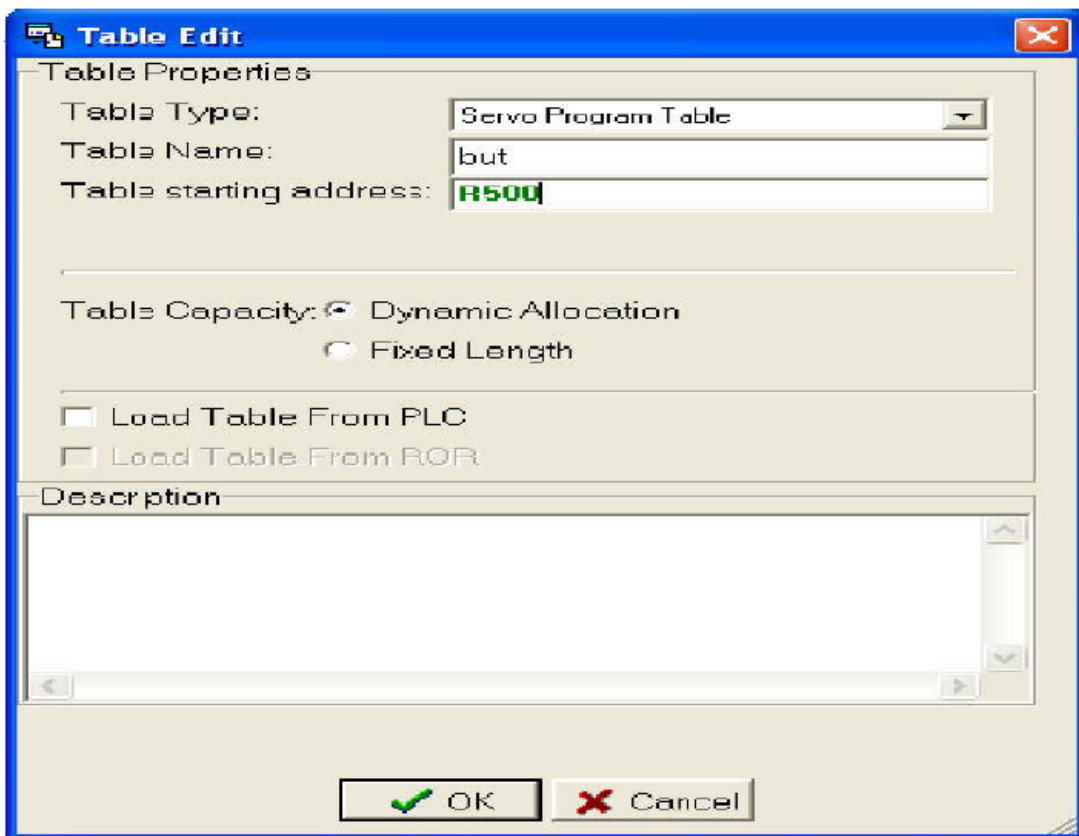
- Now set the counting mode as A/B.
- Then set A phase as X0 and mask as X2 then click OK.
- Again double click I/O configuration and click output setup.
- Mark Y1 and Y2 and set PS00 as Y0=PLS: Y1=DIR and click OK.



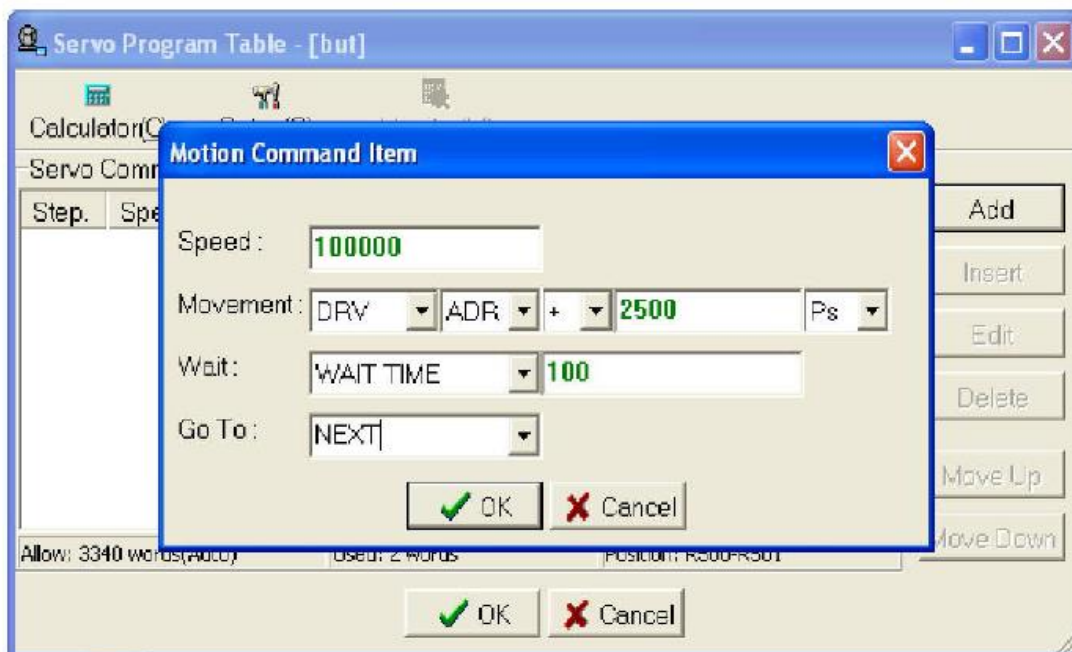
- Click contact icon and click in working space.
- Give address as X3.
- Click function icon and click near the contact in working space.
- A new window will open. Type 140 and click OK.



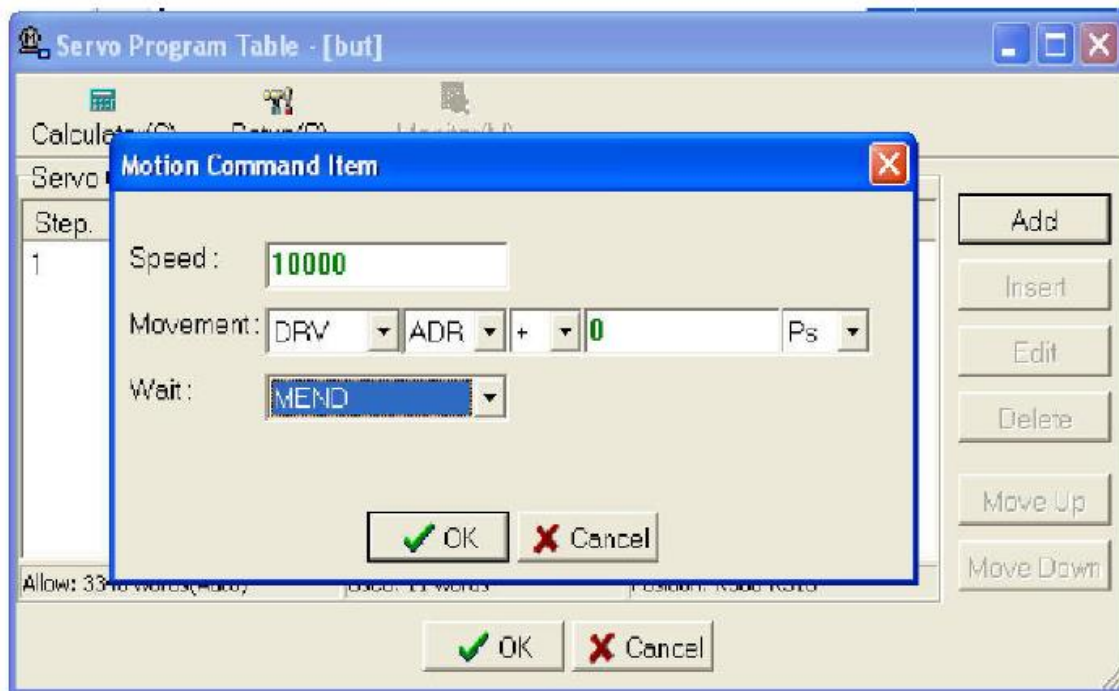
- Set Ps as 0, SR as any number with prefix R and WR SR as any number with prefix R then click OK.
- Click project on the menu bar and click servo program table and click new table.
- Give any table name and give the SR, SR should be the SR of function. Then click OK.



- A new window will open. Clicks add and give speed between 1 to 100000.
- Make changes as shown in below and click OK.



- Again click add and make changes as shown in below.



- Connect the patch cord as shown in circuit diagram.
- Click PLC and click run.

## RESULT:

Thus the performance of servomotor control for close loop system is studied.

## **VIVA QUESTIONS AND ANSWERS**

### **1. What is an incremental encoder?**

An incremental encoder is used for the measurement of angular displacement. A beam of light passes through slots in a disc and is detected by a suitable light sensor. When the disc is rotated, the sensor produces a pulsed output with the number of pulses being proportional to the angle through which the disc is rotated. Hence, the angular position of the disc is determined.

### **2. Write about absolute encoder?**

An absolute encoder is used for the measurement of angular displacement. This gives an output in the form of a binary number of several digits, each such number representing a particular angular position. The rotating disc has three concentric circles of slots and three sensors to detect the light pulses.

### **3. What are the uses of photosensitive devices?**

Photosensitive devices can be used to detect the presence of an opaque object by it breaking a beam of light or infrared radiation, falling on such a device or by detecting the light reflected back by the object.

### **4. Write about Hall Effect sensors?**

When a beam of charged particles passes through a magnetic field, forces act on the particles and the beam is deflected from its straight line path. A current flowing in a conductor is like a beam of moving charges and thus can be deflected by a magnetic field.

### **5. What are digital signals?**

Digital signals are discrete time signals in that they are not continuous functions of time but exist at only discrete times.

### **6. Why the signal conditioning is required?**

Signal conditioning of analogue signals requires components such as amplifiers filter circuits and digital signal microprocessor.

### **7. Define Actuator.**

An actuator is an output device which performs useful works

### **8. Classify actuator based on motion.**

### 1. Linear motion

- Single acting cylinder
- Double acting cylinder

### 2. Rotary Motion

- Air motors
- Rotary actuators

### 3. Flow Control valve

## 9. When is cascade control Needed?

The need for cascade control will occur when a final control element experiences signal overlap i.e. when a trip valve mechanism is still held down , but the output signal has to been used and requires removal

## 10. Write down the principles of cascade control.

- A simple design procedure to determine the minimum number of groups in the circuit
- Evolve separate supply bus for each group
- Arrange selector valves to divert the supply to whichever is the active group



## **STUDY OF LINEAR VARIABLE DIFFERENTIAL TRANSFORMER**

### **AIM**

Measurement of displacement using LVDT.

### **APPARATUS REQUIRED:**

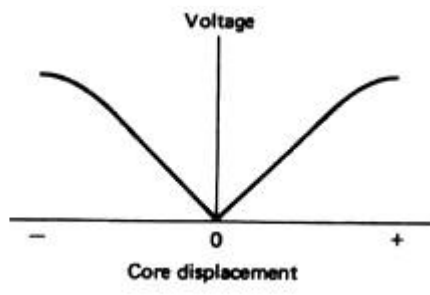
- LVDT Kit
- Multi-meter
- Connecting wires

### **PROCEDURE:**

- Connect the sensor module on the corresponding place
- Switch on the power supply
- Connect LVDT output to the voltmeters terminals
- The core is initially brought to null position
- By varying zero setting change the voltmeter reading to zero value
- First turn the nut in clockwise direction to move core inwards i.e left of null position and take respective voltage readings on the voltmeter.
- If required adjust the span setting to change the voltmeter reading
- Now run nut in anticlockwise direction to move the core towards right of null point and again take respective voltage reading from voltmeter.
- Plot the graph from the observations taken.

**OBSERVATIONS**

SL.NO.	DISPLACEMENT MICROMETER	OUTPUT VOLTAGE



Result:

## STUDY OF STRAIN GAUGE

### AIM

Measurement of strain for the applied load using given strain gauge trainer.

### APPARATUS REQUIRED:

- Strain cantilever
- Multi-meter
- Connecting wires

### PROCEDURE:

- Connect the sensor module on the corresponding place
- Switch on the power supply
- Connect strains output +ve and -ve to the output to the voltmeters terminals
- constant voltage source are given as 5V. give some time to stabilize the instrument reading.
- By varying zero setting change the voltmeter reading to zero value
- Now apply weight at the cantilever beam
- Note down the readings in strain's corresponding voltage display on the trainer.
- If required adjust the span setting to change the voltmeter reading
- Tabulate the reading and plot the graph for applied load and the output voltage.

### OBSERVATIONS

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SL.NO.	Applied Load	Displayed output voltage

**SAMPLE CALCULATION:**

$$\text{Strain} = \frac{6PL}{bt^2 * 2 * 10^6}$$

Where,

P = Applied load in Kg

(L)length = 30 cm

(b) Width = 3 cm

(t) thickness = 0.25 cm

Young's modulus =  $2 * 10^6$

$$\% \text{ of Error} = \frac{\text{Strain Practical} - \text{Strain theoretical}}{\text{Strain theoretical}} \times 100$$

Result:

## STUDY OF TEMPERATURE TRANSDUCER

### AIM

Measurement temperature of the temperature transducer and verify the performance with output voltage.

### APPARATUS REQUIRED:

- Water bath
- Thermometer
- RTD sensor
- Multi-meter
- Connecting wires

### PROCEDURE:

- Connect the sensor module on the corresponding place
- Switch on the power supply
- Initially keep the RTD switch in **o**- open -to check resistance between the RTD. Set the value of 1.4- 1.6 v (using zero setting) with room temp using thermometer
- Then keep the RTD switch in **c** - close mode, Place the sensor in water bath and insert both RTD and thermo meter in water bath.
- Switch on the heater, for every 5 deg increment, note down the output reading using voltmeter.
- Increase the temperature and note down the respective voltage readings by using voltmeter.
- If required adjust the span setting to change the voltmeter reading
- Plot the graph between temperature (thermometer) and the observations taken in terms of output (voltage).

**OBSERVATIONS**

<b>SL.NO.</b>	<b>Temperature-Thermometer in deg</b>	<b>Output voltage in Volt</b>

Result:

## STUDY OF PRESSURE TRANSDUCER

### AIM

Measurement of applied pressure to the pressure transducer and verify the performance with output voltage.

### APPARATUS REQUIRED:

- Pressure tank
- Foot pump
- Sensor
- Pressure gauge
- Multi-meter
- Connecting wires

### PROCEDURE:

- Connect the sensor module on the corresponding place(Right side of the board)
- Switch on the power supply.
- Foot pump is to give pressure to the tank and the pressure inside in the tank is displayed in the pressure gauge mounted on the tank.
- Connect Pressure transducer's output +ve and -ve to the voltmeter's +ve and -ve terminals.
- By varying Zero setting change the voltmeter reading in to Zero value.
- Give some pressure using foot pump, and note down the respective voltage readings by using voltmeter.
- If required adjust the span setting to change the voltmeter reading (Max reading).
- Plot the graph between applied pressure and the observations taken (voltage).

**OBSERVATIONS**

<b>SL.NO.</b>	<b>Applied Pressure</b>	<b>Output voltage in Volt</b>

Result:



## STUDY OF SPEED TRANSDUCER

### AIM

Measurement of speed of the PMDC motor using tacho generator transducer and verify the performance with displayed speed on the display.

