A Laboratory Manual for

ELEMENTS OF INDUSTRIAL AUTOMATION (22526)

Semester- V

Scheme- I

Diploma in Electrical Engineering Group (EE)

Bharati Vidyapeeth Institute of Technology, Navi Mumbai.

Bharati Vidyapeeth Institute of Technology

Navi Mumbai

Certificate

This is to certify that, Mr./ Ms. ……..

Roll No. …… of Fifth Semester of Diploma in Electrical Engineering Group of Bharati Vidyapeeth Institute of Technology, Navi Mumbai (Inst. code: 0027) has satisfactorily completed the term work in the subject **ELEMENTS OF INDUSTRIAL AUTOMATION (22526)** for the academic year 20…….to 20……. as prescribed in the MSBTE curriculum.

Place: ……... Enrollment No. : ……

Date: ……. Exam. Seat No. : …….

Subject Teacher **Head of the Department** **Principal**

Sign:

Name:

Seal of Institution

LIST OF EXPERIMENTS AND PROGRESSIVE ASSESSMENT FOR TERM WORK D-3

ACADEMIC YEAR 20 - 20

Course Code :- Sub & Code :

Name of Candidate : Enrollment No : Roll No :

Marks : Max : Min : Name of Staff-

Sr. No	Title of Experiment	Page No	Date of Performance	Date of Submission	Assessment Marks	Dated Sign of teacher with Remark
1	Identify symbols in Industrial control Diagrams.					
2	Connect DOL Starter control and power circuit for a small rating 3ph induction motor.					
3	Connect FOR-STOP-REV control and power circuit for a small rating 3ph induction motor.					
4	Connect STAR-DELTA control and power circuit for a small rating 3ph induction motor.					
5	Simulate a simple seal-in circuit using PLC Simulator.					
6	Connect PLC to PC and test execution of ladder programs for basic logic operations using two input switches and one output indicating lamp.					
7	Execute a PLC program by using timer to turn on a lamp 10 seconds after a push button press.					
8	Execute the PLC program to count number of push button press events and display the same on screen.					
9	Connect PLC for FOR-STOP-REV control of 3-phase Induction motor and test the ladder program for the same.					
10	Use the PLC for running a stepper motor in clockwise/anticlockwise direction.					
11	Use PLC for ON/OFF Temperature control.					
12	Use PLC for simulating traffic light control.					

Total marks out of 120	
Marks out of 25	

Name and Signature of Student **Name and Signature of Staff**

Assessment Scheme

	Performance Indicators	**Weightage**
	Process Related (10 Marks)	**(40%)**
1	Simulating various parameters within appropriate range satisfactorily	20%
2	Tabulate results independently	20%
3	**Product Related (15 Marks)**	**60%**
4	Interpretation of result	20%
5	Conclusions	20%
6	Practical related questions	20%
	Total(25Marks)	**100%**

Experiment No. : 1

Title: Identify symbols in industrial control diagrams.

Apparatus:

Procedure :

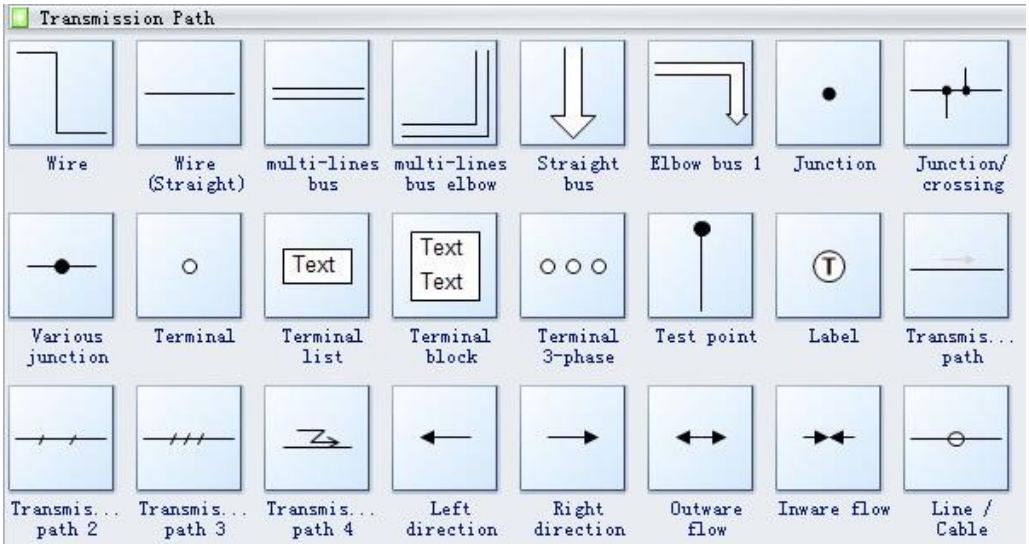
1. Visit laboratory and study the trainer kit.
2. Read the user manual before operating the trainer kit.
3. Follow the rules and safety precautions.
4. Identify the scope of subject for career development.

Concept structure:

Industrial control system (ICS) diagram is kind of diagram which are typically used in industries such as electrical, water, oil, gas and data. Based on data received from remote stations, automated or operator-driven supervisory commands to remote station control devices can be gained via the ICS diagram.

With the coming of age of process control via diagram software, industry has an opportunity to reap significant financial advantage from applying the latest systems in this field. Cost effectiveness, flexibility, total capability and reliability have now advanced to the stage where industry need no longer hesitate on the grounds of poor performance in these areas.

