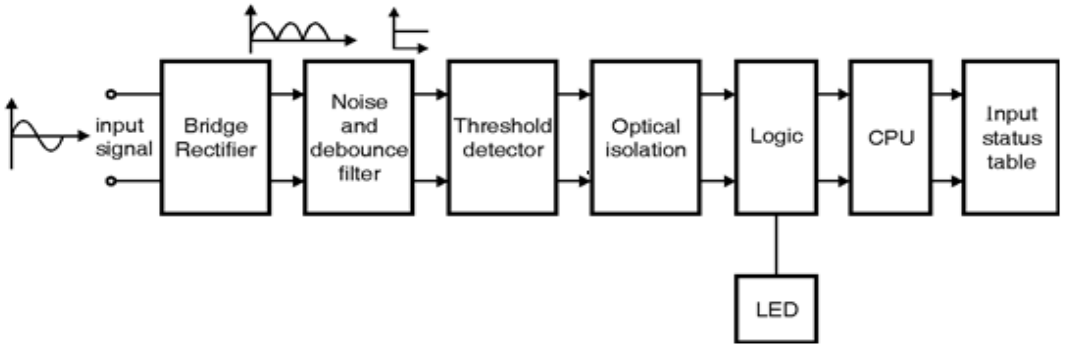
MODEL ANSWER
SUMMER– 18 EXAMINATION

Subject Title:- Industrial Automation **Subject Code:-** 17664

Important Instructions to examiners:

1. The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2. The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3. The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4. While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5. Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6. In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7. For programming language papers, credit may be given to any other program based on equivalent concept.

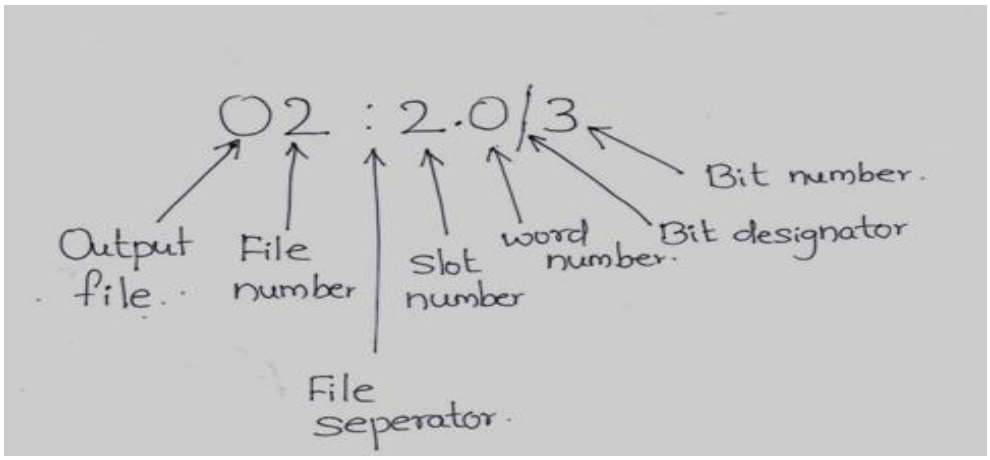
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	**Attempt any THREE :**	**12 Marks**
	a)	**Define Automation. State its benefits. (any three)**	**4 Marks**
	Ans:	**Definition of Automation:** ***Note: (Any other relevant definition can be considered)*** Automation is a technology concerned with the application of mechanical, Electronics and computer based systems to operate and control production. **Benefits of Automation:** 1. Increases productivity. 2. Increases product quality. 3. Increases flexibility and convertibility. 4. Reduces manpower. 5. Reduction of personal accident. 6. Reduces cost of product. 7. Better inventory control. 8. Increases profit.	**1mark** **1mark each (Any three)**
	b)	**Draw labelled diagram of AC input module. Write the operation of optical isolator block.**	**4 Marks**
	Ans:	**Block diagram of AC input module :**	**2mark**