### APPARATUS REQUIRED:

- PMDC motor
- Sensor
- Multi-meter
- Connecting wires

### PROCEDURE:

- Connect the sensor module on the corresponding place(Right side of the board)
- Switch on the power supply.
- Connect Speed transducer's output +ve and -ve to the Speed display's +ve and - ve terminals.
- By varying Zero setting change the voltmeter reading in to Zero value.
- Control voltage is varying from 0-12 V. This value can be verified across the motor.
- The op-amp based PWM generator and MOSFET based power driver along tacho generator feedback to get the speed output in terms of voltage.
- If required adjust the span setting to change the voltmeter reading (Max reading).
- Plot the graph between speed in RPM and the tacho generator output voltage.

**OBSERVATIONS**

<b>SL.NO.</b>	<b>Speed in RPM</b>	<b>Output voltage in Volt</b>

Result:

## **VIVA QUESTIONS AND ANSWERS**

### **1. What are the two basic types of the displacement and the position transducers?**

The two basic types are,

1. Contact sensors
2. Non contact sensors.

### **2. Write about the strain – gauged element?**

The electrical resistance strain gauge is a metal wire, metal foil strip, or a strip of semiconductor material, which is wafer – like and can be stuck onto surfaces like a postage stamp.

### **3. Write about the gauge factors for different types of strain gauges?**

The gauge factor of metal wire or foil strain gauges with the metals generally used is about 2.0. Silicon p – and n – type semiconductor strain gauges have gauge factors of about + 100 or more for p- type silicon and – 100 or more for n – type silicon.

**4. Define gauge factor.** The gauge factor is defined as the ratio of per unit change in resistance to per unit change in length. Gauge factor  $G_f = \frac{\Delta R/R}{\Delta L/L}$

### **5. Define LVDT?**

The Linear Variable Differential Transformer consists of three coils symmetrically spaced along an insulated tube. The central coil is the primary coil and the other two are identical secondary coils, which are connected in series in such a way that their outputs oppose each other.

### **6. Determine the working Principle of LVDT?**

When there is an alternating voltage input to the primary coil, alternating e.m.f.s are induced in the secondary coils. With the magnetic core central, the amount of magnetic material in each of the secondary coil is the same.

### **7. What are the uses of LVDT?**

The uses are as follows. a. Widely used as primary transducers for monitoring displacements. b. Also used as secondary transducers in the measurement of force, weight and pressure.

### **8. Write about inductive proximity switch?**

Inductive proximity switch consists of a coil wound round a core. When the end of the coil is close to a metal object its inductance changes. This change can be monitored by its effect on a

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resonant circuit and the change used to trigger a switch. It can only be used for the detection of metal objects and is best with ferrous metals.

**9. What is an encoder?**

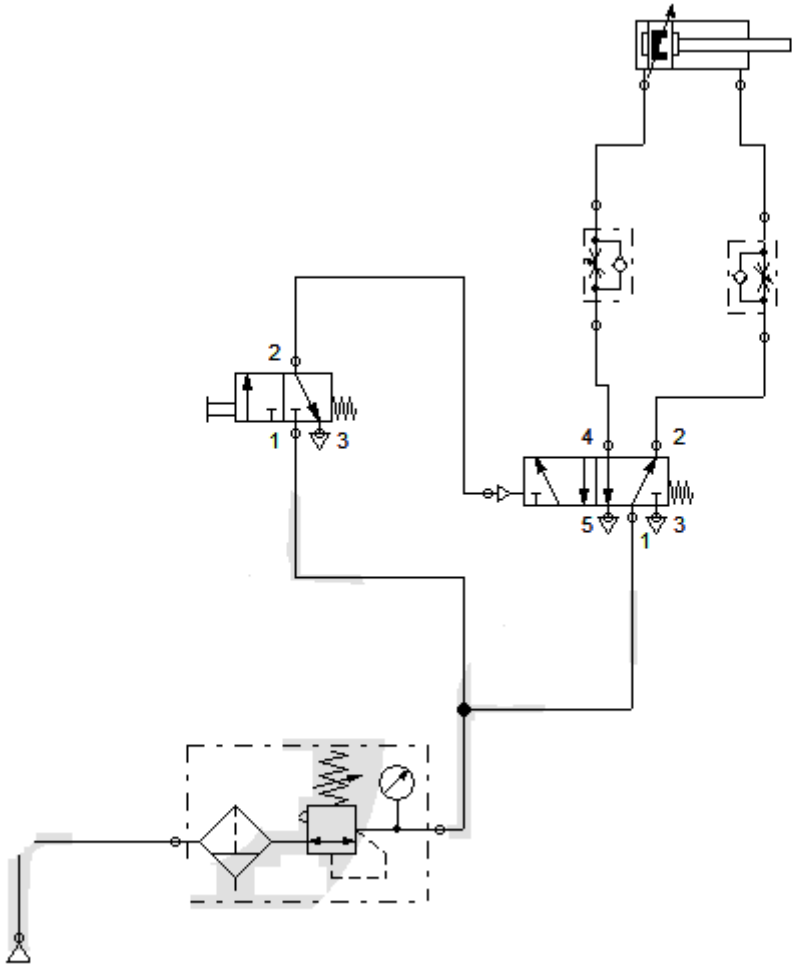
An encoder is a device that provides a digital output as a result of a linear or angular displacement

**10. What are the two types of position encoders?**

The two types of position encoders are, a. Incremental encoders b. Absolute encoders.

# **EXPERIMENTS USING PNEUMATIC TRAINER KIT**

**Ex. No:**



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF PNEUMATIC CIRCUITS TO CONTROL  
THE SPEED OF THE CYLINDER BY METER IN AND METER OUT  
VALVE CIRCUIT**

**AIM:**

To control the speed of double acting cylinder using Meter In and Meter Out valve circuit in Basic Pneumatic Training Kit

**APPARATUS REQUIRED:**

- Air service unit (Power Source unit)
- FRL Unit
- Double acting cylinder
- 3/2 push button spring return DCV
- 5/2 single pilot DCV
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the speed of double acting cylinder was controlled using Metering In and Metering Out circuit in Pneumatic Trainer Kit.

## **Viva Questions**

### **1. Define Mechatronics.**

The term Mechatronics is used for the integration of microprocessor control system, electrical systems and mechanical systems. Mechatronics is defined as the integration of precision mechanical & electronic control for the development of smart products & process.

### **2. What is a system? Give an example.**

A system can be considered as a box, which has an input, and an output and where it is not concerned with what goes on inside the box but only the relationship between the output and the input. Example: A motor may be thought of as a system, which has as its input electric power and as output the rotation of a shaft.

### **3. What is a measurement system?**

A measurement system can be considered as a black box, which is used for making measurements. It has as its input the quantity being measured and its output the value of that quantity.

### **4. Write about the sensor and give an example.**

A sensor, which responds to the quantity being measured by giving as its output a signal which is related to the quantity. Example: A thermocouple is a temperature sensor. The input to the sensor is a temperature and the output is an e.m.f. which is related to the temperature value.

### **5. Write about the signal conditioner?**

A signal conditioner takes the signal from the sensor and manipulates it into a condition, which is suitable for either display, or in the case of a control system, for use to exercise control.

### **6. What are the elements of the closed loop control system?**

The various elements of a closed loop control system are, a. Comparison element b. Control element c. Correction element d. Process element e. Measurement element

### **7. What are the two types of feedback loop?**



The two types of feedback loop are, a. Positive feedback loop b. Negative feedback loop. "The feedback is said to be negative/positive feedback when the signal; which is feedback, subtracts/adds from the input value. It is required to control a system. The control elements decide what action to take when it receives an error signal".

**8. What are the types of control elements?**

There are two types of control elements. They are a. Hard – wired systems b. Programmable systems.

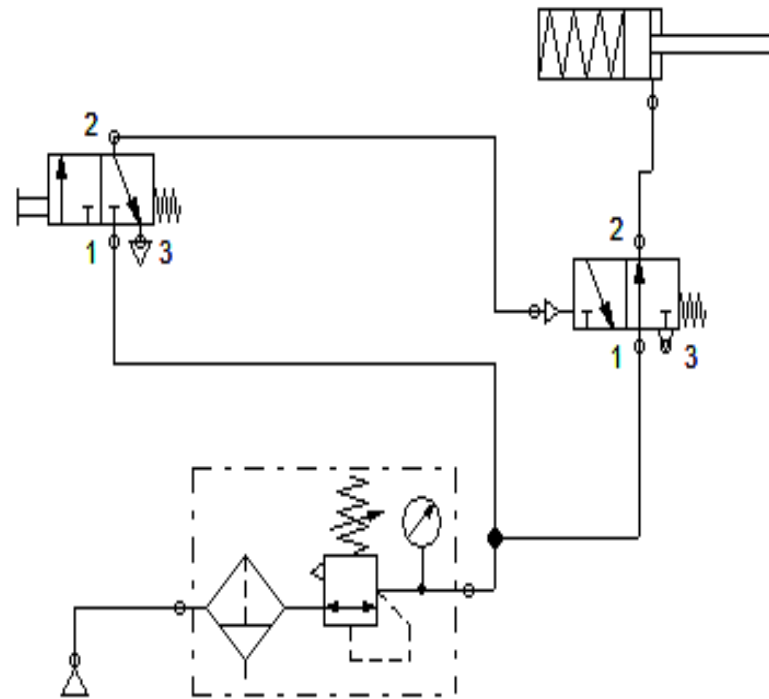
**9. Write about the Mechatronics approach in a micro-processor – controlled washing machine?**

In the microprocessor-controlled washing machine, a mechanical system has become integrated with electronic controls. As a consequence, a bulky mechanical system is replaced by a much more compact microprocessor system, which is readily adjustable to give a greater variety of programs.

**10. What is the larger scale application of Mechatronics?**

A larger scale application of Mechatronics is a Flexible Manufacturing engineering System (FMS) involving computer – controlled machines, robots, automatic material conveying and overall supervisory control.

**Ex. No:**



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF PNEUMATIC CIRCUITS IMPULSE PILOT  
OPERATION OF SINGLE ACTING CYLINDER**

**AIM:**

To operate a single acting cylinder using an impulse pilot valve in pneumatic trainer kit

**APPARATUS REQUIRED:**

- Air service unit (Power Source unit)
- FRL Unit
- Single acting cylinder
- 3/2 push button spring return DCV
- 3/2 Pilot operated spring return DCV.
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the single acting cylinder was operated an impulse pilot valve in Pneumatic Trainer kit.

## **Viva Questions**

### **1. What is pneumatic direction control valve?**

Pneumatic direction control valve is used to control the direction of air path. These Valves have generally two, three, four (or) five ports: These ports are designated as P: Compressor line port R: Exhaust port (T is case of hydraulics) A, B: Working ports connected to actuator.

### **2. What is the use of Time Delay Valves?**

Pneumatic time delay valves are used to delay operations where time based sequences are required.

### **3. What is a fast exhaust valve?**

A fast exhaust valve is used to vent cylinder quickly. It is primary used with spring return (single acting) pneumatic cylinders.

### **4. Differentiate between hydraulic and pneumatic systems?**

The working fluid of hydraulic system is water (or) oil (or) any liquid. The working fluid of pneumatic circuit is air Hydraulic systems are designed for heavy loads where as pneumatic systems are designed for low (or) medium loads.

### **5. What is the function of pneumatic circuit using quick exhaust valve?**

By quickly exhausting the air from the cylinder, the cylinder speed can be exhausted.

### **6. What is Time delay circuit?**

In certain applications, the impulse to the main direction control valve may have to be delayed to pre-determined time for different operational reasons. A pneumatic time delay valve may be used in such cases. A pneumatic circuit using this time delay valve is known as time delay circuit.

### **7. What is the use of compressor?**

A compressor is a machine which compresses air (or) any other gas from atmospheric pressure to a desired higher pressure level.

**8. Define FRL unit.**

Air is not clean and hence contamination may result in pneumatic circuit. Also, due to time fluctuations, the receiver air pressure does not remain constant. Also, some parts of the Pneumatic system have to be lubricated for proper maintenance. For cleaning the air, regulating the pressure of air and lubricating pneumatic parts, three units 'Filter - Pressure Regulator - Lubricator' (Trio unit) are put together and this combined unit - Trio unit - is called FRL unit.

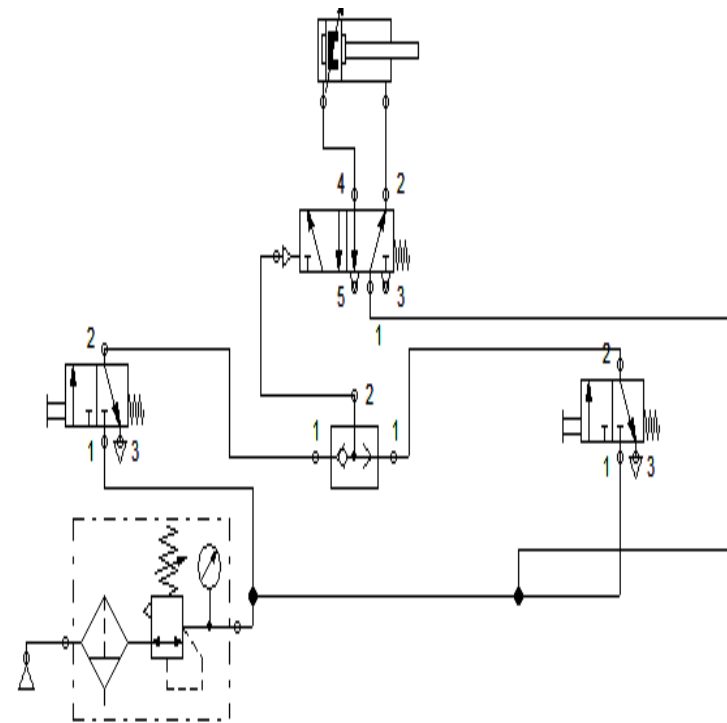
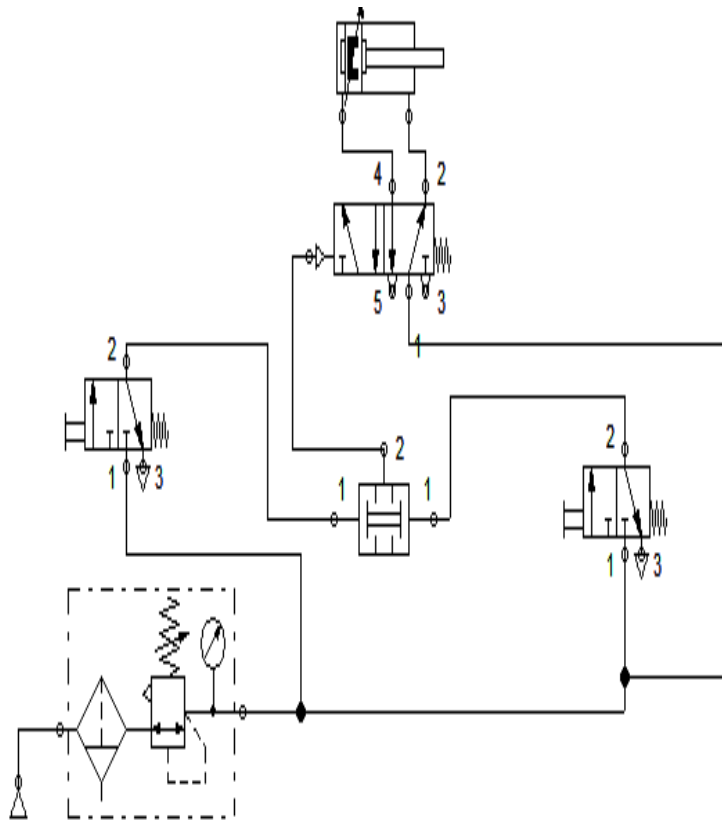
**9. Name two basic types of compressors?**

1. Positive displacement compressors
2. Dynamic (Turbo) compressors.

**10. Differentiate between single acting and double acting compressors.**

- In a single acting compressor, the compression takes place on one side of the piston for each revolution of crank shaft.
- In a double acting cylinder, compression takes place on both faces of the piston giving two compression strokes for each revolution of the crankshaft.