Industrial Control System Diagram Symbols



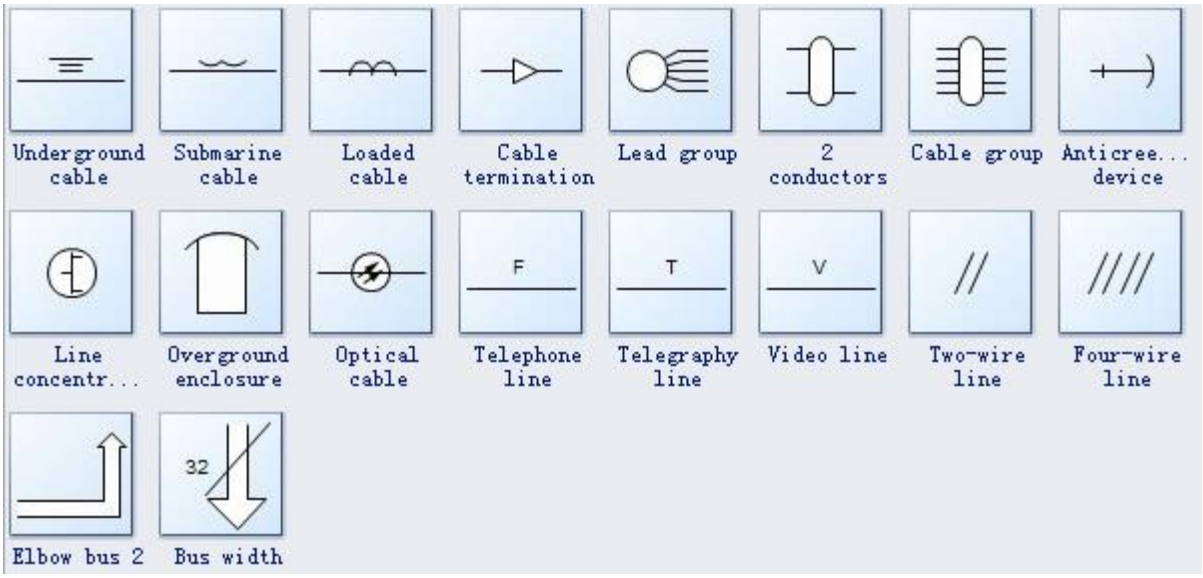
Wire is a metal drawn out into the form of a thin flexible thread or rod.

Junction is a point where two or more things are joined.

Terminal is a point of connection for closing an electric circuit.

Terminal block is a device that joins wires or cables. Terminal blocks typically snap into a metal rail or are screw mounted on the panel of a control enclosure.

Test point is a location within an electronic circuit that is used to either monitor the state of the circuitry or to inject test signals.



Underground cable is cable that is intended to be placed beneath the surface of the ground in ducts or conduit. Not necessarily intended for direct burial in the ground.

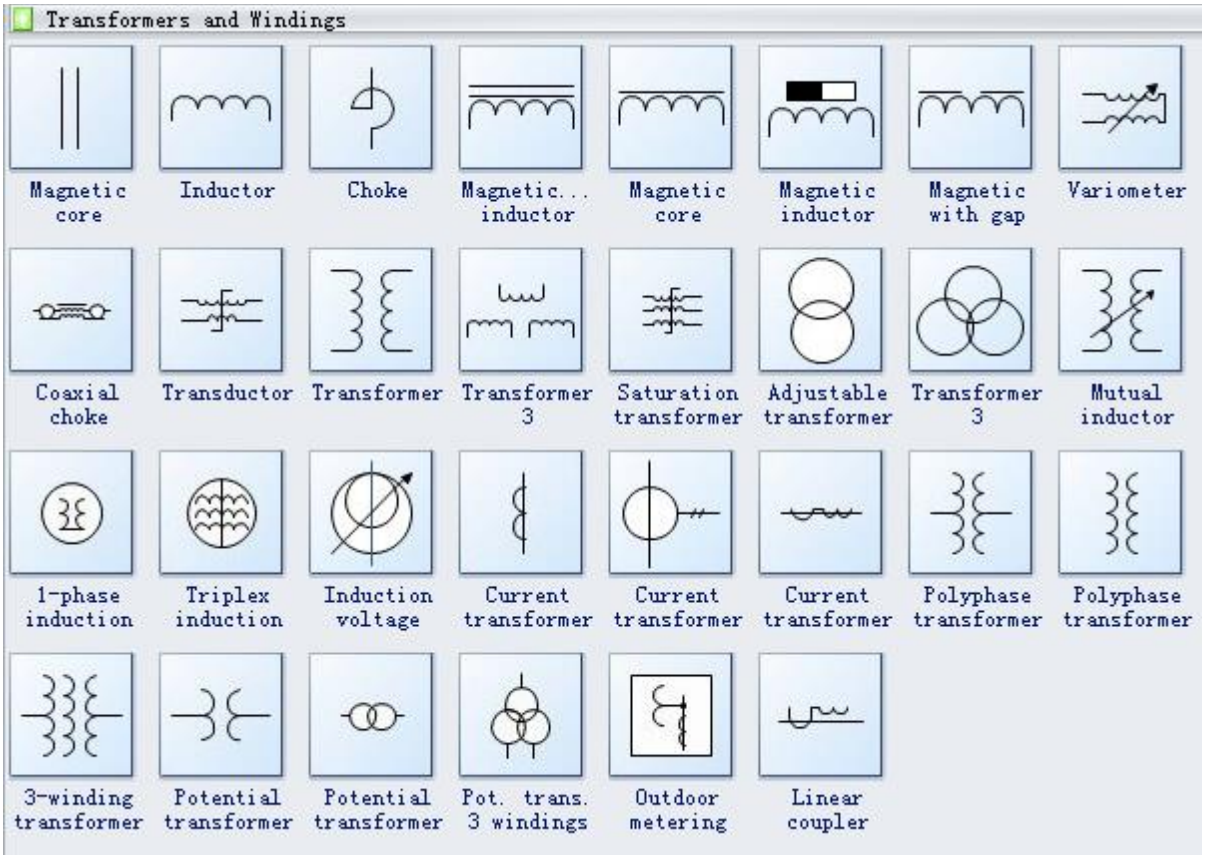
Submarine cable is a cable designed to be laid underwater.

Loaded cable generally means the final cable before the actual load.

Inductor is a component in an electric or electronic circuit which possesses inductance.

Choke in electronics is an inductor used to block higher-frequency alternating current.

Variometer is an inductor whose total inductance can be varied by altering the relative position of two coaxial coils connected in series, or by permeability tuning, and so usable to tune an electric circuit.



Conclusion:

Questions:

1. Define Industrial control Circuit Diagram.
2. Draw Industrial circuit control Symbols.
3. In industries _____ (automation/manual) processes are preferred to achieve higher productivity and accuracy.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 2

Title: Connect DOL Starter control and power circuit for a small rating 3ph induction motor.