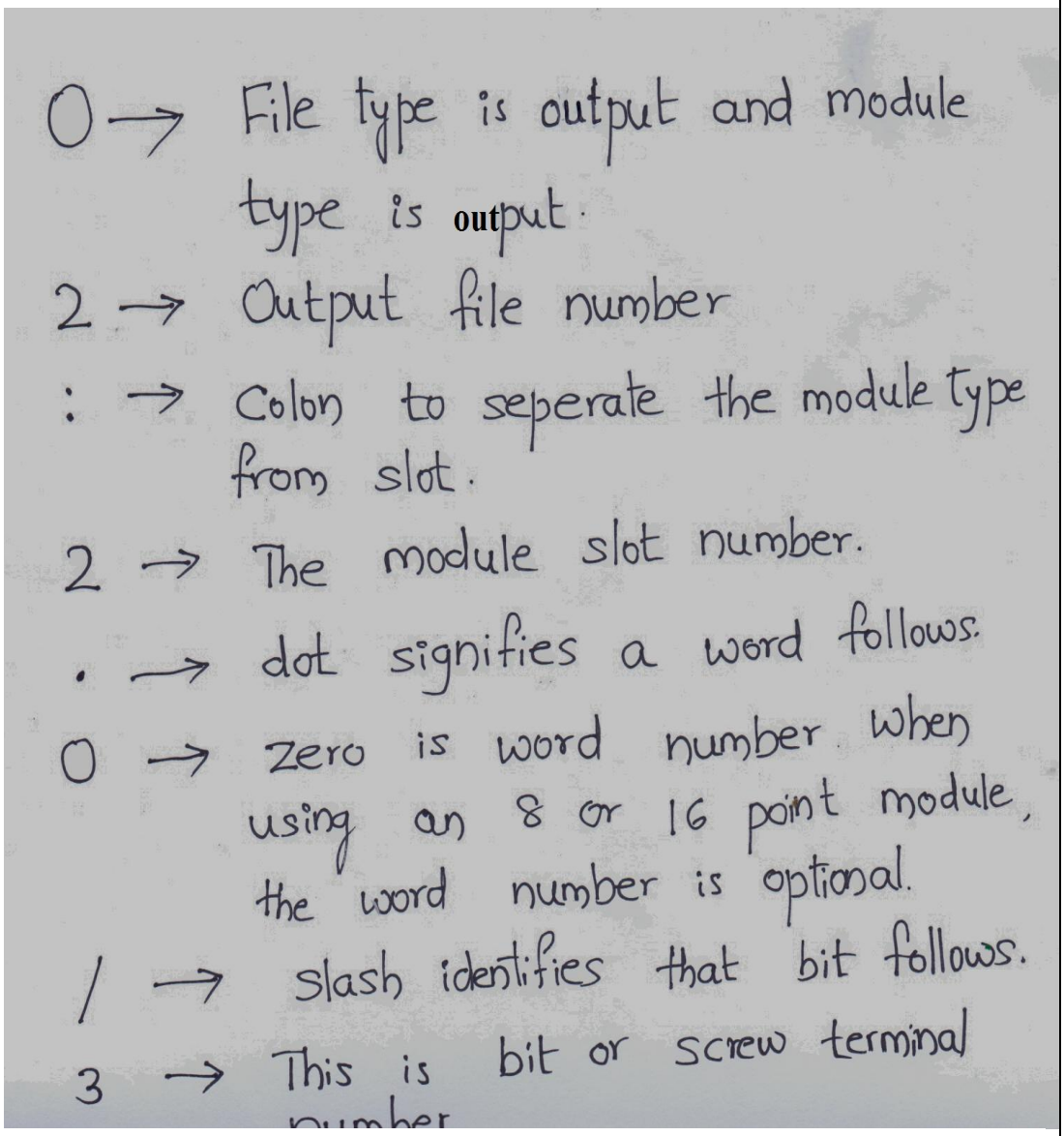


2mark

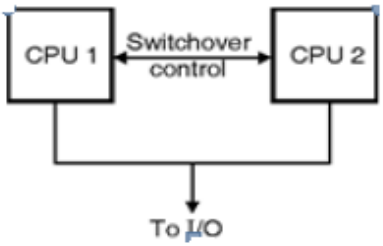
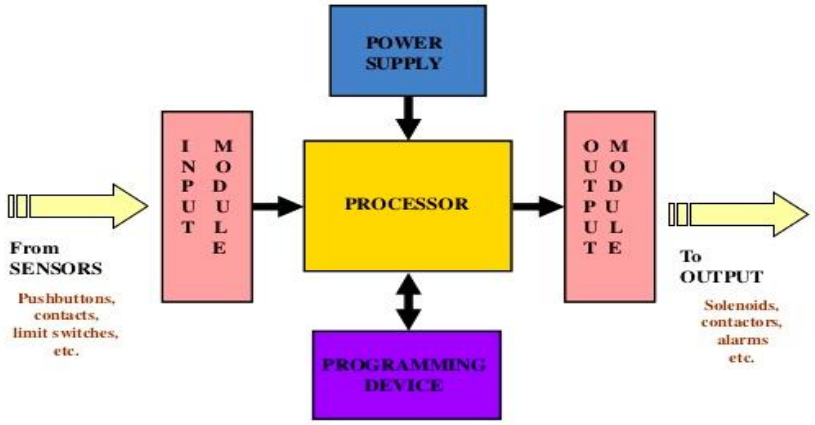
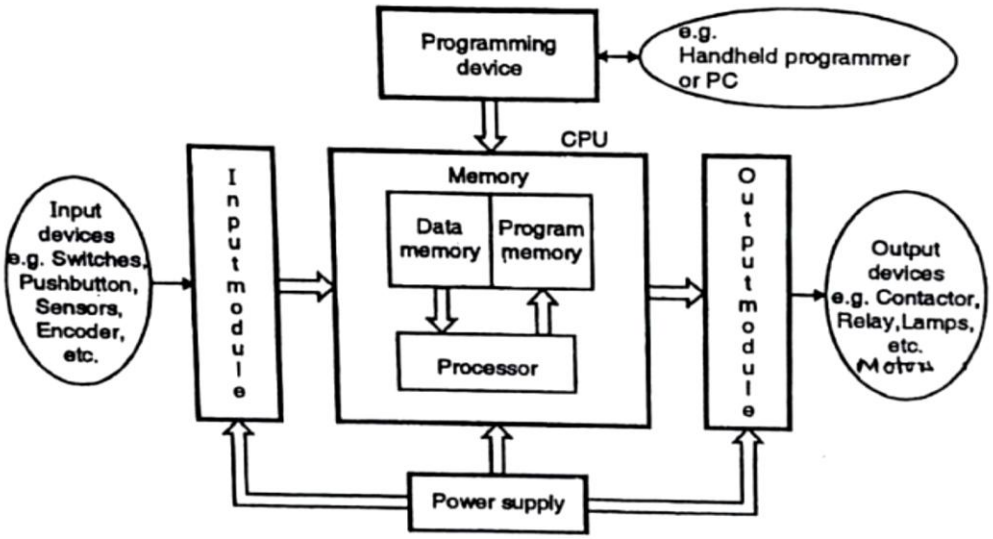
Operation of optical isolator :

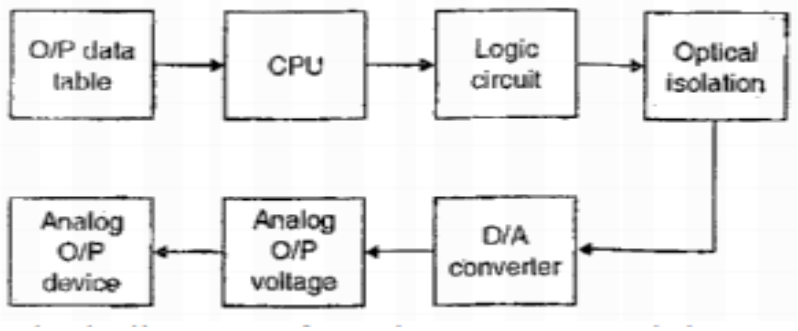
- The isolation section of the input circuit is usually made up of an opto-isolator or it may called as opto-coupler. Where a light source (e.g. LED) and a photo detector (e.g. photo diode, photo transistor, photo voltaic cell etc.) are placed in signal package.
- In a 115 VAC input module isolation separates the high-voltage, 110 VAC input signal from the CPU's low voltage control logic (typically 5 to 18 VDC) depending on the module manufacturer and the type of logic employed.
- Isolation is accomplished by the input signal energizing a light-emitting diode (LED), which transmits a signal of light energy to a receiver in the form of photo conductive diode. Here LED converts the electrical signal to an optical signal and receiver usually a photo-transistor, converts the optical signal back to the electrical signal.
- There is no actual physical or electrical coupling between the sending LED, it's associated input circuitry and the optical receiver and it's low-voltage associated logic circuitry. The signal is transferred by light (photon particles) from the LED.

c)	**If output addressing of PLC is 02 : 2.0/3. What does 0, 2, 2, 0, 3 indicates?**	**4 Marks**
Ans:	**Output addressing:** 	**1mark each**

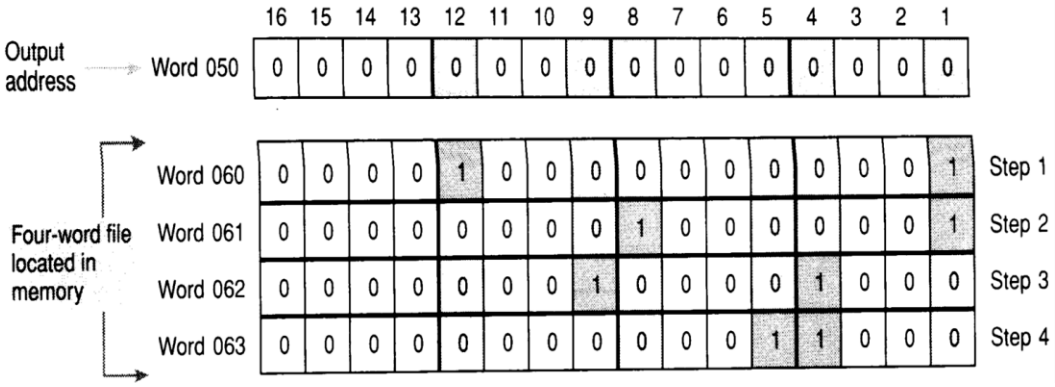


	d)	**Explain redundancy in PLC modules.**	**4 Marks**
	Ans:	**Redundancy :** ● Redundancy means extra system components or mechanisms added to decrease the chance of total system failure. ● Different types of redundancy are available in PLC like redundancy for a CPU module, power module, bases and communication module is available. ● CPU redundancy system is composed of separate bases for ideal redundancy structure. ● In case an error occurs in an active CPU module, a backup module is automatically converted to active one for continuous operation. ● In these cases two processors can be tied into one I/O system and some	**4mark**

		means is provided that switches control from the failure CPU to the backup when a failure CPU to the backup when a failure occurs as shown in Fig.  	
B)	**Attempt any ONE :**		**6 Marks**
a)	**Draw block diagram of PLC. Explain function of CPU, memory.**		**6 Marks**
Ans:	**Block diagram of PLC:**  **OR**  	**3mark**

		Function of CPU, Memory : CPU or the central processing unit is the main part of any PLC. The CPU solves the user program logic by using real time input status from input module and updates the status of output module. The CPU consists of – (i) Processor, (ii) Memory. **The processor** is responsible for the complete program scan in a PLC. During Program scan processor communicate with the memory. **Memory** is used in CPU are of two types RAM and ROM. RAM memory is used to store the data related to input status, output status, timers, counters, internal bit relay, numerical values etc. ROM memory is to store system program and user program.	**1 ½ mark each**
	b)	**Draw block diagram of analog output module. State the function of each block in brief.**	**6 Marks**
	Ans:	**Block Diagram of Analog output module:**  	**3mark**
		Explanation:- • CPU sends data to output module through different blocks. Optical isolation blocks isolate. • CPU circuit from high voltage o/p devices. • Isolation section of the input circuit. Is usually made up of an optical isolator, or opt coupler. In a 120VAC input module, isolation separates the high voltage, 120VAC input signal from the CPUs low voltage control logic. • DC signal from the optocoupler are used by the logic section to pass the input signal to the module's input address LED and the CPU and then on to the input status file. • This module accepts 16 bit status word, convert it into analog value using DAC. • Analog signals are 0 to 10Vdc, -10Vdc to +10Vdc, 0 to 5Vdc 0 to 20mA, -20 to +20mA,4mA to 20mA.etc. • These modules are selected to send output either a varying current or voltage signal, each represent particular operation. **OR** **Explanation:** Analog output modules accept 16 bit output status word, which they convert to an	**3mark**

		analog value through a digital to analog converter. The converter is a part of the electronics inside the analog output module. Typical analog signals are 0 to 10 V DC, -10 to 10 V DC, 0 to 5 V DC, 1 to 5 V DC, 0 to 20 milliamps, -20 to +20 milliamp or 4 to 20 milliamps. Analog output modules are selected to send out either a varying current or voltage signal. An analog output sends a 4 to 20 milliamp signal to variable speed drive. The drive will control the speed of a motor in proportion to the analog signal received from the analog output module. An analog valve can provide precise control. An analog output module could output a 0 to 10 volt signal to an analog valve to provide the needed control. The output signal can be divided into 32,767 increments and represented in a 16-bit word. Output module automatically converts the 1-bit output word to the proper analog voltage, the programmer only has to output the desired decimal integer value to the output status file. The above figure shows value position variations with analog signals and its decimal equivalent.	
Q 2		**Attempt any Two:**	**16 Marks**
	a)	**(i) List different types of language used in PLC.** **(ii) Write general format of sequencer output instruction.**	**8 Marks**
	Ans:	**i. PLC programming languages:** This standard specifies five languages divided into two parts namely-graphical languages and text-based languages. • Graphical languages : (i) Ladder Logic Diagram (LD) (ii) Function Block Diagram (FBD) (iii)Sequential Function Chart or Grafcet (SFC) • Text-based languages : (i) Instruction List (IL) (ii) Structured Text (ST) **ii. Sequencer output instruction.** PLC sequencer replaces the mechanical drum sequence that was used to control the sequences of repeatable operations. It acts as pointer and points one of the word from block of data words stored in memory. It fetches the words one at a time from memory and transfer or move to another memory or to the output. When block of data is finished the PLC sequencer again point the first word from the block and process begins again. Traffic light controller is a simple example of sequencer which is controlled with electronics and PLC sequencer output.16 lights are used for output. each light represent one bit address of output word 050.the lights are programmed in a four step sequence to simulate the operation of two way traffic light .Data are entered into word file for each sequencer step as shown fig.	**4 marks** **4 marks**