**Ex. No:**



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF PNEUMATIC CIRCUITS OPERATION OF  
DOUBLE ACTING CYLINDER WITH AND & OR LOGIC CIRCUIT**

**AIM:**

To operate a double acting cylinder using AND & OR logic circuit in Pneumatic Trainer Kit

**APPARATUS REQUIRED:**

- Air service unit (Power Source unit)
- FRL Unit
- Double acting cylinder
- 3/2 push button spring return DCV
- 3/2 single pilot spring return DCV
- AND/OR logic valve
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the double acting cylinder using AND & OR logic circuit was operated in Pneumatic Trainer kit.

## **Viva Questions:**

### **Viva Questions**

**1. Define kinematic pair.**

The two links or elements are joined together to form a pair. If the relative motion between them is completely or successfully constrained, the pair is known as kinematic pair.

**2. When is cascade control needed?**

The need for cascade control will occur when a final control element experiences signal overlap ie; when a trip valve mechanism is still held down, but the output signal has been use and requires removal.

**3. List the features of synchronous motor.**

It operates at a current speed from no load to full load  Power factor of the motor can be controlled easily

**4. What is a stepper motor?**

A stepper motor is a rotating machine which converts a DC voltage pulse into a series of discrete rotational steps. Each step position is an equilibrium position without further excitation; this makes it ideally suitable for the use with digital control

**5. What is stepper motor?**

A stepper motor is a device which transforms electrical pulses into equal increments of rotary shaft motion called steps.

**6. What is servomotor?**

The motors used in automatic control systems or in servomechanism are called servomotors. They are used to convert electrical signal into angular motion.

**7. What is synchro?**

A synchro is a device used to convert an angular motion to an electrical signal or vice versa.

**8. At what conditions SPDT, DPST an DPDT switches are used?**



a. SPDT (Single Pole, Double Throw): When we require ON and OFF operation as the circuit is actuated, SPDT is used. b. DPST (Double Pole, Single Throw): When we need to turn two separate circuits ON and OFF simultaneously with a single switch, DPST is used. c. DPDT (Double Pole, Double Throw): When a switch is turned ON and OFF between N and O with double pole switches, DPDT is used.

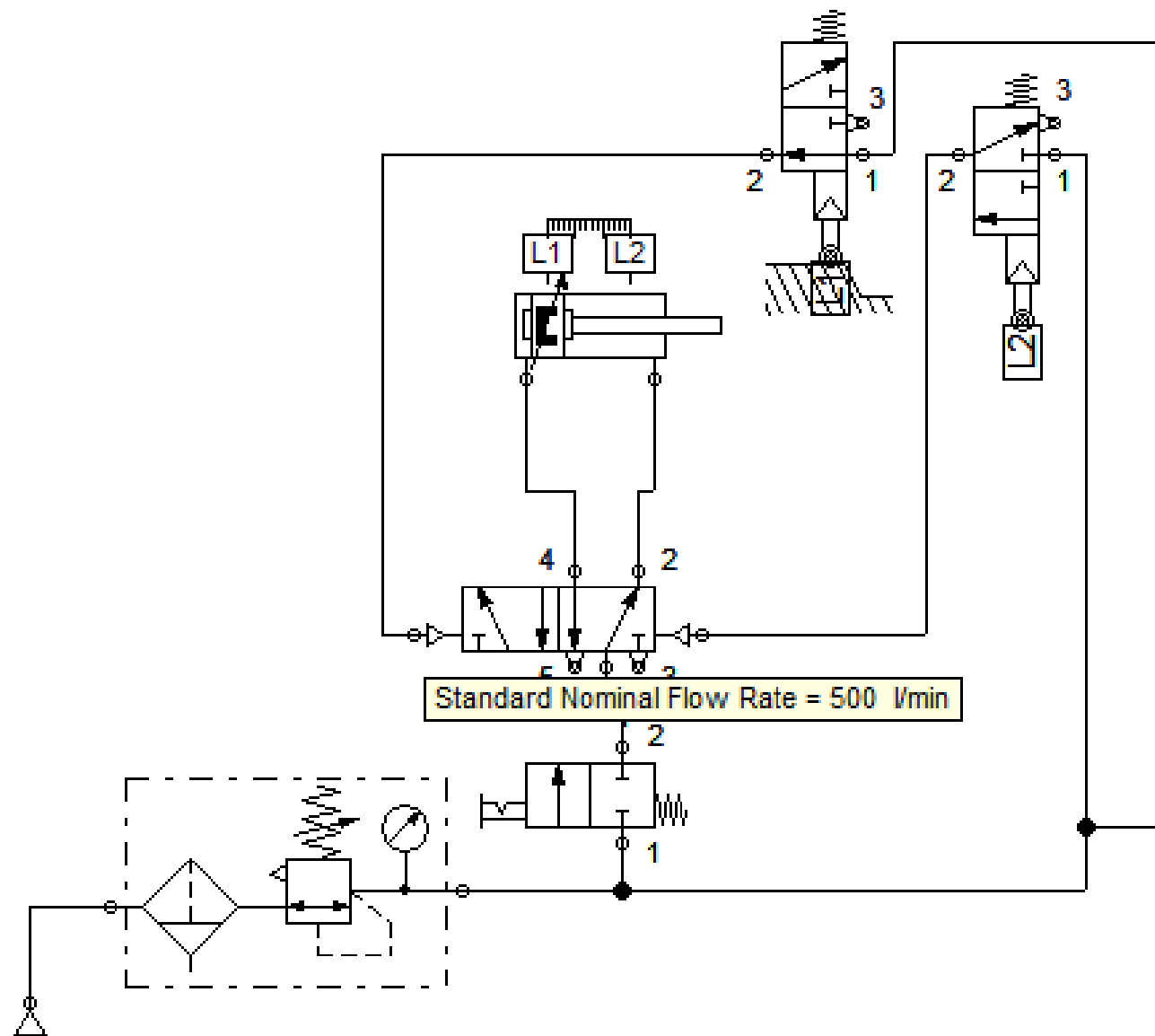
**9. What are the factors to be considered for selecting solenoids?**

a. The size of the mechanical load. b. The movement distance of plunger. c. The type of electrical connections. d. The type of value of current and voltage.

**10. What is the principle of relay?**

Relay is used for many control functions and essentially an electro-mechanical switch. It uses basic switching principles and solenoid actuation.

Ex. No:



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF PNEUMATIC CIRCUITS SINGLE  
CYCLE AUTOMATION OF DOUBLE ACTING CYLINDER  
USING LIMIT SWITCH**

**AIM:**

To operate automatic operation of double acting cylinder in a single cycle using limit switch in Pneumatic Trainer Kit.

**APPARATUS REQUIRED:**

- Double acting cylinder
- 3/2 Roller Operated Spring Return DCV
- 5/2 Pilot Operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the single cycle automation of double acting cylinder was operated by using limit switch in Pneumatic Trainer Kit.

## Viva Questions

**1. What is a Fluid Power System?**

A system that transmits and controls power through use of a pressurized fluid within an enclosed circuit.

**2. Define Pascal's -Law.**

A pressure applied to a confined fluid at rest is transmitted with equal intensity throughout the fluid.

**3. Define back Pressure.**

The pressure encountered on the return side of a fluid system.

**4. State the Bernoulli's principle?**

If the flow rate in the system is constant, then the total energy in the system will also be constant irrespective of the variation in the cross section of the fluid passages.

**5. Define Accumulator.**

A container in which liquid is stored under pressure as a source of fluid power.

**6. Explain non-separator type gas loaded accumulator?**

In this type, the gas is filled at the top and the heavy oil at the bottom of the shell. There is no separator between the gas and oil and thus the pressurized gas pushes the oil directly.

**7. What is the function of accumulator?**

Accumulator is used as an auxiliary power source. It is a device which stores the potential energy of the fluid. The stored potential energy in the accumulator acts as a quick secondary source of power and does useful work as required by the system.

**8. What is the use of bleed-off circuit?**

Bleed off circuit is used to control the flow of fluid in both directions of flow (or) on a specific line and limits speed in only one direction of the cylinder travel.

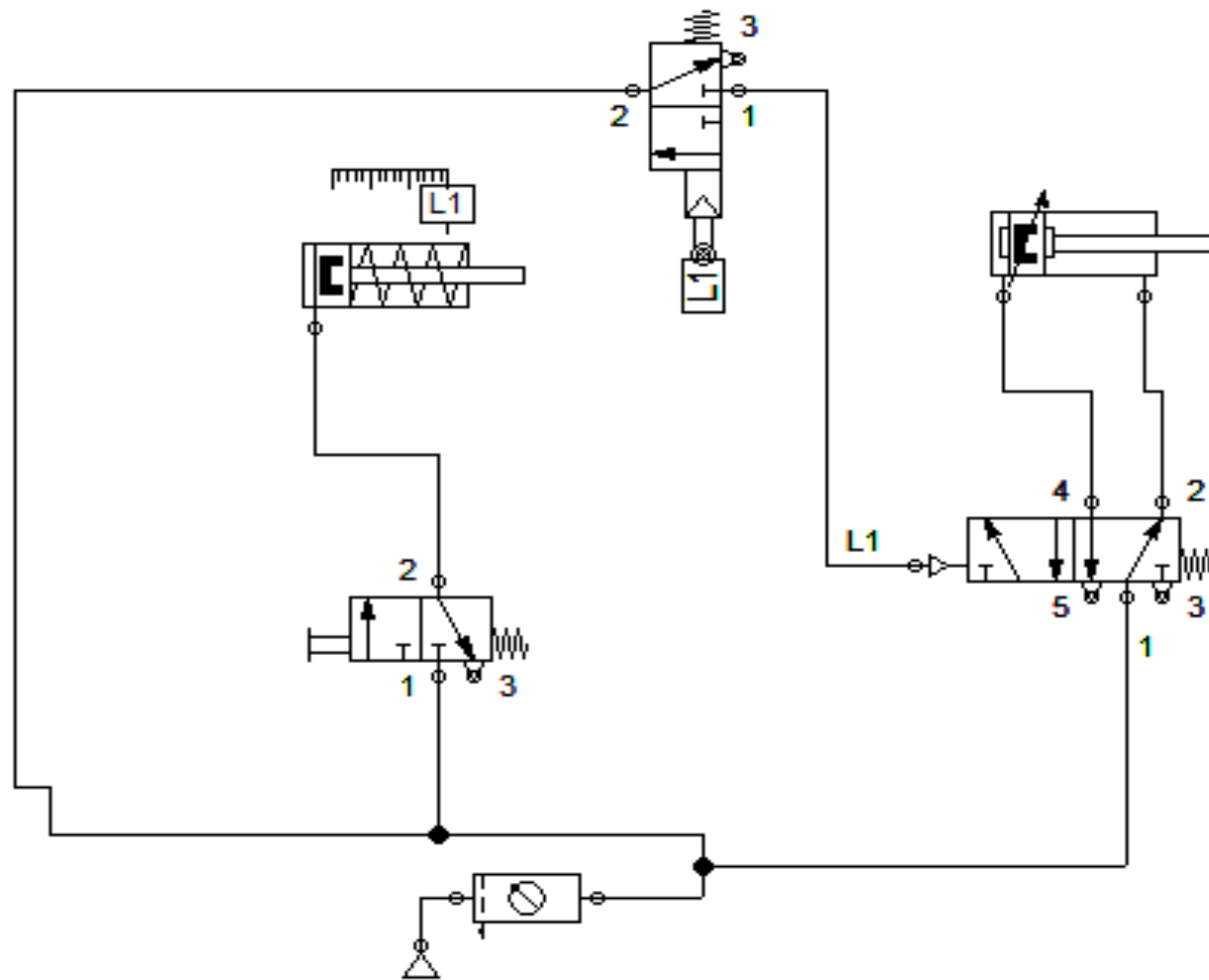
**9. What is a sequencing circuit?**

Process control pneumatics is also called as sequencing. It means performing number of actions one after another which follows each other in a simple order or with an order determined by sensors.

**10. What is pneumatic direction control valve?**

Pneumatic direction control valve is used to control the direction of air path. These Valves have generally two, three, four (or) five ports: These ports are designated as P: Compressor line port R: Exhaust port (T is case of hydraulics) A, B: Working ports connected to actuator.

Ex. No:



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF PNEUMATIC CIRCUITS SINGLE CYCLE  
AUTOMATION OF MULTIPLE CYLINDERS IN SEQUENCES (A<sup>+</sup>B<sup>+</sup>B<sup>-</sup>A<sup>-</sup>)**

**AIM:**

To operate single cycle automation of multiple cylinders in sequences A<sup>+</sup>B<sup>+</sup>B<sup>-</sup>A<sup>-</sup> in Pneumatic Trainer Kit.

**APPARATUS REQUIRED:**

- Double acting cylinder
- Single acting cylinder
- 3/2 Roller Operated Spring Return DCV
- 5/2 single Pilot Operated DCV
- 3/2 pilot operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the single cycle automation of multiple cylinders operated sequence (A<sup>+</sup>B<sup>+</sup>B<sup>-</sup>A<sup>-</sup>) in Pneumatic Trainer Kit.