Apparatus: MCB 3 Pole, single Pole ,Power Contactor, Overload relay, Push Buttons (On, Off),Auxiliary contact (NO,NC), Indication Lamp

Procedure:

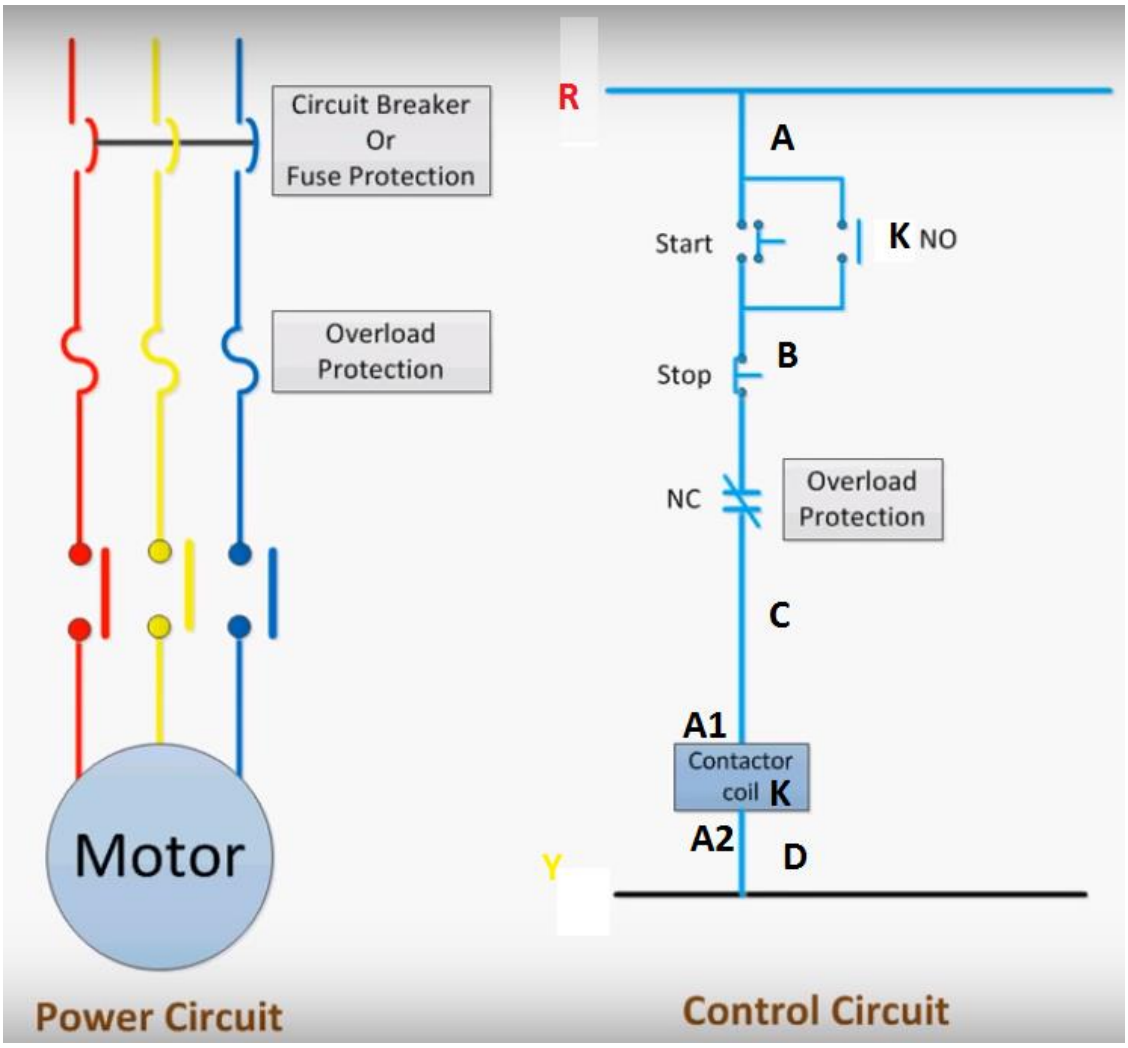
Concept Structure :

The direct-on-line (DOL) motor start is the easiest method for starting up three-phase asynchronous motors. The stator windings are directly connected to the mains supply in a single switching process. Large starting currents (surge currents) result by applying the full mains voltage, which in turn cause troublesome voltage changes on the mains supply. For small size motor (less than 2 HP) where starting torque is about twice the full-load torque and starting period lasts only a few seconds, this type starter is used.

The working principle of a DOL starter begins with the connection to the 3-phase main with the motor. The control circuit is connected to any two phases and energized from them only. When we press the start button, the current flows through contactor coil (magnetizing coil) and control circuit also. The current energises the contactor coil and leads to close the contacts, and hence 3-phase supply becomes available to the motor. The control circuit for a DOL Starter is shown below.

If we press the stop button, the current through the contact becomes discontinued, hence supply to the motor will not be available, and the similar thing will happen when the overload relay operates. Since the supply of motor breaks, the machine will come to rest. The contactor coil (Magnetizing Coil) gets supply even though we release start button because when we release start button, it will get supply from the primary contacts

Power Circuit and Control Circuit of DOL starter :



Observations:

START	STOP	CONTACTOR	MOTOR
0	1	0	0
1	1	1	1
0	1	1	1
1	0	0	0

Conclusions:

Questions:

1. What is DOL Starter.
2. Draw Control and Power circuit diagram of DOL Starter
3. Draw the wiring diagram of DOL Starter.
4. State the advantages and disadvantages of DOL Starter.
5. Write the applications of DOL Starter.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 3

Title: Connect FOR-STOP-REV control and power circuit for a small rating 3ph induction motor.

Apparatus: MCB, Over Load Relay, Contactors , Push Buttons-NO,NC.

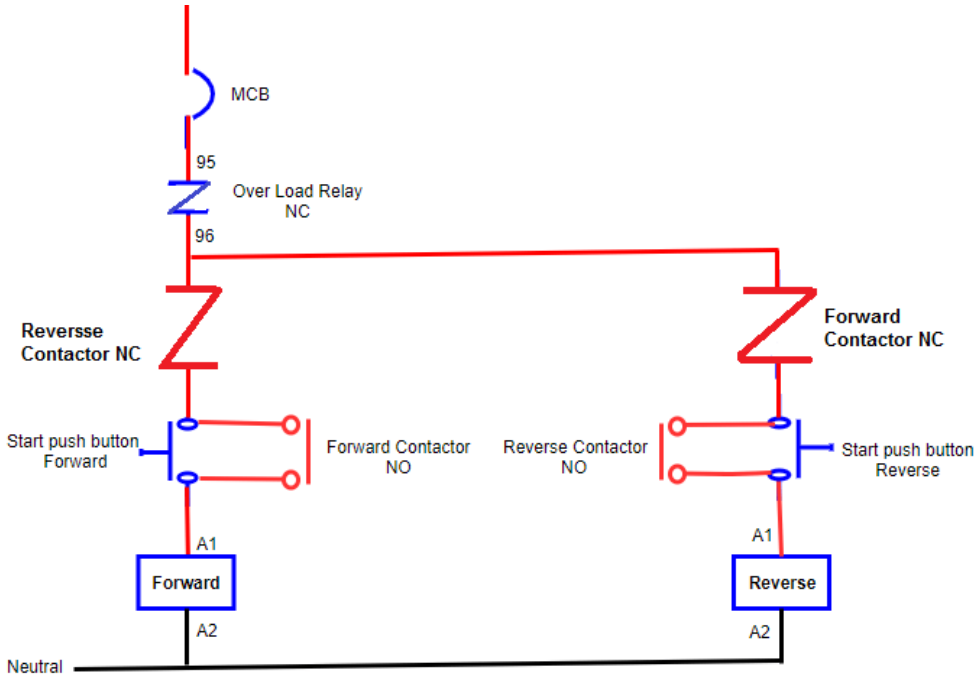
Procedure:

1. Make the connections as shown in the diagram first of all we need to connect the power supply in the MCB (Miniature Circuit Breaker).
2. Output of the MCB have to connect with overload relay NC point for reset.
3. After that wire has to connect with NC points of the contactor of opposite directions as shown in the diagram e.g for forward contactor connecct to the NC point of reverse contactor and for reverse contactor connect to the NC point of the forward contactor.
4. Then the output of these NC points connect to the Start push buttons.
5. Then connect two wires from input and output of the push buttons to the NO point of the contactor for holding of the contactor.
6. After holding connect the wire from the output of the start push button to the A1 of the both contactor. Connect the neutral wire to the A2 of the contactor.

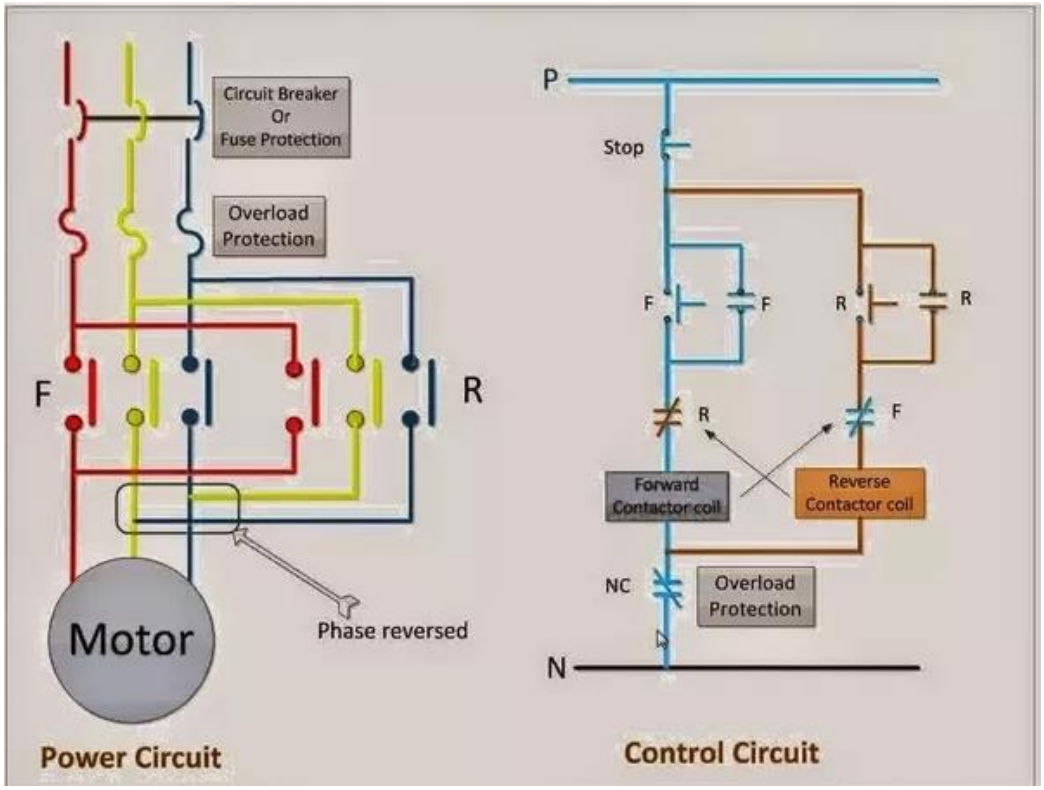
Concept Structure :

The forward reverse starter is used to run the motor in both sides forward and reverse. The figure given below shows the control and power diagram of forward and reverse starter diagram. These forward and reverse starters are DOL type and not used above the 05 HP motors. To run the motor of above 05 HP rating circuit has to made in star delta. These type of starters are used in various applications e.g- mixing of materials, dying machines etc.

Wiring Diagram of FOR-STOP-REV :

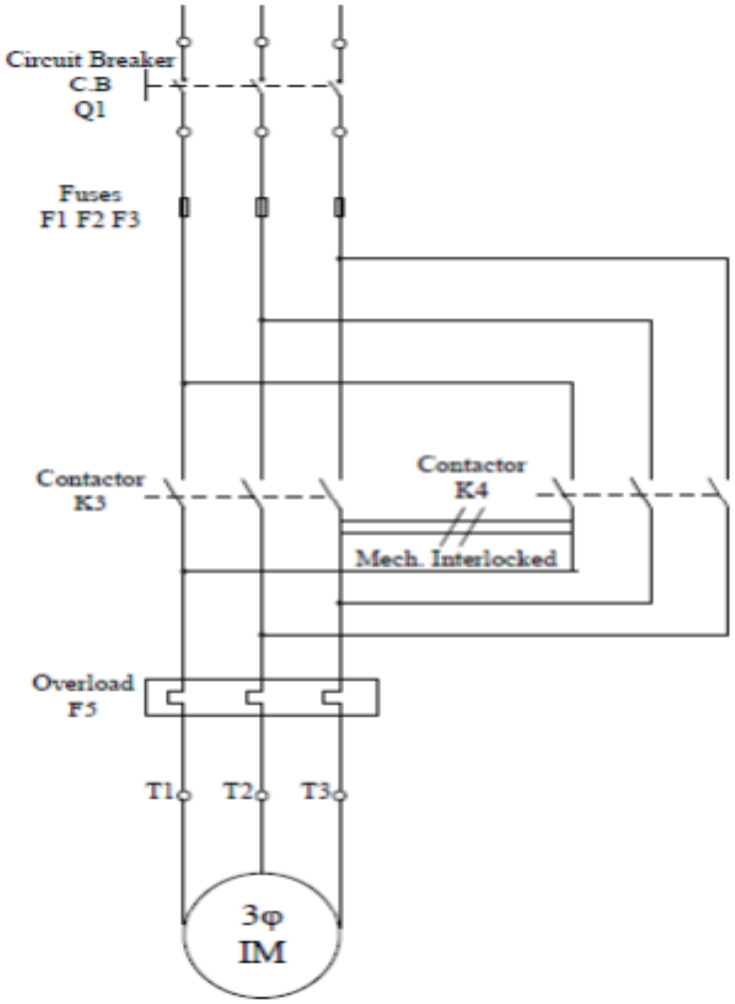


Power Circuit and Control Circuit of FOR-STOP-REV starter :