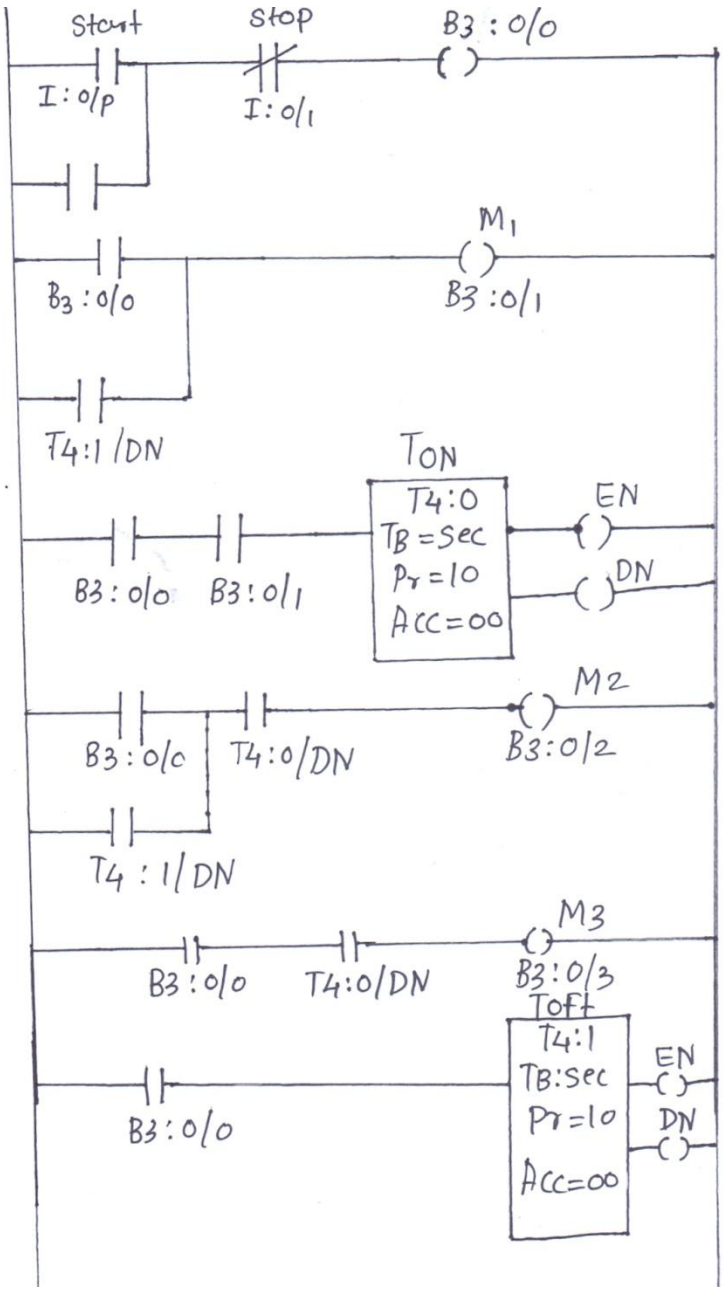


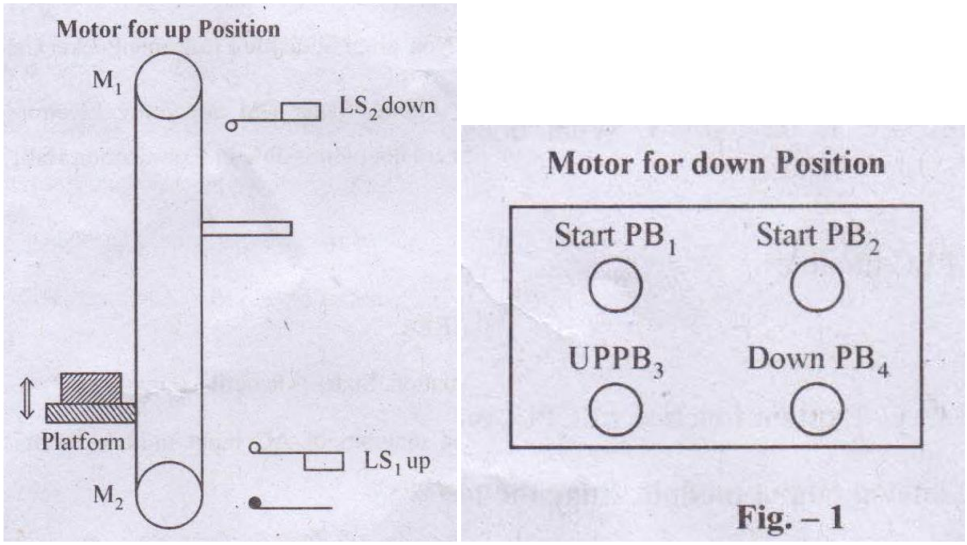
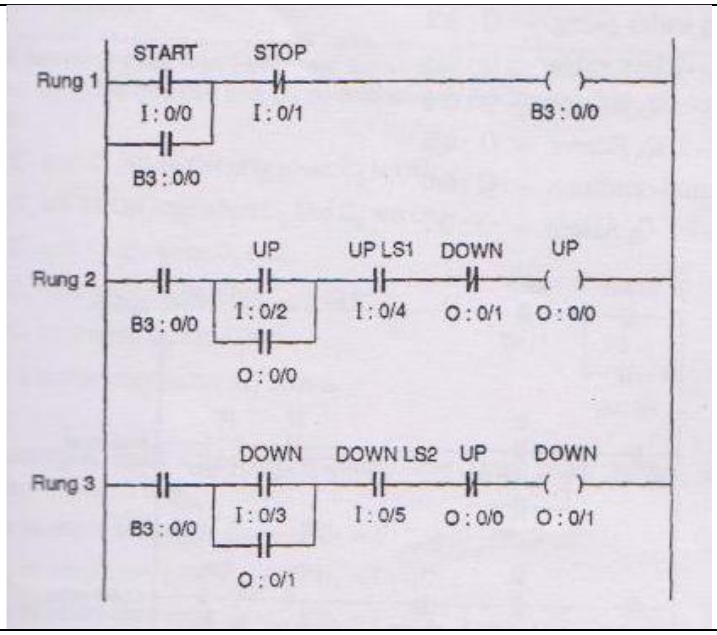
When sequencer is activated and advanced to step 1 the binary information in word 060 of file is transferred into word 050 of output as a result light 1 and 12 are switched ON and rest remains off. Advancing the sequencer to step 2 will transfer the data from 061 to word 050,as a result lamp 1 and 8 will be on and all the rest will be off and thus advancement in step 3 and step 4 is followed and finally when last step is reached, the sequencer is either automatically or manually reset to step 1.