## **Viva Questions**

### **1. List some of the applications of Mechatronics?**

1. Home Appliances: Washing machine, Bread machines etc 2. Automobile: Electrical fuel injection, Antilock brake system 3. Aircraft: Flight control, Navigation system 4. Automated Manufacturing

### **2. What are the components of Mechatronics System?**

1. Actuators 2. Sensors 3. Signal Conditioning units 4. Digital control devices 5. Graphical Displays

### **3. What is meant by a system in Mechatronics?**

The System is the group of physical component combined to perform a specific function. Any Mechatronics devices consists of systems

### **4. What are the main applications of Mechatronics?**

Washing machines, dish washers, micro ovens, cameras, camcorders, robots, automatic conveyors, computer-controlled machines

### **5. Obtain the basic functions of control systems.**

1. To minimize the error between the actual and desired output 2. To minimize the time response to load changes in the system

### **6. What are the types of control system?**

- Open loop system
- Closed loop system

### **7. List down the requirements of control systems.**

- Stability
- Accuracy
- Response

**8. Give an example for open loop system and closed loop systems.**

1. Closed loop system – Automatic water level controller 2. open loop system - Electric fire

**9. What are the basic elements of feedback system?**

- Forward path
- Feedback path
- Error detecting device
- Amplifier
- Compensating network

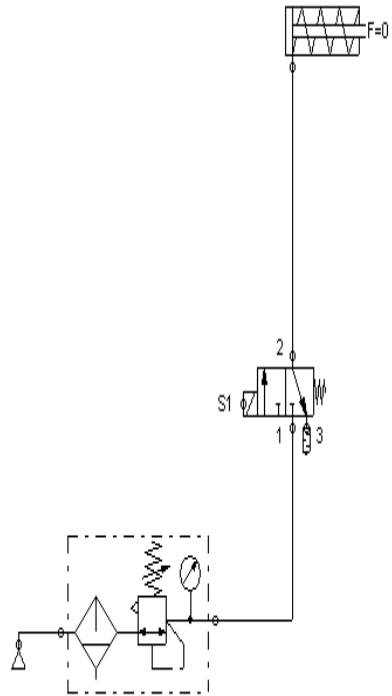
**10. What is meant by sequential control what are the two modes in it?** A system operating with sequential control is one where a set of prescribed operations are performed in sequence. The modes are,

- Event – based mode
- Time – based mode

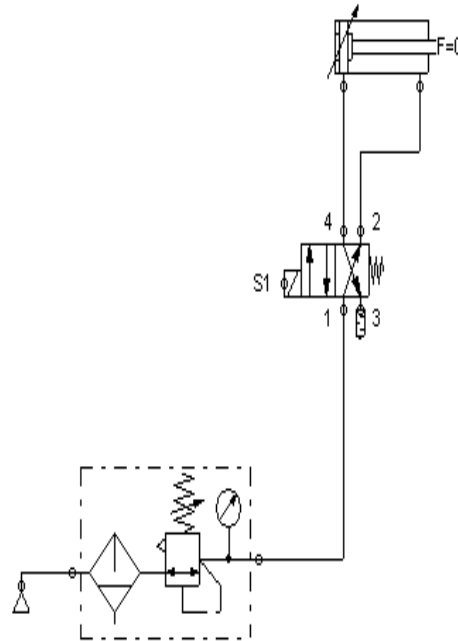
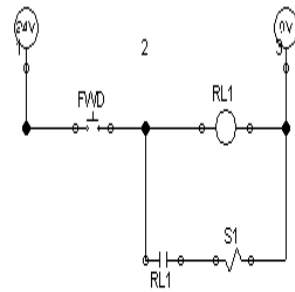


**EXPERIMENTS ON ELECTRO-PNEUMATICS TRAINER  
KIT**

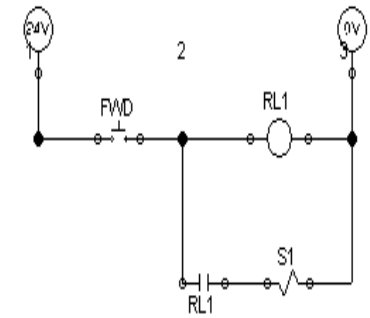
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**LADDER DIAGRAM**



**LADDER DIAGRAM**



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF ELECTRO-PNEUMATIC CIRCUITS  
OPERATION OF SINGLE AND DOUBLE ACTING CYLINDER USING  
SINGLE SOLENOID VALVE**

**AIM:**

To operate single and double acting cylinder using the single solenoid valve in Electro Pneumatic Trainer Kit.

**APPARATUS REQUIRED:**

- Single and double acting cylinders
- Input / Output Relay Box
- 3/2 Solenoid operated spring return DCV
- 5/2 Solenoid operated spring return DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the single and double acting cylinder was operated using the single solenoid valve in Electro Pneumatic Trainer Kit.

## **Viva Questions**

**1. Mention the various components of a hydraulic system.**

- Motor
- Filter
- Pump
- Pressure Regulator
- Control Valve
- Piston and cylinder

**2. What is called a pneumatic system?**

System using gas for power transmission are called pneumatic systems and industrial system are usually based on air.

**3. List down the components of pneumatic system.**

- Motor driven compressor
- Air receiver
- Directional control
- Pneumatic cylinder

**4. What is the purpose of using filters in the hydraulic systems?**

Filters are used to prevent dirt or dust entering important elements of hydraulic system like valves, seals, etc. Filters are used to remove very finer particles.

**5. What are the types of pumps used as energy source in a hydraulic system?**

- Centrifugal Pump(Hydrodynamic Pumps)
- Positive displacement pump

1. Gear Pumps 2. Vane Pumps 3. Piston pumps

**6. What are the factors to be considered for selecting compressors?**

The type of air compressor is selected dependent on quality of air, pressure and cleanliness

**7. What are the uses of air receiver?**

An air receiver is used to store high pressure air and provide constant supply of air pressure in the pneumatic system regardless of varying and fluctuating consumption. It is used for the emergency supply of air to the system in case of power failure.

**8. State the purpose of providing air dryers.**

The aim is to reduce the temperature of the air to a dew point which ensures that the water in the air condenses and drops out easily.

**9. State the function of a control valve.**

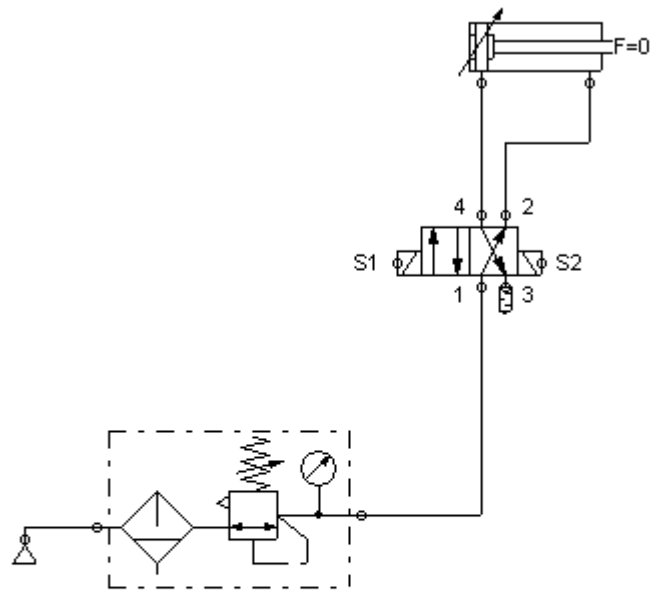
The primary function of the control valve is to direct and regulate the flow of fluid from an energy source to various loading devices. Normally the control valves are used for the purpose of sensing, processing ,and controlling. They are used for:

- Allowing the passage of air/fluid and directing it to a loading line
- Cancel the signal by blocking its passage
- Alert or generate the signal
- Release the air to atmosphere or return the fluid to tank

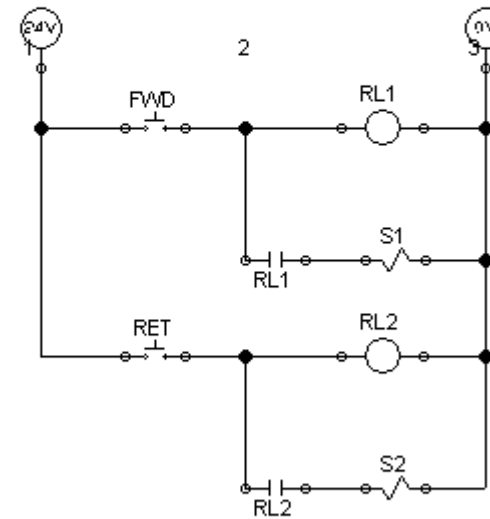
**10. Define the term degrees of freedom.**

The minimum number of independent displacement required to specify the system completely is called degrees of freedom

**Ex. No:**



### LADDER DIAGRAM



**Ex. No:**

**Date :**

**DESIGN AND TESTING OF ELECTRO-PNEUMATIC CIRCUITS  
OPERATION OF DOUBLE ACTING CYLINDER USING DOUBLE  
SOLENOID VALVE**

**AIM:**

To operate double acting cylinder using double solenoid valve in Electro Pneumatic Trainer Kit.

**APPARATUS REQUIRED:**

- Double acting cylinder
- Input / Output Relay Box
- 5/2 Double solenoid operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Design and draw circuit diagram as per the given application.
- Connect the FRL unit to the main air supply.
- The various components are connected as per circuit.
- Block the valve operation if necessary.
- Check the leakage of air supply and correct it.
- Open the valve and operate the cylinder.

**RESULT:**

Thus the double acting cylinder was operated using the double solenoid valve in Electro Pneumatic Trainer Kit.

## **Viva Questions**

### **1. What are the types of loops?**

Loops can be classified in to two groups. They are, a. Continuous loop b. Conditional loop.

### **2. Write about the continuous loop?**

A continuous loop is a set up by using the unconditional jump instruction. A program with a continuous loop does not stop repeating the tasks until the system is reset.

### **3. Write about the conditional loop?**

A conditional loop is set up by the conditional jump instructions. The instructions check flags (Zero, Carry etc.,) and repeat the specified tasks if the conditions are satisfied. These loops usually include counting and indexing.

### **4. What are the instructions of a 8085 instruction set for data transfer from memory to the microprocessor?**

The 8085 instruction set includes three memory transfer instructions. They are, a.MOV R,M : Move from Memory to Register b.LDAX B/D : Load Accumulator Indirect c.LDA 16 – bit : Load Accumulator Direct

### **5. What are the instructions of a 8085 instruction set for data transfer from microprocessor to the memory?**

The 8085 instruction set includes three memory transfer instruction. They are, a. MOV. R,M : Move from Memory to Register b. STAX B / D : Store Accumulator Indirect c. STA 16 – bit : Store Accumulator Direct d. MVI M, 8 – bit : Load 8 – bit data in memory.

### **6. What are the opcodes related to rotating the accumulator bits?**

The opcodes related to rotating the accumulator bits are, a. RLC – Rotate Accumulator Left through Carry b. RAL – Rotate Accumulator Left c. RRC – Rotate Accumulator Right through Carry d. RAR – Rotate Accumulator Right

### **7. What is dynamic debugging?**

After the steps have been completed in the process of static debugging, and if the program still does not produce the expected output, attempt is made to debug the program by observing the execution of instructions. This is called dynamic debugging.



**8. What are the tools used for dynamic debugging?**

The tools used for dynamic debugging are, a. Single step b. Register examine c. Break point.

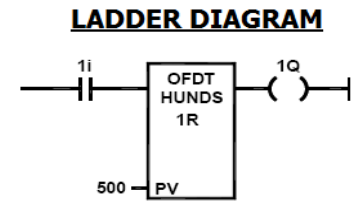
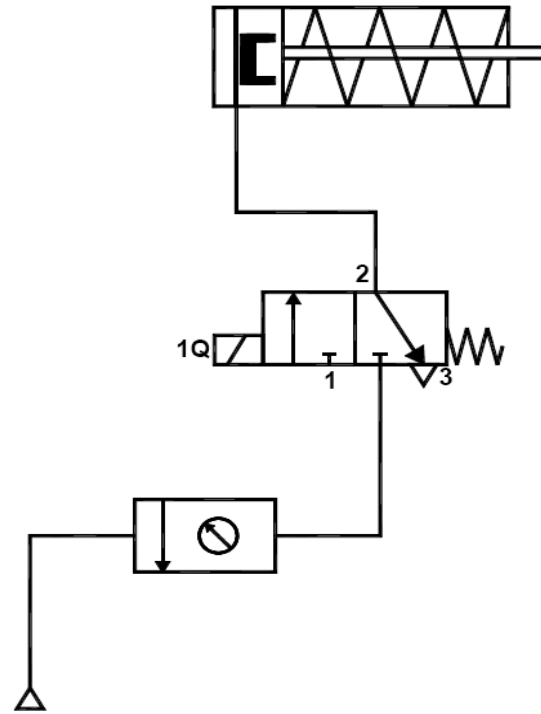
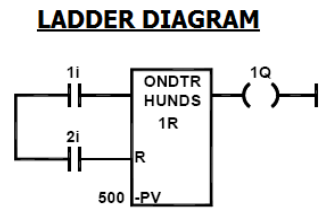
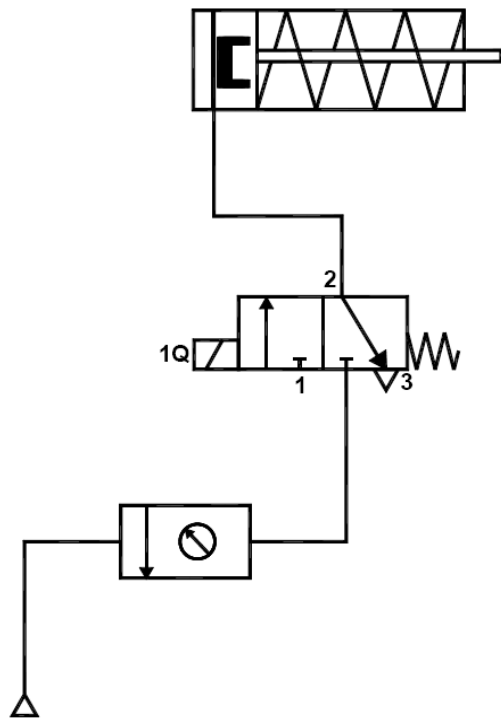
**9. Write about single step?**

The single step key on a keyboard allows to execute one instruction at a time, and to observe the results following each instruction. Generally, a single-step facility is built with a hard-wired logic circuit. When the single step key is pushed, addresses and codes are observed as they are executed.

**10. What are the advantages of single step?**

With the single step technique, it is able to spot, a. Incorrect addresses b. Incorrect jump locations for loops c. Incorrect data or missing codes.

# **EXPERIMENT ON ELECTRO-PNEUMATIC WITH PLC**



**Ex. No:**

**Date :**

## **ACTUATION OF SINGLE ACTING CYLINDER WITH ON AND OFF DELAY TIMER USING PLC**

**AIM:**

To simulate the single acting cylinder with ON and OFF delay timer in Electro Pneumatic with PLC Trainer Kit.

**APPARATUS REQUIRED:**

- Single acting cylinder
- PLC
- Versa Pro Software
- Input / Output Relay Box
- 3/2 Solenoid operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Draw the circuit diagram.
- Provide +24V and -24V from PLC trainer to panel
- Open the versa pro software in desktop
- Interface PLC with PC using RS232 cable.
- Write a ladder diagram
- Output of PLC (Q1) is direct connecting to input of solenoid coil.
- Following the opening procedure of versa pro software.
- Check the ladder diagram.
- Connect the air supply to FRL unit.
- Run the PLC
- Some delay the cylinder should be activated

**RESULT:**

Thus the actuation of single acting cylinder with ON and OFF delay timer was done using Electro Pneumatic with PLC Trainer Kit.

## **Viva Questions**

### **1. What is meant by automation?**

Automation of a process plant (or) a flow line is done by means of specially designed machinery and equipments, which represent the highest level of automation. Chemical processing and automated assembly lines are examples of such automation.

### **2. What are the salient features of "Low cost Automation".**

In most of the industrial plants, centralized compressed air supply will exist. Hence, simple automation of machining sequences (or) material handling can be done without much expense. Low cost automation is attempted without going for a major alteration of the existing set up. Low cost automation enhances productivity. The sequencing pneumatic circuit is an example of "Low cost Automation"

### **3. Name two types of control systems?**

1. Open loop control system
2. Closed loop control system.

### **4. Explain Fluidic Logic Control?**

In many plants, closed loop control is achieved by electronic devices based on I different logic functions such as AND, OR, NOT and MEMORY. Logic controls can be defined as design of control system based on reasoning arising out of deductive principle. However, the electronic control system is not only control system used in industries. If the pneumatic control system using low pressure air is used to achieve the above logic control functions, then it is known as fluidic Logic Control.