FORWARD / REVERSE OPERATION :

When a squirrel-cage rotor is placed inside a rotating magnetic field, it is pulled around in the same direction as the rotating field. Interchanging the power connections to two of the stator windings (interchanging A with B for example) interchanges two of the three currents and reverses the phase sequence. This causes the rotating field to reverse direction. As a result, the direction of rotation of the motor is also reversed. The power diagram for reversing the direction of rotation of the motor and the associated control circuits are shown in Figure below.



Reversing direction of rotation of a three phase induction motor, Power diagram

Observations:

Conclusion:

Questions :

1. Explain the principle of FOR-STOP-REV Starter.
2. Draw the wiring diagram of FOR-STOP-REV Starter.
3. Explain the working of FWD-STOP-REV control circuit of an Induction motor.
4. Draw the control circuit and power circuit diagram of FOR-STOP-REV Starter.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 4

Title: Connect STAR-DELTA control and power circuit for a small rating 3ph induction motor.

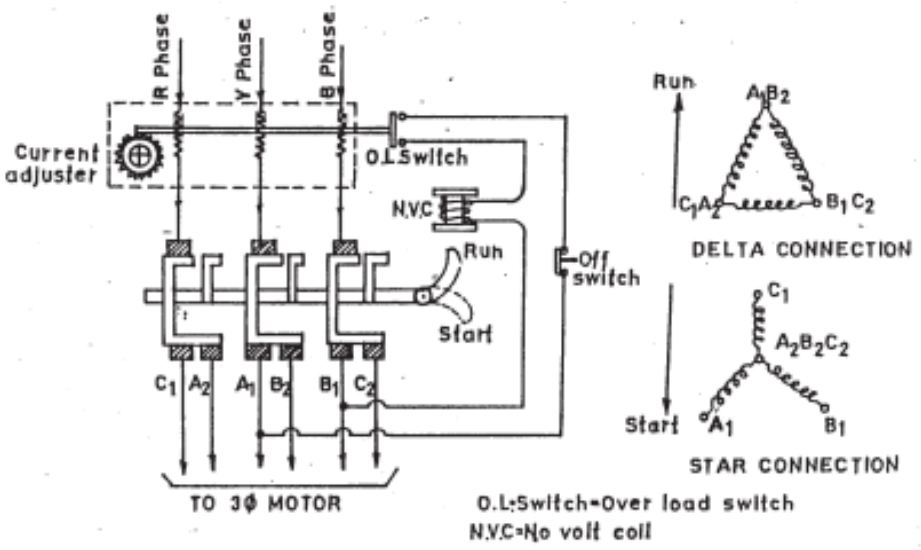
Apparatus: Contactors (Main, star and delta contactors) 3 No's (For Open State Starter), Time relay (pull-in delayed) 1 No., Three-pole thermal overcurrent release 1 No.,Fuse elements or automatic cut-outs for the main circuit 3 Nos.

Procedure :

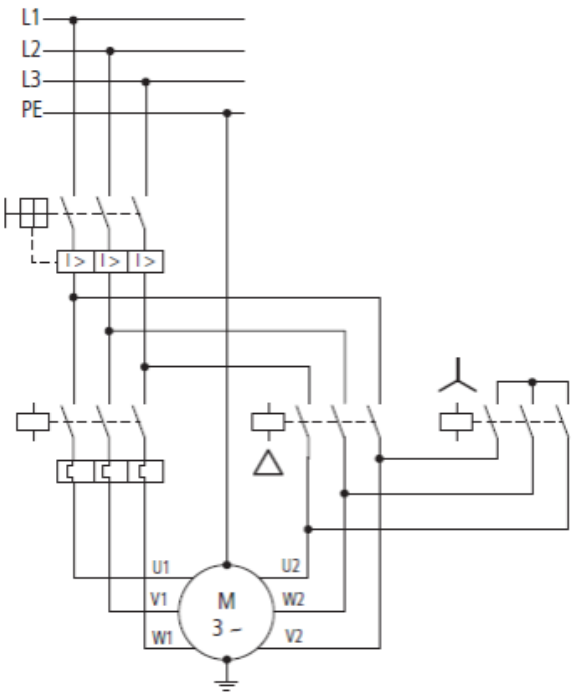
a) Make the connections as shown in the circuit diagram.
b) Set the timer at suitable value.
c) Check the three phase supply at the voltmeter.
d) Check the sequence of the operations of the contactors after switching the start button.
e) Record the no-load current at starting and at rated speed.

Concept Structure :

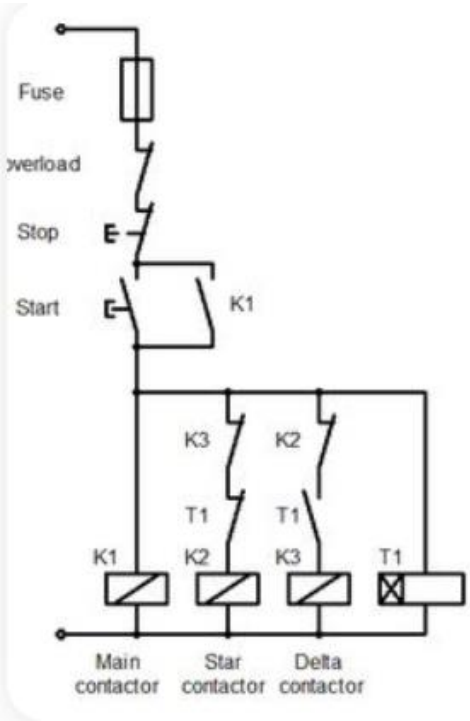
A star delta starter is the most commonly used method for the starting of a 3 phase induction motor. In star delta starting an induction motor is connected in through a star connection throughout the starting period. Then once the motor reaches the required speed, the motor is connected in through a delta connection.