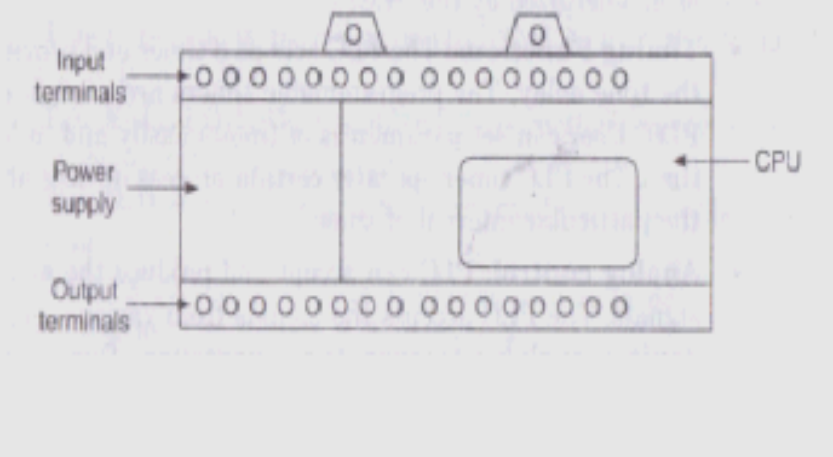
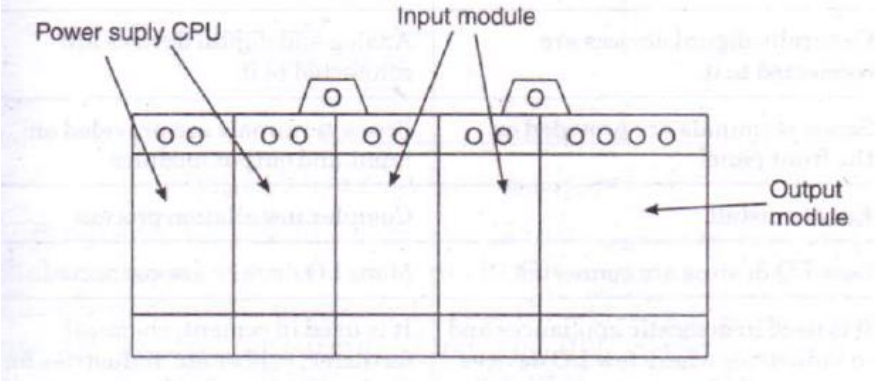
OR

Any other sequencer instruction SQI/SQL/SQO with example should be considered.

b)	**Draw a ladder diagram for 3 motor operation for following condition :** **(i) Start push button starts motor M_1. After 10 sec M_2& M_3 starts.** **(ii) Stop push button stops M_3 and after 10 sec motor M_2& M_1.**	**8 Marks**
Ans:	**Ladder diagram**	**8 marks**


Start
I:0/P
Stop
I:0/1
B3:0/0
M1
B3:0/0
B3:0/1
T4:1/DN
TON
T4:0
TB=Sec
Pr=10
ACC=00
EN
DN
B3:0/0
B3:0/1
M2
B3:0/0
T4:0/DN
B3:0/2
T4:1/DN
M3
B3:0/0
T4:0/DN
B3:0/3
TOFT
T4:1
TB:Sec
Pr=10
ACC=00
EN
DN
B3:0/0

	c)	**Draw the ladder diagram as shown in Fig. l for elevator system :**  Fig. – 1 **Logic** **(i) When the start button is pushed the platform is driven to the down position.** **(ii) When stop push button is pressed the platform is halted at whatever position it occupies at that time.** **(iii) When up button is pushed, the platform if it is not in down motion is driven to the up position.** (iii) **When the down button is pushed, the platform if it is not in up motion is driven to down position.**	**8 Marks**
	Ans:		**8 marks**

Q. 3		Attempt any F0UR :	16 Marks
	a)	**Explain with diagram types of PLC.**	**4 Marks**
	Ans:	**PLC types are as follows:** 1. **Micro PLC (Fixed I/O)** 2. **Modular PLC:** • Small PLC- Less than 100 I/O additional can be added (20 Input and 12 outputs mounted locally with the process) • Medium PLC-4000 to 8000 I /O. • Large	**1mark**
		Micro PLC (Fixed I/O)  	**1 ½ mark**
		Explanation: 1. Limited I/O (32 or less than 32) 2. A fixed PLC consists of a fixed or built in input and output sections. 3. There is one fixed, non-removable screw terminal strip containing all input screw terminals and another screw containing all output control signal screw terminals. 4. Memory capacity is fixed. 5. Generally digital devices are connected to it.	
		Modular PLC  	**1 ½ mark**

Explanation:

1. A modular PLC does not have a terminal strip built into the processor unit.
2. Modular PLC'S have their I/O points on plug in type, removable units called I/O modules.
3. PLC's with modular inputs and outputs consists chasis, rack or baseplate where power supply, CPU and all input, output modules are separate hardware items.
4. The power supply is modular is typically hooked up to line voltage on the chasis.

b) List need for automation. — **4 Marks**

Ans: **Need of Automation in process (Any four):** — **1mark each**

- To fulfill the demand of product at right time.
- To reduce the human errors and involvement of human being in the process.
- For better productivity.
- For better control of process.
- For better quality.
- For reducing man power.
- For reducing cost of product

OR

Any other relevant points shall be considered

c) Give any two specification each of AC & DC discrete input modules. — **4 Marks**

Ans: **Specification each of AC discrete input modules.** — **2mark (Any two specification)**

Voltage	Inputs	Points per Common	Backplane Current Draw at 5 V dc	Maximum Signal Delay	Maximum Off-State Current	Input Current Nominal	Maximum Inrush Current
85 to 132 VAC	4	4	0.035 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 120 VAC	0.8 A
	8	8	0.050 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 120 VAC	0.8 A
	16	16	0.085 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 120 VAC	0.8 A
170 to 265 VAC	4	4	0.035 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 240 VAC	1.6 A
	8	8	0.050 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 240 VAC	1.6 A
	16	16	0.085 Amps	ON = 35 ms OFF = 45 ms	2 mA	12 mA at 240 VAC	1.6 A

Specification each of DC discrete input modules.

Operating Voltage	10–30 V dc Sink	10–30 V dc Source
Number of Inputs	8	8
Points per Common	8	8
Backplane Current Draw at 5 V dc	.085 A	.085 A
Maximum Signal Delay	ON = 8 ms OFF = 8 ms	ON = 8 ms OFF = 8 ms
Maximum Off-State Current	1 mA	1 mA
Maximum Off-State Voltage	5 V dc	5 V dc
Nominal Input Current	8 mA at 24 V dc	8 mA at 24 V dc
Maximum Inrush Current	NA	NA

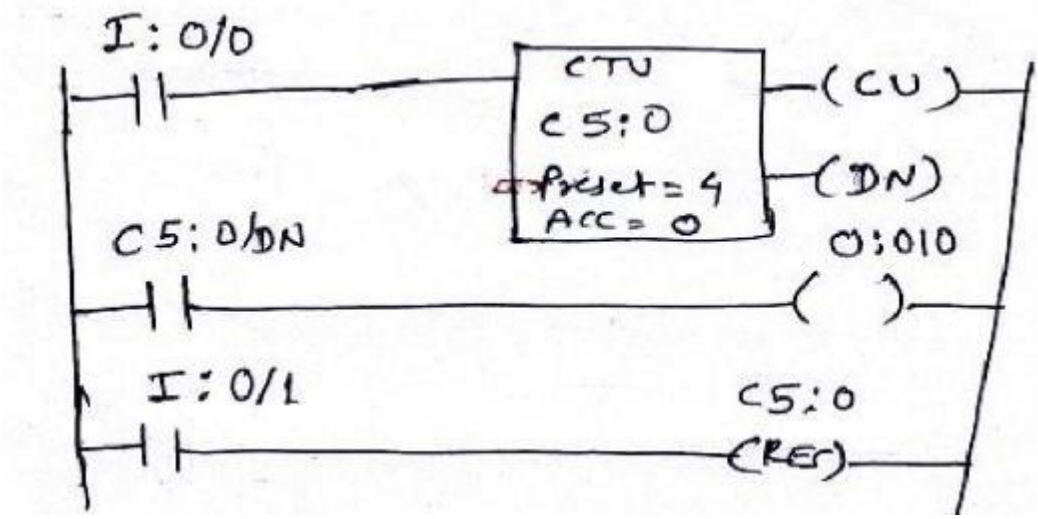
2mark (Any two specification)