### **5. How pump cavitation is identified?**

Cavitation is the inability of a pump to draw a full charge of oil either because of air leaks or restrictions in the inlet line. When a pump starts to cavitate, its noise level increases and it may become very hot around the shaft and front bearing. Other symptoms of cavitation are erratic movement of cylinders, difficulty in building up full pressure, and a milky appearance of the oil.

### **6. What is air receiver?**

Air receiver is a large cylindrical vessel used to store high pressure air from the compressor. Large surface area of the receiver dissipates the heat of compression (heat in the compressed air) to the surrounding atmosphere. It will have safety relief valve, pressure indicator and temperature switches.

### **7. Define open channel flow.**

Flow of liquid with a free surface (i.e., surface exposed to atmosphere) through any passage is known as open channel flow. The liquid flowing through any closed passage without touching the top can also be treated as open channels.

### **8. What are the various types of flow in open channels?**

The flow in open channel is classified into the following types:

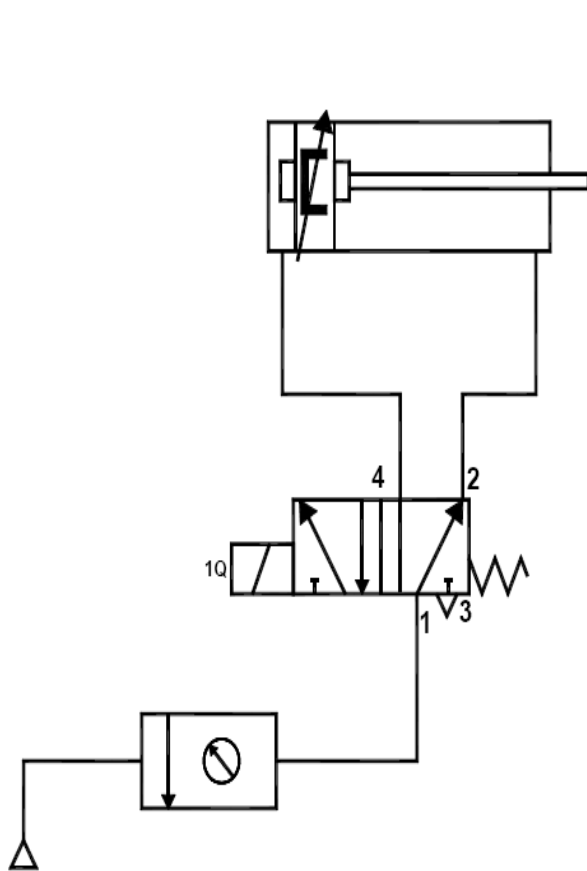
- (a) Steady and unsteady flow
- (b) Uniform and non-uniform flow
- (c) Laminar and turbulent flow
- (d) Subcritical, critical and supercritical flow.

### **9. What is meant by fluidics?**

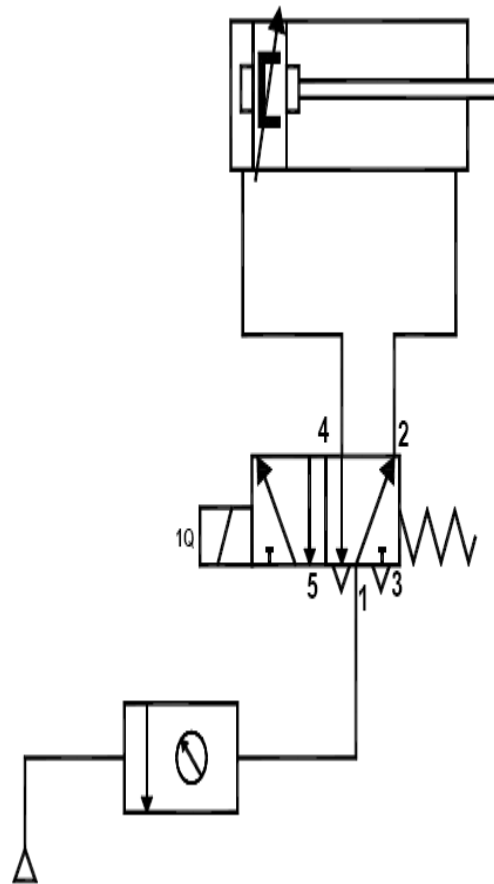
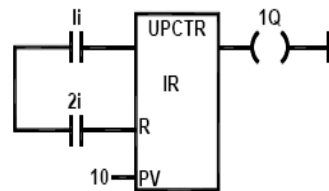
Fluidics is the branch of science which deals with Liquids, Gaseous systems, components, design, and applications of above in the industries to perform useful work.

## **10.What is Low Cost Automation?**

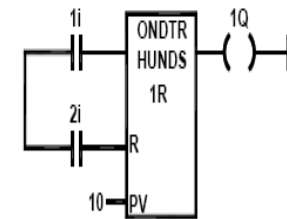
There are five stages of manufacturing process for automation namely 1. Loading 2. Clamping 3. Machining 4. Unclamping 5. Unloading. The cost involved in loading and unloading stages is very high. So, in semi automation, these two states are done manually and other stages are automated. Semi automation can be profitably being incorporated in manufacturing industries. This type of automation is called "Low Cost Automation" Also, in many industries, automation is done in selected areas to enhance the productivity. Material handling and machine sequence are examples of such type of automation.



**LADDER DIAGRAM**



**LADDER DIAGRAM**





**Ex. No:**

**Date :**

## **CONTROL OF DOUBLE ACTING CYLINDER WITH UP AND DOWN COUNTER USING PLC**

**AIM:**

To simulate the double acting cylinder with UP and DOWN counter using Electro Pneumatic with PLC Trainer Kit.

**APPARATUS REQUIRED:**

- Double acting cylinder
- PLC
- Versa Pro Software
- Input / Output Relay Box
- 5/2 Solenoid operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Draw the circuit diagram.
- Provide +24V and -24V from PLC trainer to panel
- Open the versa pro software in desktop
- Interface PLC with PC using RS232 cable.
- Write a ladder diagram
- Output of PLC (Q1) is direct connecting to input of solenoid coil.
- Following the opening procedure of versa pro software.
- Check the ladder diagram.
- Connect the air supply to FRL unit.
- Run the PLC
- Some count the cylinder should be activated

**RESULT:**

Thus the actuation of double acting cylinder with UP and DOWN counter was done using Electro Pneumatic with PLC Trainer Kit.

## **Viva Questions**

### **1. Write about the conditional loop?**

A conditional loop is set up by the conditional jump instructions. The instructions check flags (Zero, Carry etc.,) and repeat the specified tasks if the conditions are satisfied. These loops usually include counting and indexing

### **2. How will you interface the I/O devices?**

I/O devices can be interfaced using two techniques. They are,

Peripheral – mapped I/O

Memory – mapped I/O

### **3. What are A/D and D/A converter?**

The electronic signal that translates the analog signal into digital signal is called analog to digital (A/D) converter. The electronic signal that translates the digital signal into analog signal is called digital to analog (D/A) converter.

### **4. What is a PLC?**

A programmable Logic Controller (PLC) is defined as a digital electronic device that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting and arithmetic in order to control machines and processes.

### **5. What is main advantage of PLC?**

PLC's have great advantage that it is possible to modify a control system without having to rewire the connections to the input and output devices

### **6. Write about the architecture of a PLC?**

It consists essentially of a central processing unit (CPU), memory and input/output circuitry. The CPU controls and processes all the operations within the PLC. It is supplied with a clock with a frequency between 1 and 8 MHz. It also has a bus system, memory and input/output units, a system ROM for permanent storage, RAM for the users program and temporary buffers.

## **7. What is ladder programming?**

The ladder programming involves each program task being specified as though a rung of a ladder. Thus such a rung could specify that the state of switches A and B, the inputs, be examined and if A and B are both closed then a solenoid, the output is energized.

## **8. How are programs entered?**

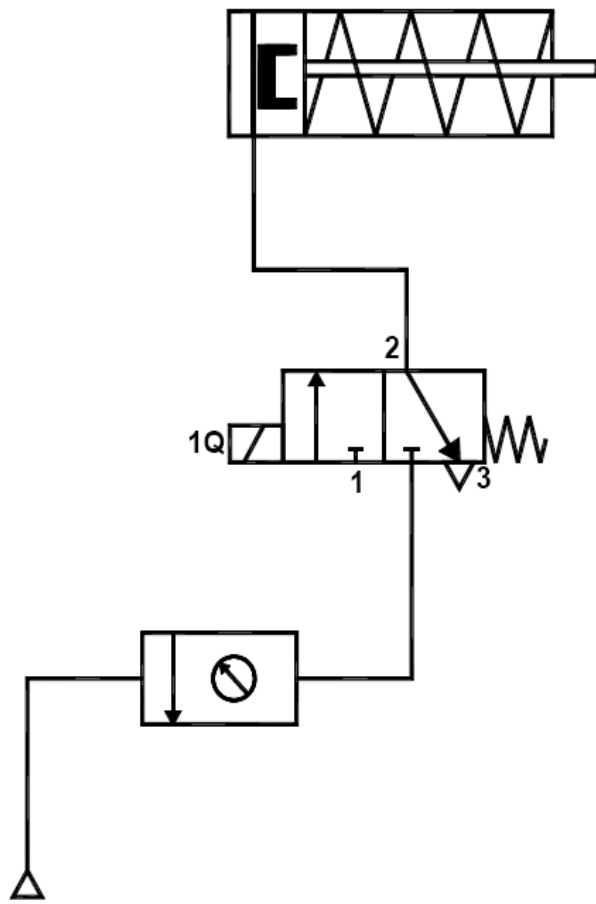
Programs are entered into the input / output unit from a panel, which can vary from small keyboards with liquid crystals to those using a visual display unit (VDU) with keyboard and screen display. Alternatively, the programs can be entered into the system by means of a link to a PC.

## **9. What are the features of PLC as a controller?**

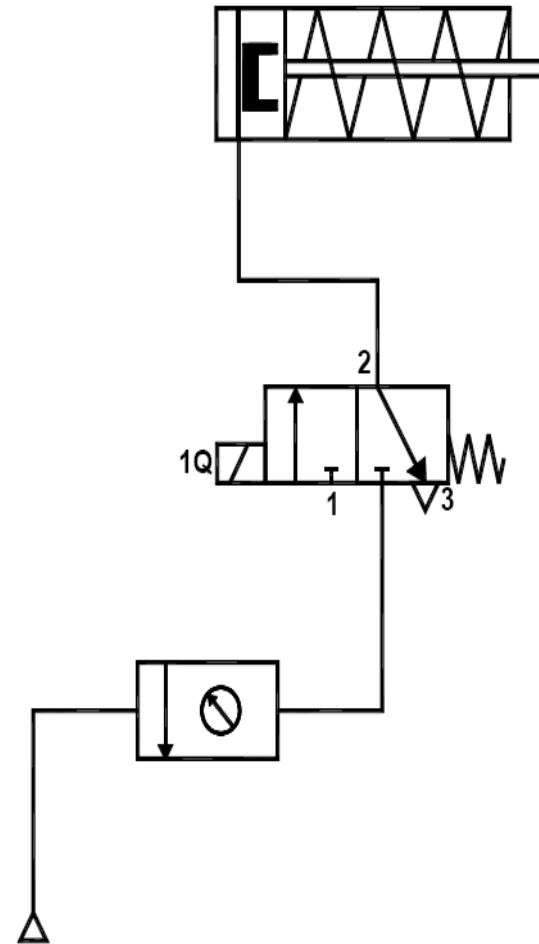
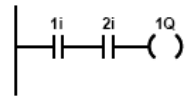
- They are rugged and designed to withstand vibrations, temperature, humidity and noise.
- The interfacing for inputs and outputs is inside the controller.
- They are easily programmed and have an easily understood programming language

## **10. Write about the input / output channels?**

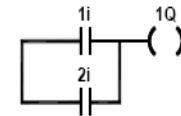
The input/output channels provide signal conditioning and isolation functions so that sensors and actuators can be generally directly connected to them without the need for other circuitry. Common input voltages are 5 V and 24V. Common output voltages are 24 V and 240 V



**LADDER DIAGRAM**



**LADDER DIAGRAM**



**Ex. No:**

**Date :**

## **OPERATION OF SINGLE ACTING CYLINDER WITH AND & OR LOGIC USING PLC**

**AIM:**

To simulate the single acting cylinder with AND & OR logic using Electro Pneumatic with PLC Trainer Kit.

**APPARATUS REQUIRED:**

- Single acting cylinder
- PLC
- Versa Pro Software
- Input / Output Relay Box
- 3/2 Solenoid operated DCV
- FRL unit
- Connecting Tubes

**PROCEDURE:**

- Draw the circuit diagram.
- Provide +24V and -24V from PLC trainer to panel
- Open the versa pro software in desktop
- Interface PLC with PC using RS232 cable.
- Write a ladder diagram
- Output of PLC (Q1) is direct connecting to input of solenoid coil.
- Following the opening procedure of versa pro software.
- Check the ladder diagram.
- Connect the air supply to FRL unit.
- Run the PL
- When two input (1i & 2i) are high, the output is high (For AND gate)
- When any one input (1i & 2i) is high, the output is high (For OR gate)

**RESULT:**

Thus the double acting cylinder with AND & OR logic was done using Electro Pneumatic with PLC Trainer Kit.

## **Viva Questions**

### **1. Write about the relay?**

With the relay type, the signal from the PLC output is used to operate a relay and so is able to switch currents of the order of a few amperes in an external circuit. The relay isolates the PLC from the external circuit and can be used for both D.C. and A.C. switching. Relays are, however, relatively slow to operate.

### **2. What are opto isolators?**

Opto isolators are used with transistor switches to provide isolation between the external circuit and the PLC. They are also used to provide isolation.

### **3. What are the methods used for input / output processing?**

There are two methods used for input / output processing. They are

- a. Continuous updating
- b. Mass input/output copying.

### **4. What is continuous updating?**

This involves the CPU scanning the input channels as they occur in the program instructions. Each input point is examined individually and its effect on the program determined. Each input is scanned with a 3 ms delay, before the program has the instruction for a logic operation to be executed and an output to occur. This process is called continuous updating.

### **5. What is the disadvantage of continuous updating?**

Because of the 3 ms delay in the continuous updating on each input, the time taken to examine several hundred input/output points can become comparatively long.

### **6. Write about the mass input/output copying?**

To allow a more rapid execution of a program, a specific area of RAM is used as a buffer store between the control logic and the input/output unit. At the start of each program cycle the CPU scans all the inputs and copies their status into the input/output address in RAM. At the end of each program cycle all the outputs are transferred from RAM to the output channels. The outputs are latched so that they retain their status until the next updating

**7. What is a LATCH circuit?**

The term latch circuit is used for the circuit used to carry out such an operation. It is a self – maintaining circuit in that, after being energized, it maintains that state until another input is received. It remembers its last state.