STAR DELTA STARTER



Power diagram for star-delta starter



Control Circuit diagram for star-delta starter

Observations:

Conclusion:

Questions:

1. Explain Star-Delta Starter.
2. What are the features of Star-Delta Starter.
3. Draw the wiring diagram of Star-Delta Starter.
4. State the applications of Star-delta Starter.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 5

Title: Simulate a simple seal-in circuit using PLC Simulator.

Apparatus: PLC simulator, NO and NC switches,Contactor.

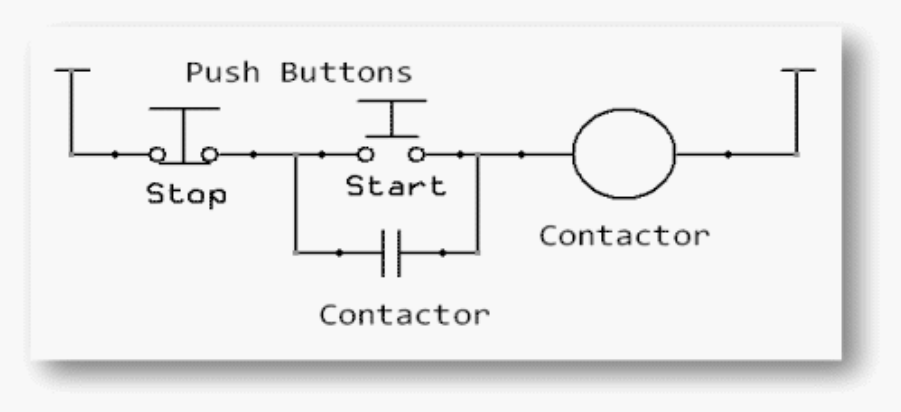
Procedure:

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

Explanation:

Seal in Circuit :

This logic in this file implements the common latch or "seal-in" circuit shown in the figure below. This logic is used to run drives using push buttons. The circuit "latches in" when the start push button is pressed and releases when the stop push button is pressed.



Ladder diagram:

Observations:

Conclusion:

Questions:

1. What do you mean by Seal-in circuit.
2. Draw the Ladder diagram for Seal-in circuit.
3. State the function of seal in circuit w.r.t. PLC.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 6

Title: Connect PLC to PC and test execution of ladder programs for basic logic operations using two input switches and one output indicating lamp.

Apparatus: PLC software, NO and NC switches, output coil,

Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

Concept structure:

TIMER :

Ladder Diagram	**Waveform**

COUNTER :

Ladder Diagram

Waveform

COMPARISON:

Ladder Diagram

LOGICAL:

Ladder Diagram

ARITHMETIC:

Ladder Diagram

.

Conclusion:

Questions :

1. List types of timers.
2. List types of counters.
3. Give different comparison instruction.
4. Draw format of logical instructions.
5. List different arithmetic instructions.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 7

Title: Execute a PLC program by using timer to turn on a lamp 10 seconds , after a push button press.

Apparatus: PLC software,timer, NO and NC switches.

Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

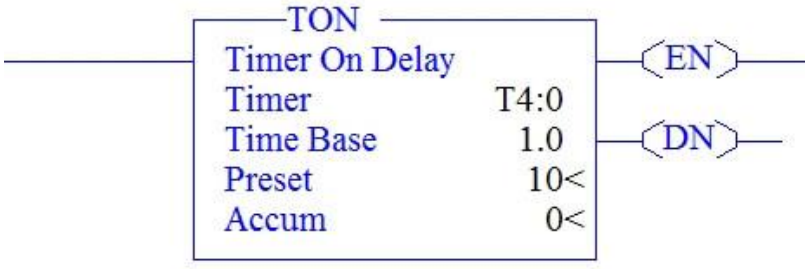
Concept structure:

PLC Timers :

Timers are output instructions that are internal to the programmable logic controller.Timers provide timed control of the devices that they activate or de-activate.

Basic functions of Timer:

- Timers are used to delay an action.
- Timers are used to run an operation for a predetermined period of time.
- Timers are also used to record the total accumulated time of continuous or intermediate events.



Ladder Diagram:

Explanation:

Observations:

Lamp will be ON for	

Conclusions:

1. LED will be on for _____ seconds.

Questions:

1. When is the enable bit of timer instruction true?
2. When does the done bit of timer change state?
3. Explain the status bits of timer.
4. Draw the format of different types of timer?
5. Explain different types of timer with neat timing diagrams.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 8

Title: Execute the PLC program to count number of push button press events and display the same on screen.

Apparatus: PLC software, Counter, NO and NC switches.

Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

Concept structure:

PLC Counters :

A counter is a PLC instruction that either increment (counts up) or decrements (counts down) an integer number value when prompted by the transition of a bit from 0 to 1 (“false” to “true”).

Counter instructions come in three basic types:

- Up counters
- Down counters
- Up/Down counters.

For both UP and Down counters there is only one trigger is needed to start the counting, but for up/down counter it is needed two triggers, one for up and other for down counter.

Both the counters are retentive,it requires reset pulse to reset it.

Ladder diagram :

PROBLEM STATEMENT:

A Conveyor belt is used to move an item to a work station. The presence of the item at the workstation is detected by means of a limit switch. After 50 items sensed by limit switch, it stops conveyor belt motor. The process is restarted by a normally open START push button and stopped anytime by a normally closed STOP push button. Develop ladder diagram for the above case.

Explanation :

Observations:

Sr. no.	Switch positions	Up Counters (starts/stops)	LED Status (ON/OFF)
1	SW ‘A’ pressed 10 times		
2	SW ‘B’ pressed		

Conclusion :

1. The PLC counters range from _____ (C0 to C250/ C0 to C255).

2. Maximum value of reset in PLC counters is _____

Questions:

1. Develop a ladder diagram that will latch ON an output B 20 seconds after input A has been turned ON. After A is pushed, there will be a 10 second delay until A can have any effect again. After A has been pushed 3 times, B will be turned OFF.
2. List applications of PLC counters.
3. What the reset bit in PLC counter indicates?
4. State the function of accumulator with reference to PLC counter.
5. How Up Down counter works?
6. State range of preset in PLC counter.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 9

Title: Connect PLC for FOR-STOP-REV control of 3-phase Induction motor and test the ladder program for the same.