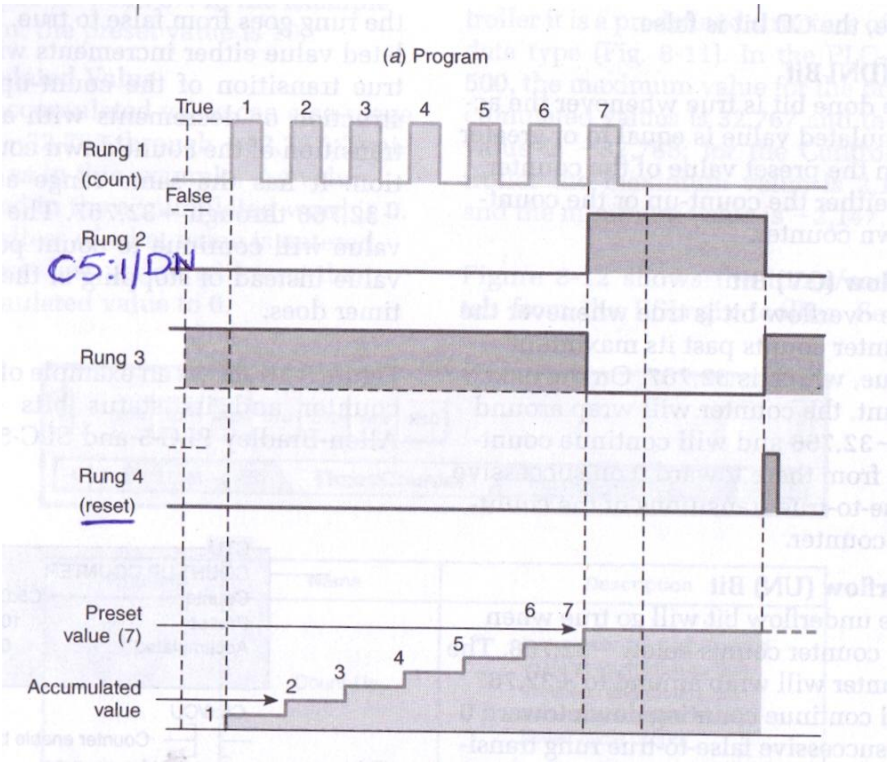
Relevant specifications shall be considered

d)	**List and explain any four types of Relay type instruction.**	**4 Marks**
Ans:	**Relay type instruction;** **1. Normally open (XIC)** **2. Normally closed (XIO)** **3. One shot instruction(OSR)** **4. Output instruction** **5. Output latch instruction(L)** **6. Output unlatch instruction(U)** **Explanation:**	**2mark** **½ mark each**

BIT INSTRUCTIONS		
Instruction	Symbol	Use This Instruction
Normally Open or Examine ON	—| |—	As a normally open, or examine if ON, input instruction on your ladder rung
Normally Closed or Examine OFF	—|/|—	As a normally closed, or examine if OFF, input instruction on your ladder rung
One-Shot	—(OSR)—	To input a single digital pulse from a maintained input signal
Latch Output Coil	—(L)—	To latch an output ON. Output stays ON until the unlatch instruction becomes true
Unlatch Output Coil	—(U)—	To unlatch a latched ON instruction with the same address
Output Coil	—( )—	As an output instruction that becomes true when all inputs on the rung are true
Negated Output	—(/)—	As an output instruction that passes power at all times except when all rung inputs are true

e)	**Explain the need of grounding in PLC installation.**	**4 Marks**
Ans:	Proper grounding is an important safety measure in all electrical installations. The authorative source on grounding requirements for a PLC installation is the National Electrical Code. The code specifies the type of conductors, color codes, and connections necessary for safe grounding of electrical components. According to the code, the grounding path must be permanent (no solder), continuous, and able to conduct safely the ground-fault current in the system with minimal impedance. In the event of a high value of ground current, the temperature of the conductor could cause the solder to melt, resulting in interruption of the ground connection. In addition to the grounding required for the controller and its enclosure, you must also provide proper grounding for all controlled devices in your application. The following grounding practices will help reduce electrical noise interference: • All PLC equipment and enclosure back plates should be grounded individually to a central point on the enclosure frame. • Ground wires should be separated from power wiring at the point of entry to the enclosure. All ground connections should be made with star washers between the grounding wire and lug and metal enclosure surface. • Paint or other nonconductive material should be scraped away from the area where a chassis makes contact with the enclosure. • The minimum ground wire size should be No.12 AWG stranded copper for PLC equipment grounds and No.8 AWG stranded copper for enclosure	**4mark**

		backplane grounds. • The enclosure should be grounded properly to the ground bus. • The machine ground should be connected to the enclosure and to earth ground. • The ground connection should have a very low resistance. A rule of thumb would be less than 0.1Ωdc resistance between the device and ground.	
Q. 4	**A)**	**Attempt any THREE :**	**12 Marks**
	a)	**Explain up counter instruction with waveform.**	**4 Marks**
	Ans:	 **Format of up-counter:** **Explanation:** When i/p to count up counter goes true the Acc value will be increased by 1 , not matter how long the i/p is true. So every true rung condition acc will increment by 1. When acc value reaches the preset value the counter DN bit will be set. For example as shown in figure, IN example preset value is 5 , in waveform when /p goes high then CU bit also goes high and Acc values is incremented by one .When Next high i/p arises at counter i/p then CU bit also goes high and Acc is incremented by 1. Like this when Acc value becomes equal to preset value then DN bit is set and related o/p device is ON. This DN bit remains high until counter is reset by reset instruction. When reset instruction is executed counter gets reset and DN bit also goes low and Acc also goes to zero.	**2 marks instruction**

		Waveform:  	**2 marks waveform**
	b)	**List specially I/O modules. Explain any one in brief.**	**4 Marks**
	Ans:	**Different types of specialty I/O modules:** **1) Communication module** **2) High speed encoder** **3) RTD input module** **4) Stepper motor control** **5) Thermocouple input module** **Explanation:** **1. Communication module:** • **ASCII I/O Modules**: ASCII I/O modules allow the interfacing of bar code readers, meters, printers, and data terminals to a PLC. ASCII modules, which accept only valid ASCII data, are not used as extensively as they once were. Today, the RS-232 module is the module of choice in many applications. • **RS-232CInterface Modules**: Communication modules are available that reside in a PLC chassis and enable you to connect a PLC to telephone lines using a modem. PLCs connected to phone lines allow central control room operators to examine ladder programs to modify or edit program operation at remote PLC sites. Today many remote oil, gas, and wastewater applications are unmanned. Remote access by way of phone lines saves maintenance personnel from driving to remote sites each time a PLC encounters a problem or a program change is necessary. .	**2 marks** **2 marks (Any one)**

OR

2. **High-Speed Encoder Input Modules:**
   When input pulses come in faster than a discrete input module can handle them, a high-speed input module is used. High-speed counters are also used to interface encoders to a PLC.

OR

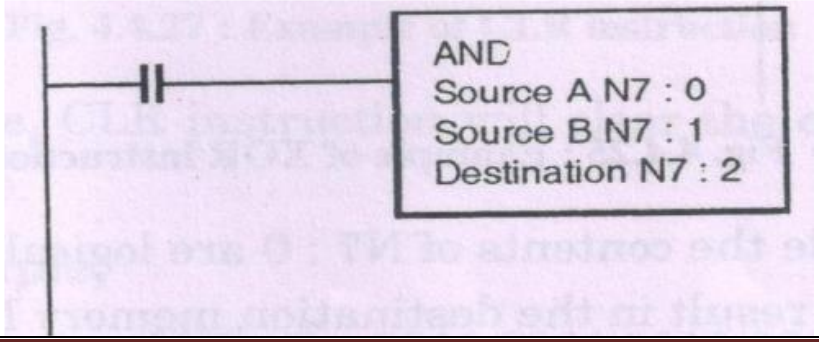
3. **Resistance Temperature Detector (RTD) input Modules:**
   A resistance temperature detector (RTD) input module interfaces a PLC to RTD temperature-sensing elements and other types of resistance input devices such as potentiometers. The RTD input module converts analog input signals from a potentiometer or. RTD into input signals understood by the PLC. These values are stored in the PLC input table.

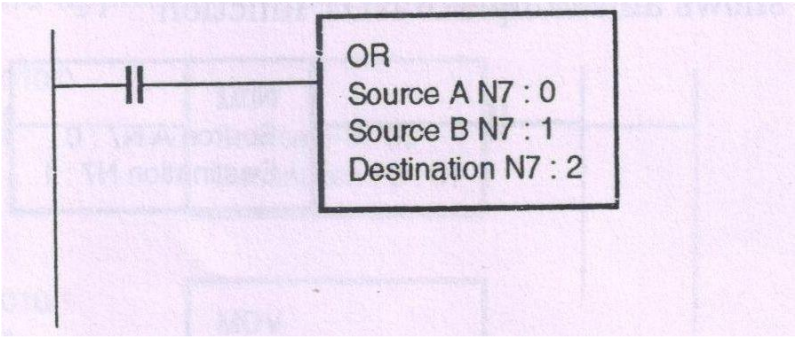
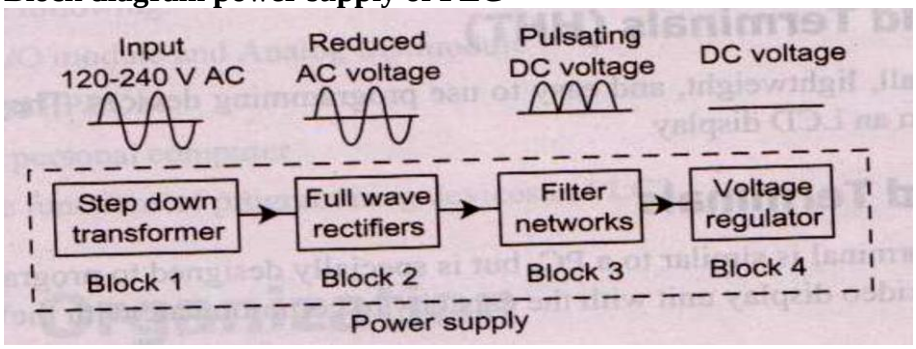
OR