**8. Define the term point and delay–on?**

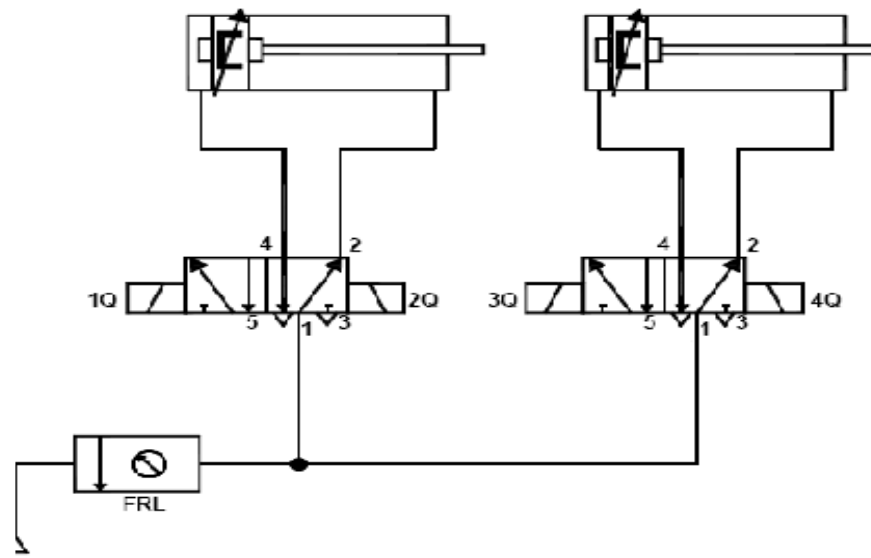
The term point is used for a data point and so is a timing, marker (internal relay) or counter element. Thus, the 16 points for timers means that there are 16 timer circuits. The term delay on is used to indicate that this type of timer waits for a fixed delay period before turning on.

**9. Write about timer circuit?**

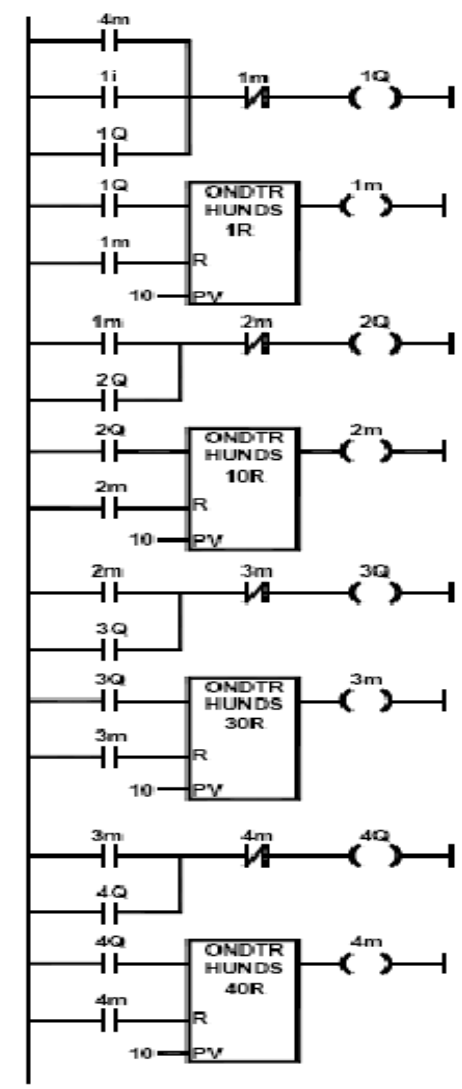
A timer circuit is specified by stating the interval to be times and the conditions or events that are to start and / or stop the timer. They are commonly regarded as delays with coils which, when energized, result in the closing or opening of input contacts after some preset time.

**10. Write about internal relays?**

The term internal relay, auxiliary relay or marker is used for what can be considered as an internal relay in the PLC. These behave like relays with their associated contacts, but in reality are not actual relays with their associated by the software of the PLC. Internal relays are often used when there are programs with multiple input conditions.



## LADDER DIAGRAM





**Ex. No:**

**Date :**

## **AUTOMATION OF MULTIPLE CYLINDERS IN SEQUENCE ( $A^+B^+A^-B^-$ ) USING PLC**

### **AIM:**

To operate single cycle automation of multiple cylinders in sequence ( $A^+B^+A^-B^-$ ) using Electro Pneumatic with PLC Trainer Kit.

### **APPARATUS REQUIRED:**

- Single and double acting cylinders
- PLC
- Versa Pro Software
- Input / Output Relay Box
- 5/2 Solenoid operated DCV
- 2/2 Solenoid operated DCV
- FRL unit
- Connecting Tubes

### **PROCEDURE:**

- Draw the circuit diagram.
- Provide +24V and -24V from PLC trainer to panel
- Open the versa pro software in desktop
- Interface PLC with PC using RS2332 cable.
- Write a ladder diagram
- Both output of PLC (Q1, Q2, Q3 and Q4) is direct connecting to input of solenoid coil.
- Following the opening procedure of versa pro software.
- Check the ladder diagram.
- Connect the air supply to FRL unit.
- Run the PLC
- Observe the working of double acting cylinder is automatic reciprocating using the circuit  $A^+B^+A^-B^-$

### **RESULT:**

Thus the single cycle automatic of multiple cylinder is operated in sequence ( $A^+B^+A^-B^-$ ) was done using Electro Pneumatic with PLC Trainer Kit.

## **Viva Questions**

### **1. Write about counters?**

Counters are used when there is a need to count a specified number of contact operations. Example – where items pass along a conveyor into boxes, and when the specified number of items has passed into a box the next item is diverted into another box.

### **2. What is an up counter?**

An up counter would count up to the preset value i.e., events are added until the number reaches the set value. When the set value is reached the counters contact changes state.

### **3. What is a down counter?**

Down counter means that the computer counts down from the preset value to zero i.e., events are subtracted from the set value. When zero is reached the counters contact changes state.

### **4. Write about shift register?**

The term shift register is used because the bits can be shifted along by one bit when there is a suitable input to the register.

### **5. What are the inputs of shift register?**

There are three inputs of shift register. They are,

- a. One to load data into the first element of the register (OUT).
- b. One as the shift command (SFT).
- c. One for resetting (RST).

### **6. What is the criteria need for the selection of a PLC?**

- Input/output capacity is required.
- Types of inputs/outputs are required.
- Size of memory required.
- Speed and power is required for the CPU.

**8. What are the advantages of the microprocessor controlled system?**

The microprocessor controlled system can cope easily with giving precision and programmed control. The system is much more flexible. This improvement in flexibility is a common characteristic of Mechatronics systems when compared with traditional systems.

**9. What is the advantage of using PLC solution over mechanical solution?**

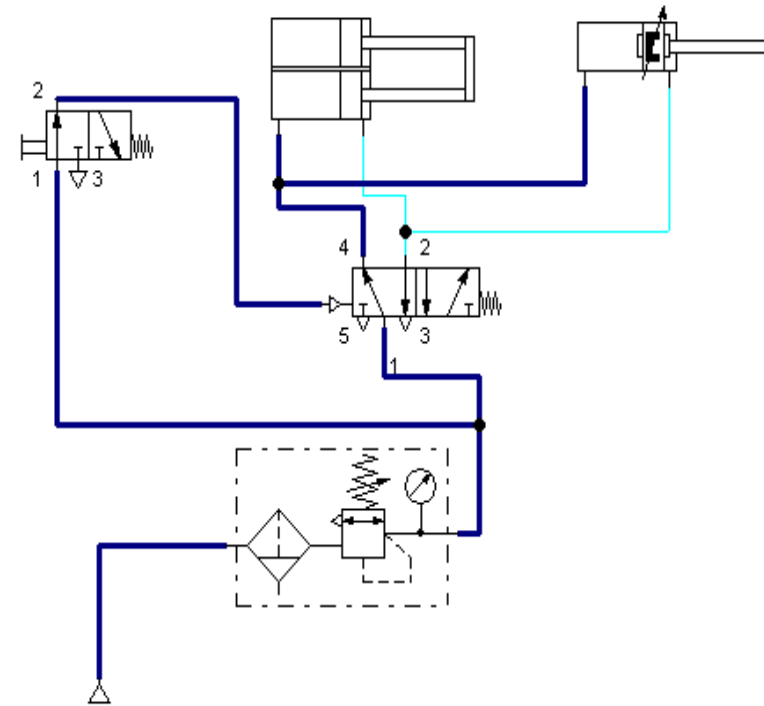
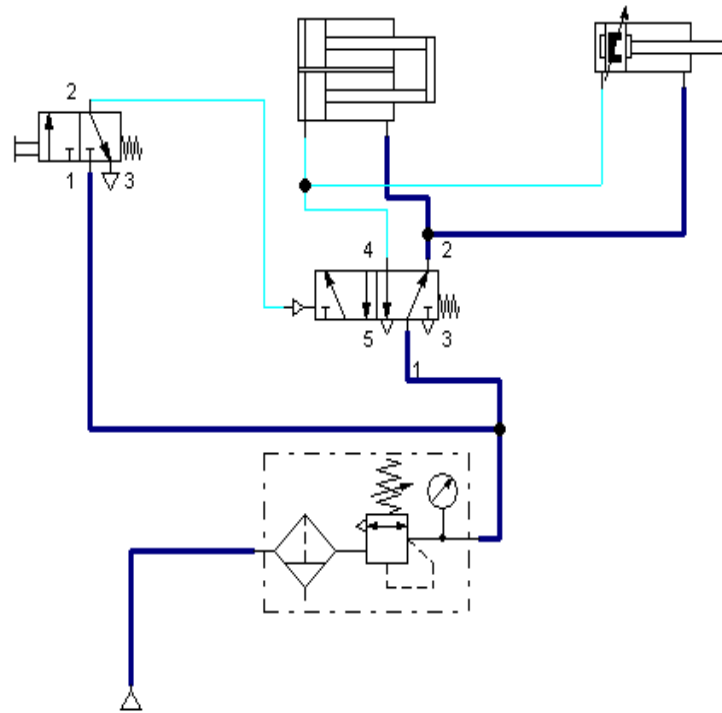
A PLC solution could involve the arrangement with the given ladder program. This would have the advantage over the rotating cam of having off and on times which can be adjusted by purely changing the timer preset values in the program whereas a different cam is needed if the times have to be changed with the mechanical solution

**10. What is the use of PLC in automatic car park system?**

An illustration of the use of a PLC in the coin operated barriers for a car park. The in-barrier is to open when the correct money is inserted in the collection box and the out – barrier is to open when a car is detected at the car park side of the barrier.

# **EXPERIMENTS ON FLUID SIM SOFTWARE**

**Ex. No:**



**Ex. No:**

**Date :**

## **SIMULATION OF BASIC PNEUMATIC, HYDRAULIC AND ELECTRICAL CIRCUITS USING FLUID-SIM SOFTWARE**

**AIM:**

To simulate the Pneumatic, Hydraulic and Electrical circuit with single acting, double acting cylinders by manual and automatic mode using pneumatic simulation software (Fluid-SIM).

**REQUIREMENTS:**

- Personal Computer
- FLUID SIM (Pneumatic and Hydraulic) Software's

**PROCEDURE:**

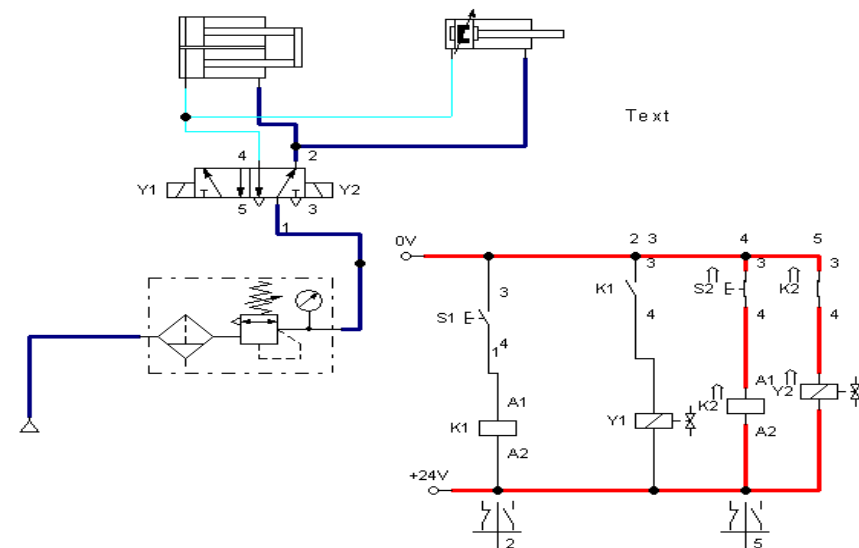
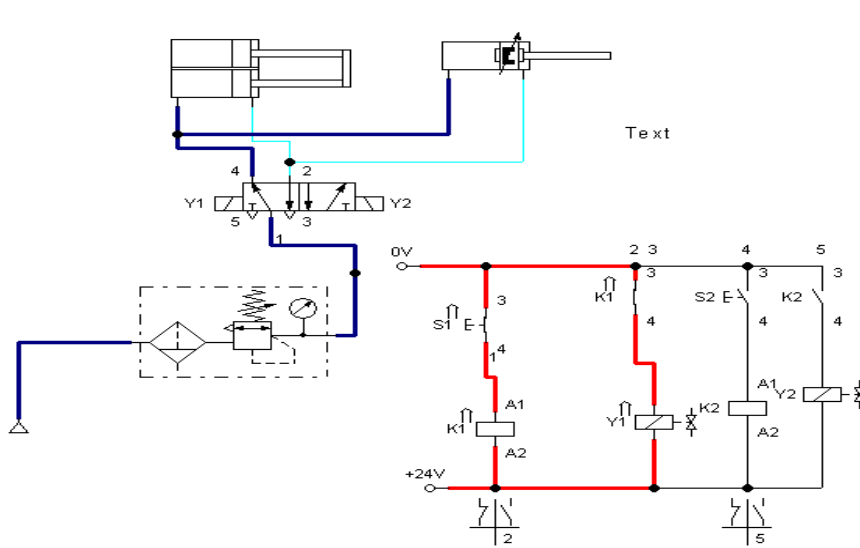
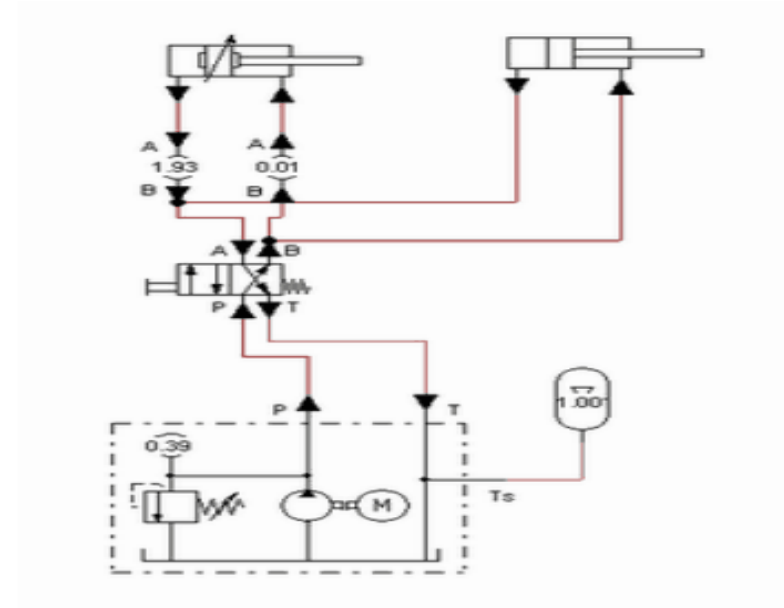
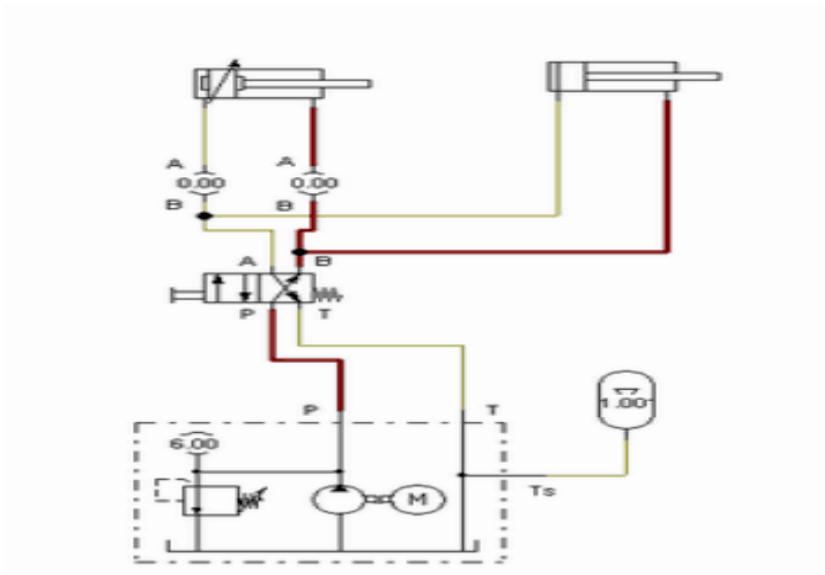
### **SIMULATION OF PNEUMATIC CIRCUITS**

- Open the software in the personal computer.
- Select the new file in it.
- Click on the supply elements and then select, copy, paste the compressor.
- Click the attenuator and then select copy, paste the single and double acting cylinder.
- Then select, copy, paste the required components as per the given application 3/2, 5/2 single and double solenoid valve etc.
- Select the air supply unit.
- Connect all the components.
- Start and operate the single, double acting cylinders.