Apparatus: PLC software, NO and NC switches.

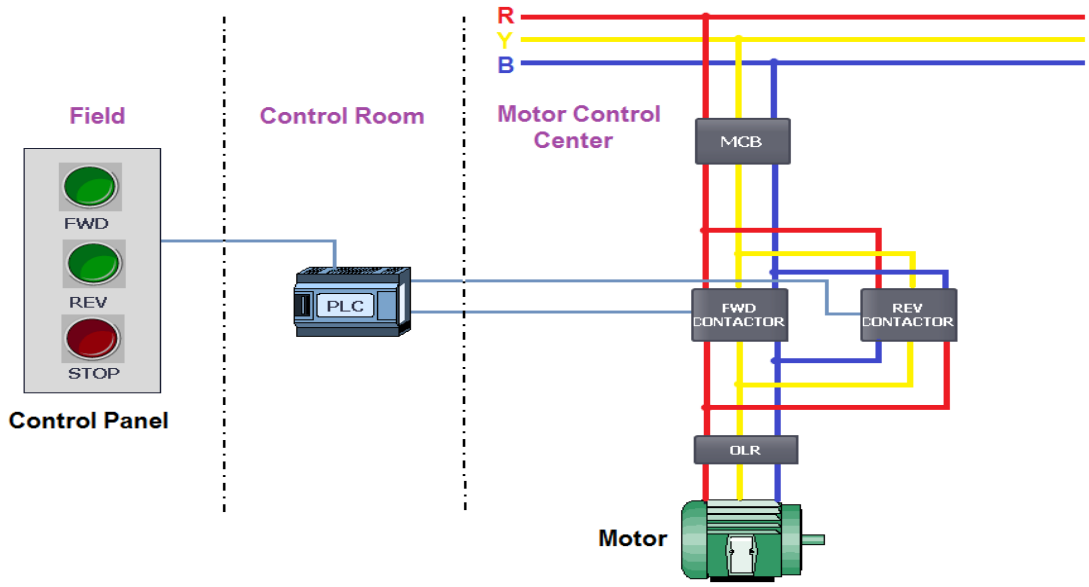
Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

Concept structure:

- There are lots of motors and conveyors used in industries for different purposes.
- In some cases motors or conveyors need forward and reverse operation for some control purpose.
- For example overhead crane, in crane every time operators moves it forward and reverse for material handling.
- So we can use PLC systems for programming the motor for forward/reverse operation.

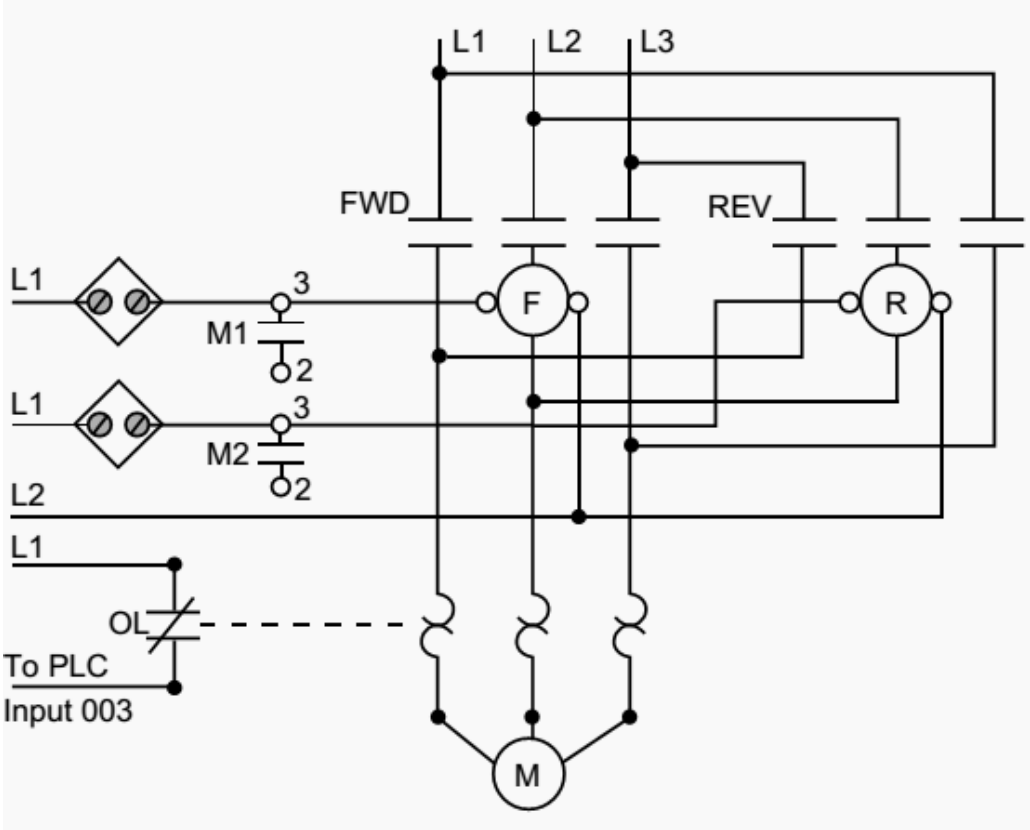
Problem Diagram:



Problem Solution :

- In this case we need to operate motor in both direction, that can be possible only by forward/Reverse Control Relay Circuit or through Logic.

- Here we solve this problem by using simple Forward/Reverse Control Logic in the PLC.
- So here we will consider one 3 phase motor for Forward and Reverse Operation.
- And we will take two contactors or relays for motor control because we need two different directions here i.e. Forward/Reverse. First contactor for Forward Direction control and Second contactor for Reverse Direction control of Motor.
- Also we should consider three push buttons i.e. for forward, reverse and stop functions of motor.
- So here operator will use FWD PB for forward operation, REV PB for reverse operation and STOP PB for stop function.



Wiring Diagram of FOR-STOP-REV control of 3-phase Induction motor

Ladder Diagram :

Observation:

Conclusion:

Questions:

1. State the applications of forward and reverse motor in PLC.
2. Draw the control circuit and Power circuit for Forward and reverse motor.
3. Explain FOR-STOP-REV starter in detail.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 10

Title: Use the PLC for running a stepper motor in clockwise/anticlockwise direction.

Apparatus: PLC software, stepper motor, NO and NC switches.