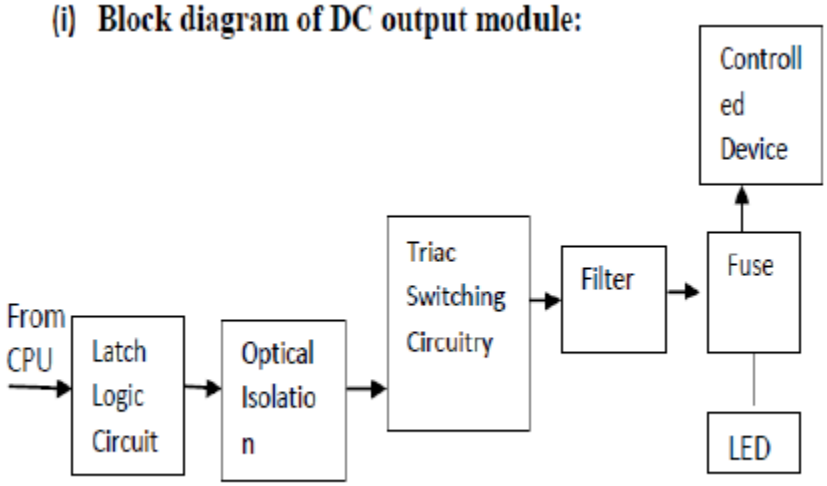
4. **Stepper Motor Control Modules:**
   A stepper module is an intelligent module that resides in a PLC chassis and provides a digital output pulse train for micro stepping stepper motor applications.

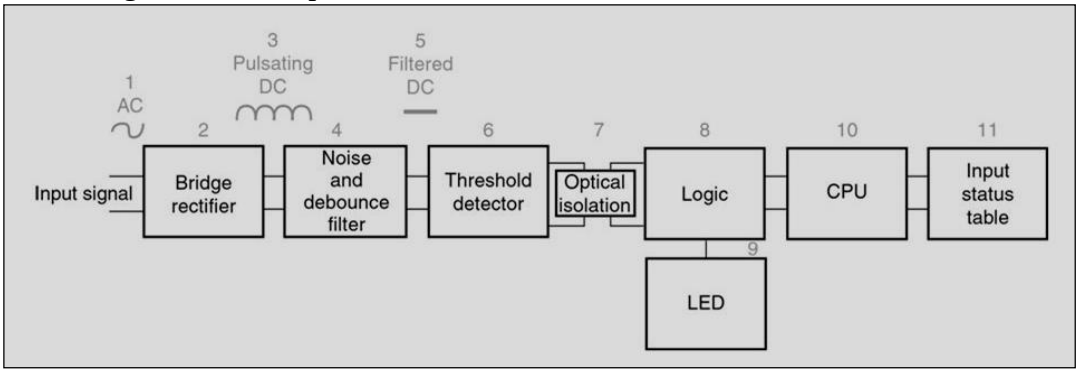
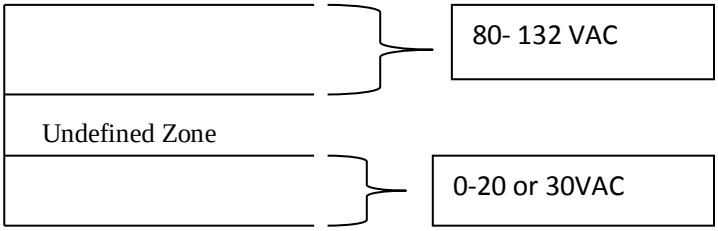
OR

5. **Thermocouple/Millivolt Input Module:**
   The thermocouple/milli volt input module converts inputs from various thermocouple or milli volt devices into values that can be input and stored into PLC data tables. This module greatly enhances the flexibility of a PLC system by interfacing thermocouples, thus eliminating expensive thermocouple transmitters. Using an RTD module ,PLCs can thus be used for interface applications requiring temperature and measurement control.

c)	**List logical instructions. Explain AND, OR instruction.**	**4 Marks**
Ans:	**List logical instructions** **a. AND instruction** **b. OR instruction** **c. NAND instruction** **d. NOR instruction** **e. NOT instruction** **f. X-ORinstruction** **g. X-NOR instruction**	**2 marks**
	1. AND instruction: It performs the logical AND operation between two operands. 	**1 mark each**

		2. OR instruction: It performs the logical OR operation between two operands. If one of the bit or both the bits of two operands are 1 then output bit is 1 otherwise 0.  	
	d)	**State maintenance guidelines for PLC.**	**4 Marks**
	Ans:	**Guidelines for maintenance of PLC:** 1) Periodically check the tightness of I/O Module terminal screws. They can became loose over period 2) Periodically check for corrosion of connecting terminals. moisture & corrosion atmospheres can cause poor electrical connections 3) Replace the PLC batteries used for backup in time 4) Have a written check list , control list for each PLC 5) Make sure that components are free of dust 6) Stock commonly needed spare parts **7)** Keep duplicate record of operating programs being use	**01 mark for each point (any relevant 4 points)**
	B)	**Attempt any ONE :**	**6 Marks**
	a)	**Explain with block diagram power supply of PLC. Describe function of each block.**	**6 Marks**
	Ans:	**Block diagram power supply of PLC**  Explanation: It consists step down transformer , rectifier , filter and regulator • **Step down transformer** The step-down transformer converts the high voltage (HV) and low current from the primary side to the low voltage (LV) and high current value on the secondary	**3 marks diagram,**

		side • **Rectifier**: **1.** It converts ac into dc voltage. **2.** o/p of is fed to filter • **Filter**: **1.** This removes ac part present in the o/p of rectifier **2.** It gives pure dc signal • **Regulator**: This regulates o/p voltage level	**3 marks explaination**
	b)	**Draw the block diagram of DC output modules. Explain its block.**	**6 Marks**
	Ans:	**(i) Block diagram of DC output module:**  **OR** **Any other relevant diagram shall be considered** DC output modules simply act as a switch to control output field device to control output field device. Each output point contains switching devices, which is located inside the output module it is seen that the module consists of some potential free contacts operated by signals from the CPU. Once this signal appears at the output terminals of the module, the indicating LED glows. This signal is again isolated from the output power circuit by an opto-isolator, amplified by the amplifier and interfaced with the real world power circuit. Field output devices like coils, relays etc., powered by a power supply external to the PLC receive the signal to operate for final control action.	**3 marks diagram, 3 marks explaination**

Q.5		Attempt any TWO :	16 Marks
	a)	**Draw block diagram of AC input modules. Explain its block.**	**8 Marks**
	Ans:	Block diagram of AC input module:  Input Module is composed of two sections 1. Power section 2. Logic section The power and logic section are coupled with electrical isolation. **Rectifier :**This section consists of resistors and a bridge rectifier to convert the incoming AC signal to a pulsating DC signal. **Filter:**The pulsating DC signal is then passed through filter and other logic circuitry in order to get clean, denounced DC input signal to the threshold detection. **Threshold detection:** Threshold detection circuitry detects whether the incoming signal has reached or exceeded a predetermined voltage level for a predetermined time and whether it should be classified as a valid ON or OFF signal. A typical valid OFF state is below 0 and 20 or 30 VAC depending on the module's manufacture and a valid ON state is between 80 and 132 VAC again depending on the module's manufacturer.  Fig. Logic level detection The signal area between the upper voltage limit for a valid OFF state (20 VAC) and minimum voltage for a valid ON state (80 VAC) is called undefined zone or input state not guaranteed The signals falling within this undefined zone may be ON or OFF making them unstable and unreliable. Filtering and time delays are used to filter out electrical noise that may be interrupted as a false input pulse. To eliminate the possibility a faulty operation due to electrical noise, a valid AC input signal must not only be a specific value, but must be present for a specific amount of time before the input module allows the	**4 mark labeled Block diagram** **4 mark explanation**

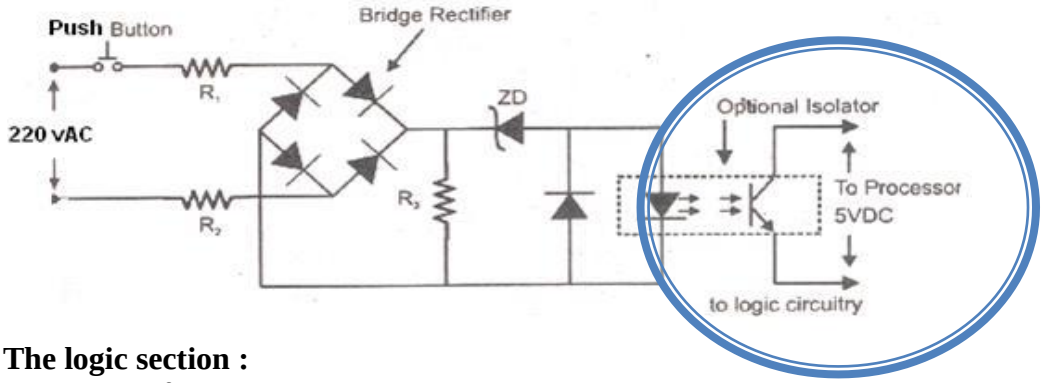
valid signal to pass to the isolation section.