### **SIMULATION OF HYDRAULIC CIRCUITS**

- Open the software in the personal computer.
- Select the new file in it.
- Click on the supply elements and then select, copy, paste the pump and tanks.
- Click the attenuator and then select copy, paste the single and double acting cylinder.
- Then select, copy, paste the required components as per the given application 3/2, 5/2 single and double solenoid valve.
- Connect all the components
- Start and operate the single, double acting cylinders.

Ex. No:



## **SIMULATION OF ELECTRICAL CIRCUITS**

- Open the software in the personal computer.
- Select the new file in it.
- Click on the supply elements and then select, copy, paste the power supply (24 V and 0V) unit, compressor and pump and tanks.
- Click the attenuator and then select copy, paste the single and double acting cylinder.
- Then select, copy, paste the required components as per the given application 3/2, 5/2 single and double solenoid valve, electrical switches and relay etc.
- Connect all the components
- Start and operate the single, double acting cylinders.

### **RESULT:**

Thus the Pneumatic, Hydraulic and Electrical circuit for single acting and double acting cylinder was simulated using FLUIDSIM software.



## **Viva Questions**

**1. Give an example for event-based and time-based sequential control.**

- Time-based Water Heater
- Event-based Domestic washing machine

**2. What is the purpose of a sensor?**

Sensor is used for an element which produces a signal relating to the quantity being measured. I.e., an electrical resistance temperature element, the quantity being measured is temperature and the sensor transforms an input of temperature into a change in resistance.

**3. Define transducer?**

The term transducer is often used in place of the term sensor. Transducer is defined as elements that when subject to some physical change experience a related change. Thus, sensors are transducers.

**4. What are the terms that define the performance of the transducers?**

1. Range and span
2. Error
3. Accuracy
4. Sensitivity
5. Hysteresis error
6. Non – linearity error
7. Repeatability / reproducibility
8. Stability
9. Dead band / time
10. Resolution
11. Output impedance.

**5. Define static characteristics?**

The static characteristics are the values given when the steady – state conditions occur. i.e., the values given when the transducer has settled down after having received some input.

**6. Define dynamic characteristics?**

The dynamic characteristics refer to the behavior between the time that the input value changes and the times that the value given by the transducer settles down to the steady – state value. Dynamic characteristics are stated in terms of the response of the transducer to inputs in particular forms.

**7. What are the terms that you can find from the dynamic characteristics?**

1. Response time.
2. Time constant.
3. Rise time
4. Settling time.

**8. What is a displacement sensor?**

Displacement sensors are concerned with the measurement of the amount by which some object has been moved

**9. What is a position sensor?**

Position sensors are concerned with the determination of the position of some object with reference to some reference point.

**10. What is a proximity sensor?**

Proximity sensors are a form of position sensor and are used to determine when an object has moved to within some particular critical distance of the sensor

# STUDY OF IMAGE PROCESSING TECHNIQUE

## Objective:

At the end of the lab session, students will have the information's on image, digital image, and the processing techniques.

## Image

An image may be defined as a two dimensional function  $f(x,y)$ , where 'x' and 'y' are spatial coordinates, and the amplitude of 'f' at any pair of coordinates x,y is called intensity or gray level of the image at that point.

## Digital Image

'x', 'y' and the amplitude 'f' are all finite and discrete quantities means then the image is called as digital image.

## Image resolution

Image resolution is defined as the number of pixels that can be accommodated in a unit area. Image resolution depends on number of values for N and number of bits used in a gray level (m). If N and 'm' is high, then the resolution will be more.

## Hue

Hue is an attribute associated with the dominant wavelength in a mixture of light waves. Thus hue represents dominant colour as perceived by an observer eg., red, yellow.

It refers to relative purity or the amount of white light mixed with the hue. The pure spectrum colours are fully saturated (RGB). Colour such as pink and lavender are less saturated. ie., The degree of saturation being inversely proportional to the amount of white light added. Hue and saturation taken together are called chromaticity.

## Image Histogram

An image histogram is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value.

Horizontal axis → tonal variations

Vertical axis → represents the number of pixels in that particular tone.

The left side of the horizontal axis represents the black and dark areas, the middle represents medium grey and the right hand side represents light and pure white areas. The Vertical axis represents the size of the area that is captured in each one of these zones.

The histogram for the very dark image will have the majority of its data points on the left side and centre of the graph.

The histogram for the very bright image with few dark areas is shadows will have most of its data points on the right side and the centre of the graphs.

## FFT Transform

Typically, 2-D-Fourier transform (2-D-FT) is used as the representation of complex SAR images. However, the energy of the coefficients of 2-D FT on the complex SAR image distributes in the whole frequency domain. Generally, the frequency signals are divided into real and imaginary parts, and quantized with Lloyd-Max quantize. However, the compression ratios of the frequency domain compression algorithms are almost limited in 10.4:1 or 9.8:1, which are not very high. Wavelet transform can locally analyze time and frequency in multiscale and shows very strong decorrelation ability. As it is particularly suitable for non stationary signal processing, wavelet transform has been applied to complex SAR image compression currently; most compression algorithms of complex SAR image adopt the traditional wavelet transform.

However, for the complex SAR images, which are rich in edges and texture, traditional wavelet transform does not show efficient representation. proposed an algorithm which extracted edges of SAR image with wedge let transform and encoded the edges and texture separately. used 2-D oriented wavelet transform for remote sensing compression.

The SAR images used in are not complex SAR images. To the best of our knowledge, directional wavelet transform has not be applied to the compression of complex SAR images. Directional wavelet transform achieves the direction extraction while keeping the property of multiscale analysis of discrete wavelet transform (DWT). Directional wavelet transform can be divided into two classes: frequency-domain transform and spatial-domain transform.

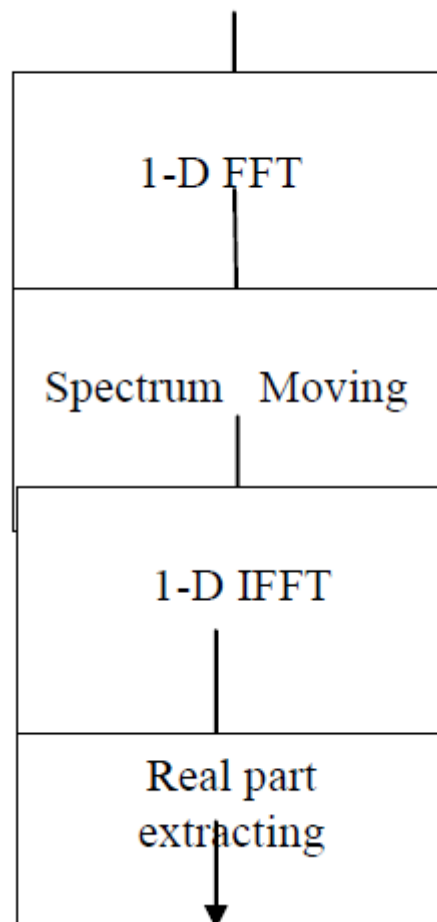
The frequency-domain directional wavelet transform, such as contour let which continuously performs directional filter on the high-frequency sub bands of wavelet transform, gives an efficient representation of the edges at the cost of high redundancy. The spatial-domain directional wavelet, such as directional lifting wavelet transform (DLWT), employs direction prediction for wavelet decomposition, which adapts the wavelet transform direction to the image edges. DLWT integrates spatial direction prediction into the wavelet transform lifting framework, provides an efficient representation of edges along multiple directions of images, and thus reduces the energy of high-frequency bands and achieves more energy clustering.

As the real parts and imaginary parts of complex SAR image as well as the real image of fast FT (FFT) are rich in edges, two complex SAR image coding schemes using DLWT are proposed. Fourier Transform (FT) with its fast algorithms (FFT) is an important tool for analysis and processing of many natural signals. FT has certain limitations to characterise many natural signals, which are non stationary (e.g. speech). Wavelet compression system consists of several components: **1)** filters and algorithms for performing wavelet decomposition and reconstruction, **2)** a bit allocation strategy, and **3)** quantizers. In order to minimize algorithm complexity and to reduce susceptibility to channel errors, the quantizer output is not encoded with an entropy or arithmetic coder. Side information concerning normalization and bit allocation can be coded in only a few bits for an entire image.

The wavelet transform is a relatively new technique for decomposition of a data set with orthogonal (or nonorthogonal) basis functions and is becoming widely used in image compression. The orthogonal wavelet decomposition provides a multi resolution representation of a signal over an orthonormal basis. It offers several advantages for SAR data compression:

1. The decomposition of an image into a representation selective both in frequency and spatial orientation allows allocation of quantization bits to "important" components.
2. Algorithms for performing a wavelet decomposition and reconstruction are recursive, computationally efficient, and easily implemented in hardware. The computation of a wavelet transform, as described by Mallat, has a computational burden on the order of  $O(N \log N)$ . Fast wavelet transform algorithms can reduce the computational burden.
3. The decomposition of an image into a pyramid of detail images results in a set of coefficients that have reduced dynamic range compared to the original image. This is particularly important for compression of SAR imagery due to its very large dynamic range.
4. A wavelet multiscale decomposition of an image is convenient for progressive image transmission. A coarse resolution image can be selected from a sensor or database, and then a) browsed at coarse resolution for data quality, data validation, correct location, etc. and or processed by algorithms which require only coarse resolution input data, or b) a subset of the image can be transmitted and displayed at the finest available resolution.

### Complex SAR Image



## **SAR Image**

Synthetic aperture radar (SAR), which is an all-time, all-weather microwave imaging system, is an important tool for achieving information in the application field of microwave remote sensing. With synthetic aperture radar (SAR) developing along the directions of high resolution, multi polarization, multiband, and multimode, the quantity of SAR image data rises steadily. Data compression technology is an effective way to alleviate the pressure of transmission and storage on SAR system.

## **Complex SAR Image**

The complex SAR image, which consists of amplitude and phase, is the first level image data of the SAR system. The phase information fidelity in complex SAR image is crucial to some special applications, such as interferometry and moving target detection. Therefore, complex SAR image compression requires not only reasonable amplitude fidelity but also high phase information accuracy, which is different from the ordinary optical image compression.

Furthermore, compared with optical images, complex SAR images exhibit significantly higher dynamic range and less spatial correlation. Thus, common optical image compression algorithms are not suitable for the compression of complex SAR images. Efficient representation is important to the compression of complex SAR images.

Reconstructions of the compressed detected imagery were of good to excellent quality at data rates as low as 0.25 bpp (compression ratio of 32 : 1 when compared to an uncompressed data rate of 8 bpp). Visual impressions of the imagery were much better than the SNR's implied. SNR's for compressed SAR imagery are lower than those reported for optical imagery because the high spatial frequency speckle of SAR imagery does not get accurately reconstructed during the compression process.

However, accurate reconstruction of speckle is of virtually no importance to human interpretation of SAR imagery. Complex data rates are expressed as bits per real or imaginary element (bpe), which corresponds to twice the data rate of detected data since each pixel consists of two elements. Even when complex data rates are reported in bits per element, the quality of the reconstructed complex images is poorer than that of the reconstructed detected images; both shadows and objects are less well defined in the complex compressed imagery. Reasonable looking images were obtained at data rates as low as 0.5-1 bpe or 1-2 bpp. On the other hand, since complex imagery is commonly represented with a two-byte integer for each real and imaginary part, a compressed data rate of 1 bpp (0.5 bpe) corresponds to a 32:1 compression ratio for complex data.

The first scheme directly encodes real parts and imaginary parts of complex SAR images using the CCSDS algorithm which replaces DWT by DLWT. The second scheme first converts a complex image into a real image using FFT, and then encodes the real image in the CCSDS coding algorithm which also replaces DWT by DLWT.

Compared with the original CCSDS image coding schemes using DWT, the proposed two coding schemes show significant performance gain not only in amplitude peak signal-to-noise ratio (PSNR) but also in mean phase error (MPE). the best in terms of PSNR and structure similarity (SSIM)]. However, the coding algorithm based on DLWT achieves better rate-distortion performance than that of DWT. It is because the rate-distortion performance of coding algorithm is determined not only by the number of significant coefficients, but also by the position distribution of significant coefficients, i.e., the clustering capability of significant coefficients. b the coding bits of significant coefficients with CCSDS algorithm with K-term nonlinear approximation gets less PSNR and SSIM than DWT, DLWT coefficients need less actual coding bits for the same number of significant coefficients than DWT.

Therefore, at the same bit rate, we can encode more coefficients with DLWT than DWT, and then DLWT may outperform DWT in terms of rate-distortion performance eventually. DLWT consuming less coding bits is due to the better clustering capability. In the first approach the complex image data is converted to a real data format using a FFT scheme without neglecting any phase information. Shifting the frequency spectrum by the half bandwidth to positive frequencies, one obtains a negative spectrum equal to zero. After applying the inverse Fourier transform, the resulting complex signal can be represented by its real part without loss of any information, since real and imaginary part of the signal are mutual Hilbert transforms.

The sampling rate are doubled, but because of only using the real part of the converted signal the data amount is not raised. The particular advantage of this transformation is, that the wavelet decomposition and compression schemes can be applied as usual to ordinary intensity data. The reconstructed complex image data is received by undoing the FIT transformation scheme in reverse order.

In the second approach the complex image data is divided into magnitude and phase, applying two different compression techniques to both parts. The magnitude of the complex image data has the same properties as intensity SAR data and can be compressed, using the discrete wavelet transform and a compression scheme described below.