Procedure :

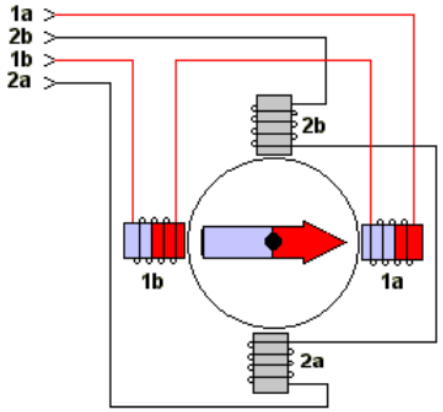
1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

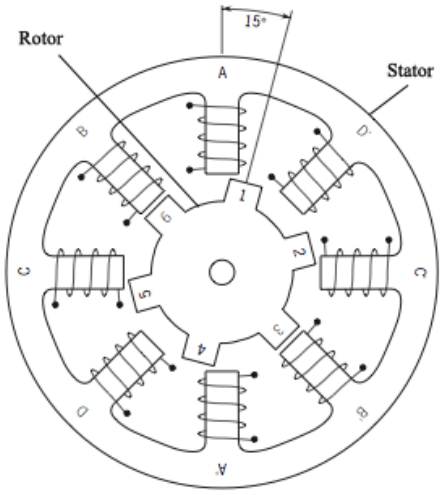
Concept structure:

Stepper Motor :

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements.The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence.

The motors rotation has several direct relationships to these applied input pulses.The sequence of the applied pulses is directly related to the direction of motor shafts rotation.The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.





Ladder diagram : (Forward Direction)

Explanation :

Ladder diagram : (Reverse Direction)

Explanation:

Observation:

Clockwise motion:

Step	Terminal 1a	Terminal 2a	Terminal 1b	Terminal 2b
1				
2				
3				
4				
1				

Anticlockwise motion:

Step	Terminal 1a	Terminal 2a	Terminal 1b	Terminal 2b
1				
2				
3				
4				
1				

Conclusion:

- The time delay controls the _____ (speed/direction) of stepper motor.
- The stepper motor rotates _____ (in step/ continuously).

Questions:

1. Explain operating principle of stepper motor.
2. Define step angle.
3. Define scanning cycle.
4. Define speed of execution.
5. List out four industrial applications of stepper motor.
6. Compare DC motor and stepper motor.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 11

Title: Use PLC for ON/OFF Temperature control.

Apparatus: PLC software, NO and NC switches.

Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

Concept structure:

Temperature	Temperature condition	Action taken by PLC
0°C to 64.9°C		Heater ON and cooler OFF
65°C	Lower cut off	Both heater and cooler are OFF
70°C	Upper cut off	Both heater and cooler are OFF
70.1°C to 100°C		Heater OFF and cooler ON

Problem statement :

- Temperature controller will start when START switch is closed.
- Temperature shall be maintained between 60° C to 70°C.
- When the temperature is less than 60°C the heater is turned ON and cooler is OFF.
- When the temperature is greater than 70°C the heater is turned OFF and cooler is ON.
- Temperature range is 0°C to 100°C.

Ladder diagram:

Explanation:

Observations:

Sr. no.	Value of temperature	Temperature when heater is		Temperature when cooler is	
		ON	OFF	ON	OFF
1					
2					
3					
4					

Conclusion:

1. When the measured temperature is less than lower cut off temperature then _____ (heater/cooler) is ON.
2. When the measured temperature is greater than higher cut off temperature then _____ (heater/cooler) is ON.

Questions:

1. State need of temperature controller in various industries?
2. List advantages of temperature controller using PLC.
3. List comparing instruction of PLC.
4. List out types of continuous and discontinuous controller.
5. List out various type of temperature transducer used for measurement of temperature.

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	

Experiment No. : 12

Title: Use PLC for simulating traffic light control.

Apparatus: PLC software, NO and NC switches.

Procedure :

1. Load the RS Logix software to the PC.
2. Open the RS Logix software.
3. Switch On the PLC trainer.
4. Open the New project and draw the ladder logic program.
5. Compile the program.
6. Run the Program.
7. Give force and observe the output.

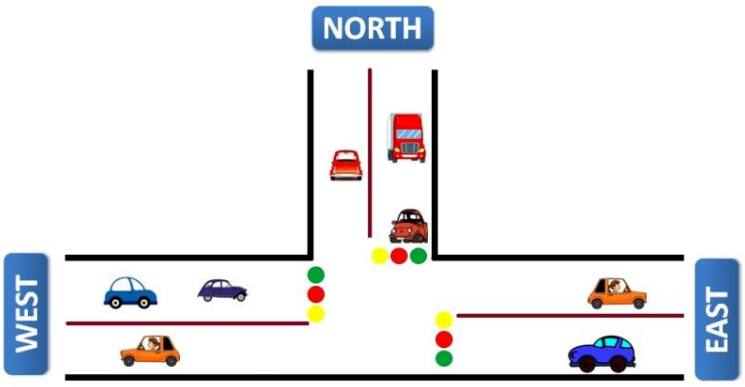
Concept structure:

Traffic Light Control

Traffic light is an arrangement of three colour lights. It is used for controlling the traffic at road junctions by providing a particular sequence of these lights. Different colour lights used are Red, Green and Amber (or Yellow). The red light indicates 'STOP', green light indicates 'GO' and amber light indicates 'WAIT' for red or green.

Timers are devices that count increments of time. Traffic lights are one example where timers are used. In this example timers are used to control the length of time between signal changes. The lights in a traffic signal go through a sequence: Red,green,amber, Red,green,amber etc.

When an ON/OFF switch is turned on and a START button is momentarily pressed, the red signal (R) lights for 30 seconds, then turns off and the green (G) lights for 25 seconds, then turns off and the Amber (A) turns on for 5 seconds and then turns off and back to the red. On the opposite street, the red light (R') is on during the time the light on the other street is either green or amber. Transition from red to green to amber is accomplished by cascading timer circuits. The sequence then repeats itself.



Ladder Diagram:

Explanation:

Observations:

Red light will be ON for	
Green light will be ON for	
Amber light will be ON for	

Conclusions:

Questions:

1. When is the enable bit of timer instruction true?
2. When does the done bit of timer change state?
3. When is the output of a programmed timer energized?
4. How RES instruction in relation with retentive PLC timer works?
5. How accumulated count of programmed timer energized?

Space for Answers

Marks obtained			Dated sign. Of Teacher
Process Related(10)	Product Related(15)	Total(25)	