Isolation : The isolation section of the input circuit is usually made up of an opto-isolator or it may called as opto-coupler. Where a light source (e.g. LED) and a photo detector (e.g. photo diode, photo transistor, photo voltaic cell etc.) are placed in signal package.

In a 115 VAC input module isolation separates the high-voltage, 110 VAC input signal from the CPU's low voltage control logic (typically 5 to 18 VDC).

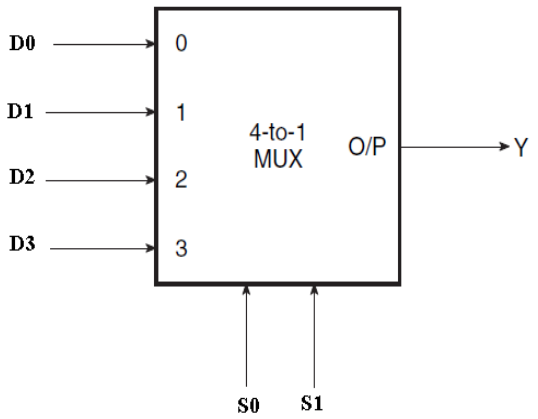
Isolation is accomplished by the input signal energizing a light-emitting diode (LED), which transmits a signal of light energy to a receiver in the form of photo conductive diode. Here LED converts the electrical signal to an optical signal and receiver usually a photo-transistor, converts the optical signal back to the electrical signal.

There is no actual physical or electrical coupling between the sending LED, it's associated input circuitry and the optical receiver and it's low-voltage associated logic circuitry. The signal is transferred by light (photon particles) from the LED.



The logic section :

DC signals from the opto-coupler are used by the logic section to pass the input signal to the module's input address LED and the CPU. Then CPU saves the respective input in Input Status Table.

	b)	**Draw Ladder diagram for 4 : 1 multiplexer.**	**8 Marks**
	Ans:		**1mark logic diagram** **1mark Truth Table** **1mark Expression** **4mark Ladder diagram** **1mark explanation**

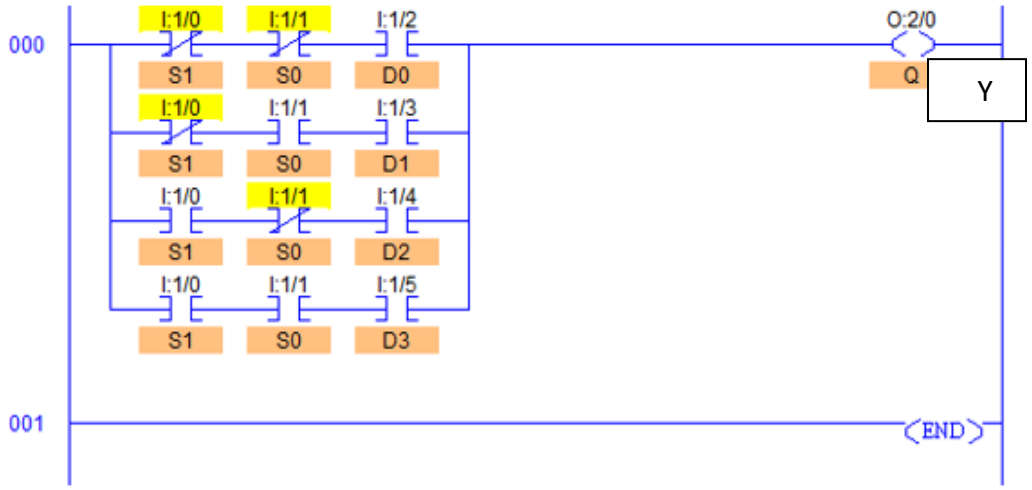
Select Data Inputs		Output
S_1	S_0	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

Logic Diagram Truth Table

Expression:

$$Y = \overline{S1S0}\,D0 + \overline{S1}S0D1 + S1\overline{S0}D2 + S1S0D3$$

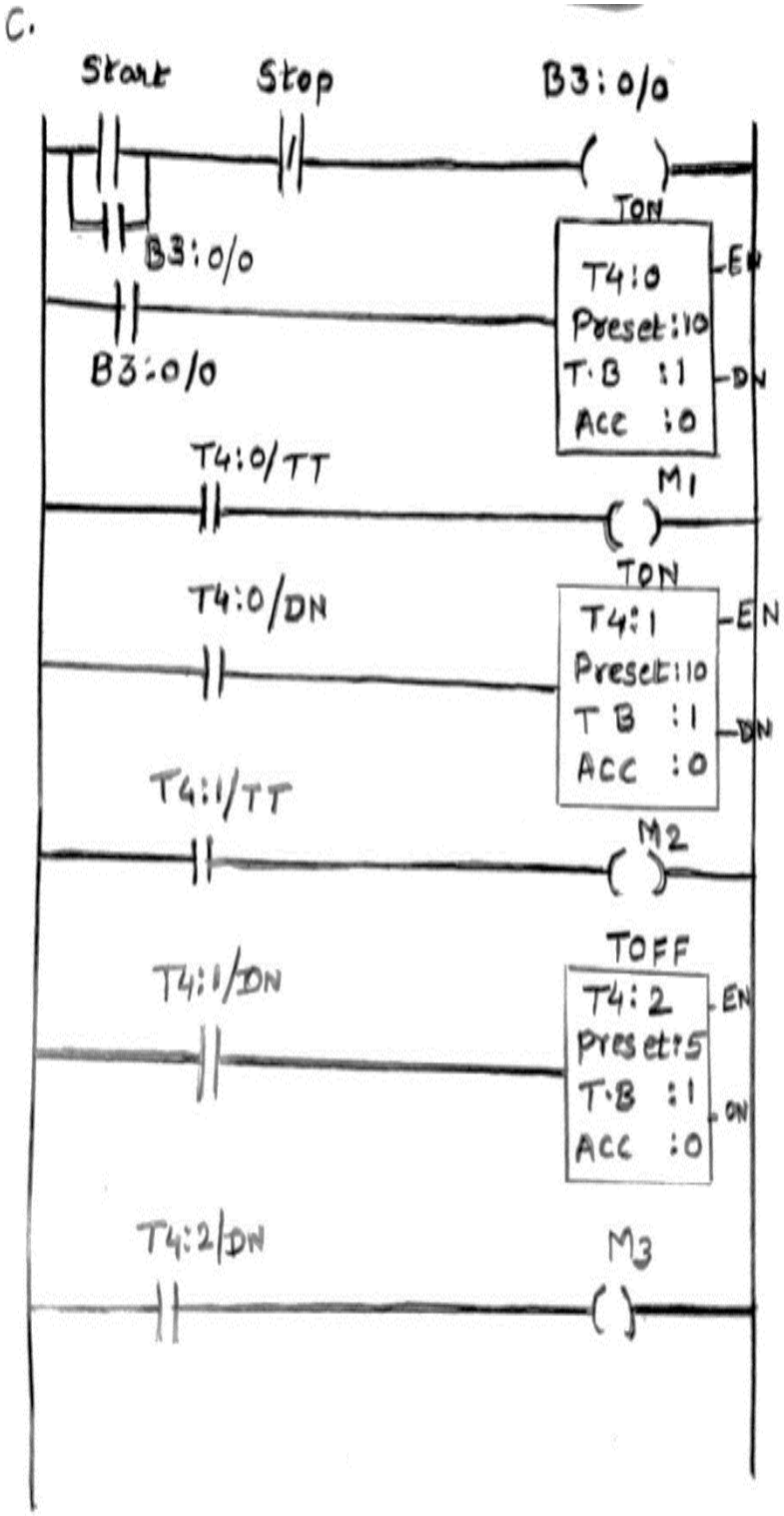
Ladder Diagram

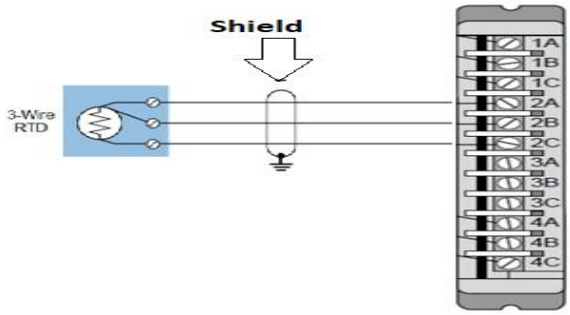
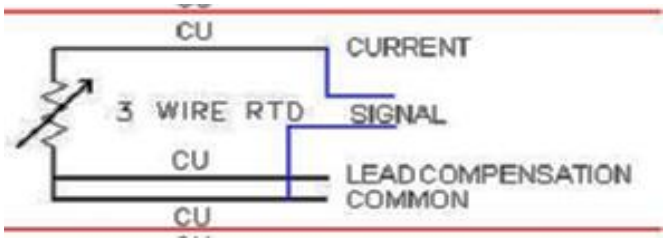