The phase of the data is uniformly distributed and highly decorrelated, so that a nearly lossless compression technique has to be used. In this paper a vector quantizer was chosen for that. The codebook of the vector quantizer is trained, using a typical image area of a similar image. In both schemes a block adaptive Max quantizer was used with a fixed 5 bit quantization, either for the magnitudes of the image data in our first approach or for the real part of the converted complex image data in our second approach.

Additionally, a vector quantizer is used on the Max-quantized data, grouping neighbouring image pixels to specific vectors. The phase of the image data in the second approach is always quantized by a vector quantizer without utilization of a block adaptive Max quantizer. The complex SAR data set, we used for both compression methods, was taken in X-Band by the experimental SAR of DLR during a mission in 1996 and shows a part of Mount Etna.

For each approach two numerical examples **are** given with different compression ratios Both proposed schemes lead to good visual image quality as where only one compression example of each approach is depicted. The histograms of the reconstructed image magnitudes are also maintained with respect to their originals.

The image quality parameters SNR and PSNR as well as the mean phase error (MPE) and phase standard deviation (PSD) for all the four examples are listed in the first table with their resulting compression ratio. Additionally, the second approach is extended to multi polarization mode. The magnitudes of four polarization channels are separately quantized using a block adaptive Max quantizer with a fixed 5 bit quantization as well. The low-pass component of the final wavelet decomposition was linearly quantized with maximum quantization.



## **Viva Questions**

### **1. Define Image.**

An Image may be defined as a two dimensional function  $f(x,y)$  where  $x$  &  $y$  are spatial (plane) coordinates, and the amplitude of  $f$  at any pair of coordinates  $(x,y)$  is called intensity or gray level of the image at that point. When  $x,y$  and the amplitude values of  $f$  are all finite, discrete quantities we call the image as Digital Image.

### **2. Define Image Sampling.**

Digitization of spatial coordinates  $(x,y)$  is called Image Sampling. To be suitable for computer processing, an image function  $f(x,y)$  must be digitized both spatially and in magnitude.

### **3. Define Quantization.**

Digitizing the amplitude values is called Quantization. Quality of digital image is determined to a large degree by the number of samples and discrete gray levels used in sampling and quantization.

### **4. What is Dynamic Range?**

The range of values spanned by the gray scale is called dynamic range of an image. Image will have high contrast, if the dynamic range is high and image will have dull washed out gray look if the dynamic range is low.

### **5. Define Mach band effect.**

The spatial interaction of Luminance from an object and its surround creates a Phenomenon called the mach band effect.

### **6. Define Brightness.**

Brightness of an object is the perceived luminance of the surround. Two objects with different surroundings would have identical luminance but different brightness.

### **7. Define Tapered Quantization.**

If gray levels in a certain range occur frequently while others occurs rarely, the quantization levels are finely spaced in this range and coarsely spaced outside of it. This method is sometimes called Tapered Quantization.

### **8. What do you meant by Gray level?**

Gray level refers to a scalar measure of intensity that ranges from black to grays and finally to white.

## **9. Define Resolutions.**

Resolution is defined as the smallest number of discernible detail in an image. Spatial resolution is the smallest discernible detail in an image and gray level resolution refers to the smallest discernible change in gray level.

## **10. What do you mean by Zooming of digital images?**

Zooming may be viewed as over sampling. It involves the creation of new pixel locations and the assignment of gray levels to those new locations.

## **MODELLING AND ANALYSIS OF BASIC HYDRAULIC SYSTEMS USING LAB VIEW**

### **Aim:**

To actuate the hydraulic cylinder and find out the force vs. Pressure and 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 for force vs. Pressure**

- Switch on the electrical power supply with motor.
- Switch on the power supply to the control unit.
- Open the lab view software in the system.
- Inter face hydraulic trainer with system using RS-232.
- Open the force. Go to operate, click the run. Than power on (below).
- Now extend the system by pressing the up button.
- Load cell indicate the force value in the monitor.
- Now adjust the pressure regulator and set the maximum pressure as 25kg/cm<sup>2</sup>.
- Retract the cylinder.
- Once again forward the cylinder; you have adjusted the pressure in pressure regulator.
- You have seen the force value in monitoring.
- Repeat the force value for different pressure.

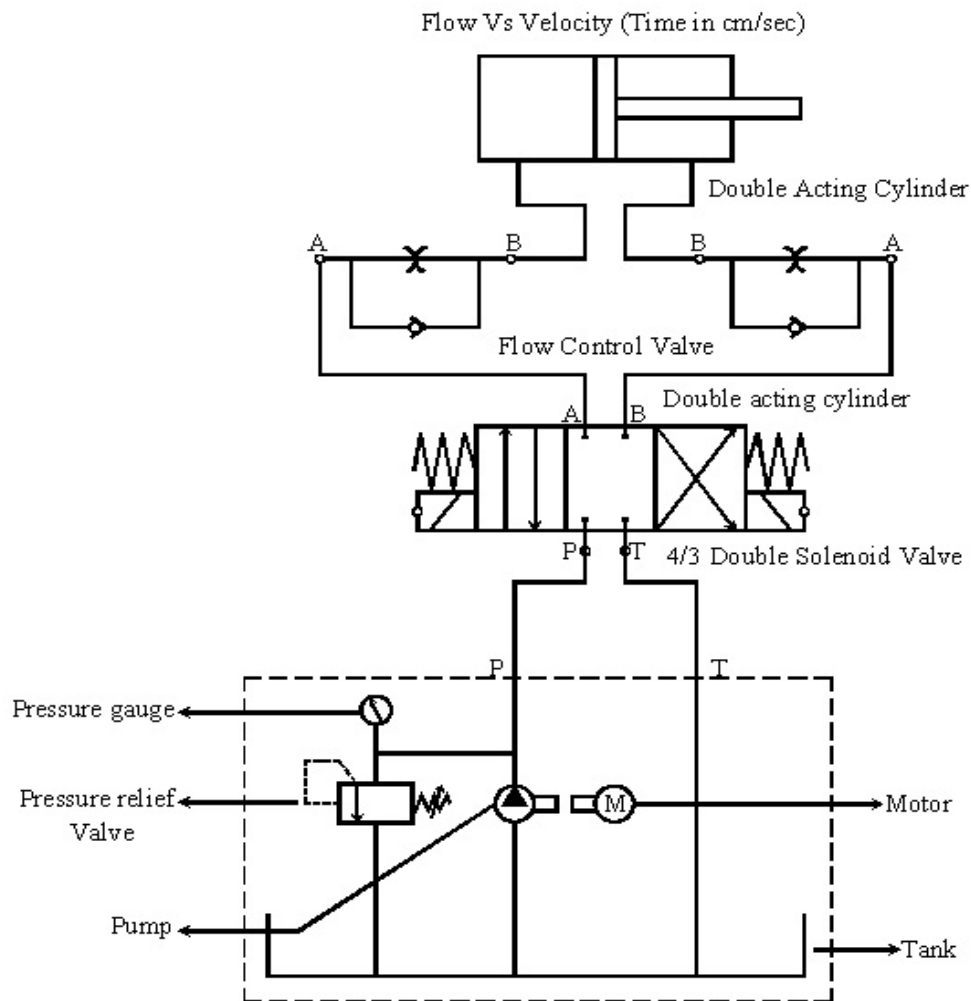
### **Procedure speed vs. Discharge**

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

- Now adjust the flow control valves and set the maximum flow, to find the up and velocity.
- Repeat the velocity values for different flows

**STUDY REPORT:**

# HYDRAULICS CIRCUIT



## COMPONENT DESCRIPTION

### Hydraulic system power pack with load cell

#### 1. Motor:

Rotation Per minute	: 1426rpm
Input Voltage	: 220/230 V AC
Frequency	: 50Hz
Torque	: 1HP

**2. Pump:**

Working Maximum Pressure : 100 Kg./cm<sup>2</sup>

Usable Pressure : 50 Kg/cm<sup>2</sup>

**3. Manifold:**

4/3 Manifold

**4. Direction Control Valve**

Operating Voltage : 24 V DC

**5. Pressure Gauge:**

Maximum Working Pressure Kg./cm<sup>2</sup>

Usable Pressure : 50 Kg/cm<sup>2</sup>

**6. Tank:**

Total Capacity 40 Lts.

Rectangular Shape

**7. Double Acting Cylinder:**

Stroke Length : 150mm

Cylinder Piston Dia : 40mm

**8. Flow Control Valve:**

15 ltr. Per Min.

**9. Load Cell:**

Maximum Kg : 500Kg

Types : Strain Gauge

Force : Bi Direction

Single conditioner output: 0-5V DC

### Data Acquiencing System:

AD $\mu$ C 841 Micro Controllers:

62 KB Flash Memories

8 Channel 12 Bit ADC

2 Channel 12 Bit DAC

### TABULATION FORCE VS. PRESSURE

S.No.	Pressure in GM/CM <sup>2</sup>	Displayed Force in KG	Calculated Force in KG	% of Error

#### CALCULATED FORCE (FORMULA)

$$PRESSURE = \frac{FORCE}{AREA}$$

PRESSURE in kg/cm<sup>2</sup>

FORCE in kg

AREA in cm<sup>2</sup>

$$AREA = \frac{3.1428}{4} \times D^2$$

D = Cylinder diameter

Cylinder dia = 40mm

Cylinder rod dia = 30mm

Cylinder stroke length = 150mm

$$\% OF ERROR = \frac{DISPLAYED FORCES - CALCULATER FORCES}{DISPLAYED FORCES} \times 100$$

## TABULATION SPEED VS. DISCHARGE

S.No.	Velocity in UP (Speed in cm.sec)	Velocity in Down (Speed in cm.sec)	Discharge in Up (Flow in Lit/Sec)	Discharge in Down (Flow in Lit/Sec)

### CALCULATED FLOW (FORMULA)

$$VELOCITY(SPEED) = \frac{FLOW}{AREA}$$

SPEED in CM/SEC

FLOW=DISCHARGE (Q) IN LIT/SEC

$$AREA IN CM^2 = \frac{31428}{4} \times D^2$$

D = diameter of cylinder

Cylinder diameter = 40mm

FLOW = VELOCITY × AREA



## **Viva Question:**

### **1. Define Hydraulics.**

The engineering science pertaining to liquid pressure and flow.

### **2. How pumps are classified?**

Positive displacement pumps

Hydrodynamic (or) Non-positive displacement pumps.

### **3. Write about positive displacement pumps?**

Positive displacement pumps have the internal working elements which make a very, close fit together so that there is very little leakage (or) slippage between them. This type of pumps ejects a fixed quantity of liquid into the hydraulic system per revolution of the' pump shaft.

### **4. Define Axial Piston pump.**

A pump having multiple pistons disposed with their axes parallel to shaft axis

### **5. Define Radial Piston pump.**

A pump having multiple pistons disposed radically to the shaft axis, actuated by an eccentric element.

### **6. Define Gear pump.**

A pump having two or more intermeshing gears or lobed members enclosed in housing.

### **7. Define Vane pump.**

A pump having multiple radial vanes within a supporting rotor.

### **8. Define Viscosity .**

A measure of the internal friction or the resistance to fluid flow.

### **9. Define Motor.**

A device which converts .fluid power into mechanical power. It usually delivers Torque and rotary motion to a shaft.

**10.How velocity of the hydraulic actuator is calculated?**

Velocity of the hydraulic actuator = Input flow rate / Area of piston.

## **EXPERIMENT OF BOTTLE FILLING MODULE**

### **AIM:**

To study the PLC control process of bottle filling Module

### **Apparatus Required:**

- Bottle filling module
- Power supply
- Personal Computer

### **Procedure:**

- Check initially the tank level is to be high.
- Check the bottles are empty before starting the process.
- Check the PLC is stop mode at starting.
- Switch ON the power supply.
- Connect the RS 232 cable for communicating the PC to PLC.
- Click to open the file EXPERIMENT OF BOTTLE FILLING MODULE.

### **CONCLUSION:**

Thus the Bottle filling system was studied.

# SPEED CONTROL OF DC DRIVES USING PID CONTROLLER INTERFACING UNIT

## AIM

To control the speed of the DC motor using PID controller interfacing unit.

## THEORY

### PID CONTROLLER

One of the most powerful but complex controller mode operation combines the proportional, integral and derivative mode. This system can be used for virtually any process condition. The analytical expression is.

$$P = K + p e_p + K_p K_i \int_0^t e_p \cdot dt + K_p K_D \frac{de_p}{dt} + P_I (0)$$

Where  $K_p$  = Proportional gain between error and controller Ouptut (% per %)  
 $de_p / dt$  = Rate of change of error (%S)  
 $K_D$  = Derivative gain constant (% - S/%)  
 $K_i$  = Scaling between error and controller output.

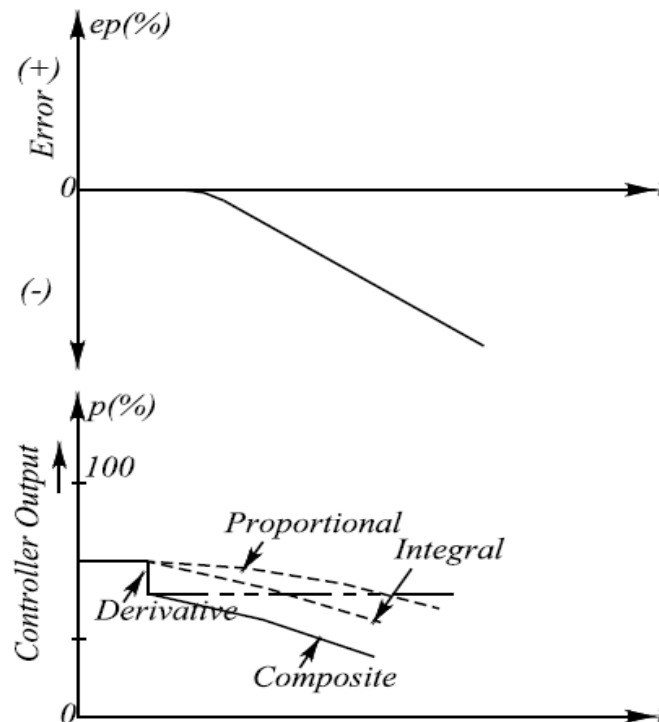
$$K_i \int_0^t e_p \cdot dt = \text{Controller output equal to the net are a}$$

*under the e-time curve multiplied by  $K_i$ . We often say that the integral term accumulates error as a function of time.*

*For every 1% s of accumulated error time area*

## Response of Three Mode

Response of Three Mode :



The mode eliminates the offset of the proportional mode and still provides fast response. The three mode controller action exhibits proportional, integral and derivative action.

### PROCEDURE

- Switch ON the power button.
- User will see the following message.

Welcome to Vi Microsystems

Digital PID Controller

Select the PID Algorithm

INC-NORMAL PID DEC-SQUARE ROOT

- Press INC key to select NORMAL PID.

<p><b>INC = AUTO MODE</b></p> <p><b>DEC = MANUAL MODE</b></p>
---

- Press INC key to run PID in Auto mode mode.

<p><b>AUTO MODE</b></p> <p><b>Max Range = 0000</b></p>
--

- Set Max Range -500
- Set Point range-250
- $K_p = 0.1$
- $K_i = 0.01$
- $K_d = 1$
- Measure the motor speed CV and PV

S.No	Time (Secs)	Kp	Ki	Kd	Set Range	Max Range	Cv	Cp	Error= Set value- Pv value

**Results:**