Explanation:

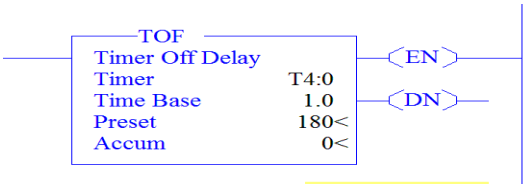
For every combination of select lines that particular input is selected at output
For eg. If s1=,S0=0; D0 will be selected at output ,Y=D0

c)	**Write a ladder program for following conditions :** **(i) When start button is pressed motor M_1 is started.** **(ii) After 10 sec. motor M_1 stops and M_2 starts.** **(iii) After 10 sec. motor M_2 stops and M_3 start.** **(iv) When stop button is pressed after 5 sec. M_3 stops.**	**8 Marks**
Ans:	**ladder program:**	**6mark ladder**

		C.  **(Any other relevant program should be considered)**	**diagram 2mark explanation**

		Explanation: 1.When start Push Button is pressed, B3:0/0=1 2. For B3:0/0=1, T4:0 is enabled and EN=1, TT=1 for 10sec. 3. T4:0/TT=1 for 10 seconds M1 remains ON then M1 turns Off. 4. After first 10 sec. when T4:0/DN=1, T4:1 is enabled and EN=1,TT=1 for next 10 sec. 5. For these 10 sec. T4:1/TT =1, M2 remains ON. After these next 10 sec. M2 turns Off. 6.Thus after total 20 sec. since start, T4:1/DN=1 which Enables T_{OFF} and T4:2/DN=1 Thus M3 turns ON. 7. When Stop P.B is forced, B3:0/0=0 Thus both Timers T4:0 and T4:1 are disabled and T_{OFF} T4:2/TT =1 , for next 5 sec. 8. After 5sec of T4:2/TT=1, T4:2/DN =0 and M3 stops.	
Q.6		**Attempt any FOUR :**	**16 Marks**
`	**a)**	**Draw block diagram of 3 wire RTD input module.**	**4 Marks**
	Ans:	 The three wires in RTD are  **(Any other relevant diagram should be considered)**	**4mark for proper labeled diagram**
	b)	**Explain with diagram off delay timer instruction. Draw the waveform of it.**	**4 Marks**
	Ans:		**1mark Format of TOFF**

2mark waveforms



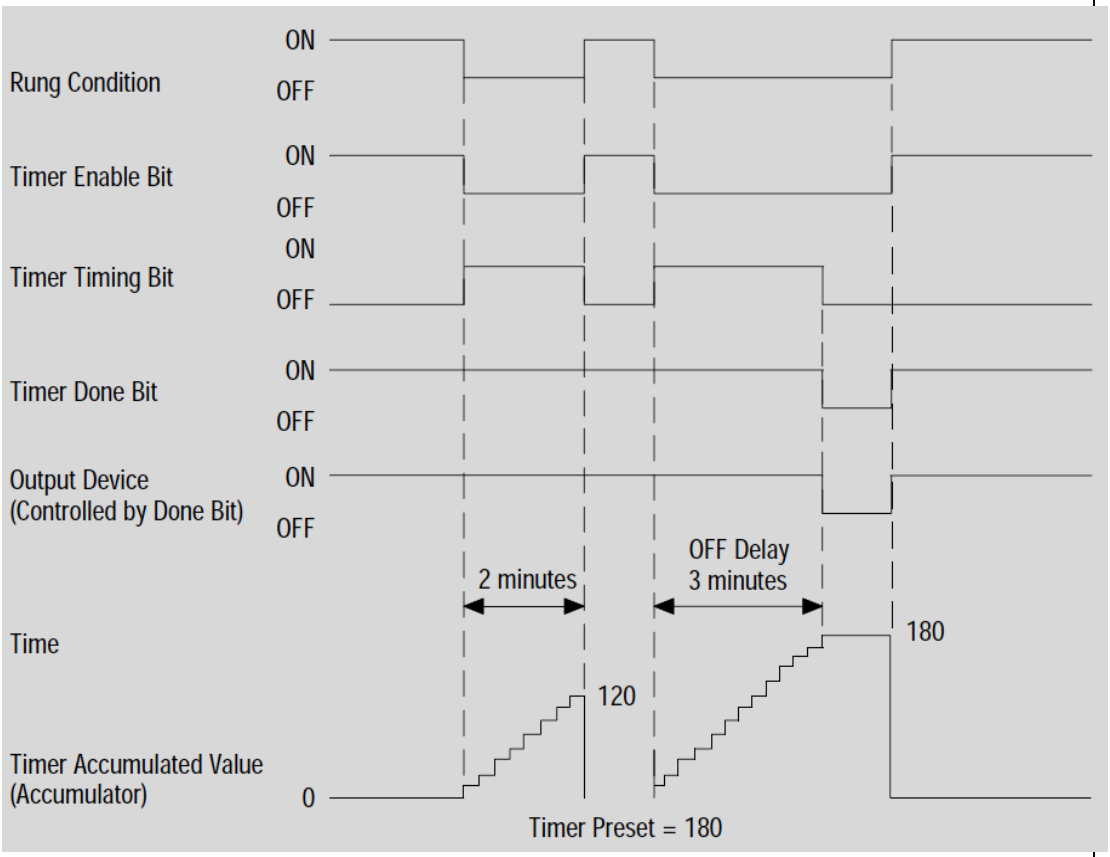


Fig. waveform for T_{OFF}

1 mark explanation

Preset value: is multiplied by the time base of the timer to specify the time delay.
Accumulated value: specifies the time from the moment that was disabled up to the current moment. The address is for accumulators as follows T4: 0.ACC
Enabled bit is set when the line is true, indicates that the timer is enabled. It is clear when the line is false. The address for these bits is T4: 0 / EN.
Timing timer bit is set in the time interval that occurs between the timer is disabled and when the accumulated value reaches the preset(here=180 seconds) value. The rest of the time this bit is clear. The address for these bits is T4: 0 / TT.
Done bit is set when the accumulated value is equal to the preset value and the timer is disabled. It is clear when the timer is enabled. The address for these bits is for example T4: 0 / DN.

	c)	**Explain input and output troubleshooting using module LED status.**	**4 Marks**
	Ans:	**Troubleshooting PLC inputs:** If the field device connected to an input module does not seem to turn ON, a problem may exist somewhere between the L1 connection and the terminal connection to the module**.** An input module's status indicators can provide information about the field device, the module, and the field device's wiring to the module. The first step in diagnosing the problem is to place the PLC in standby mode**,** so that it is not activating the output**.** This allows the field device to be manually activated. When the field device is activated, the module's power status indicator should turn ON, indicating that power continuity exists. If the indicator is ON, then wiring is not the cause of the problem.	**2 mark for input module** **2mark for output module**

Input device troubleshooting guide

Input device condition	Input module status indicator	Monitor display status indicator		Possible problem source(s)
Closed — ON	ON	True	False	None, correct status indication
Open — OFF	OFF	False	True	None, correct status indication
Closed — ON	ON	False	True	1. I/O module 2. Processor/operator terminal communication
Closed — ON	OFF	False	True	1. Wiring/power to I/O module 2. I/O module
Open — OFF	OFF	True	False	1. Programming error 2. Processor/operator terminal communication
Open — OFF	ON	True	False	1. Short circuit in input device or wiring 2. Input module

Fig. Input Module troubleshooting

Troubleshooting PLC outputs:

PLC output interfaces also contain status indicators that provide useful troubleshooting information. Like the troubleshooting of PLC inputs, the first step in troubleshooting outputs is to isolate the problem to either the module, the field device, or the wiring.

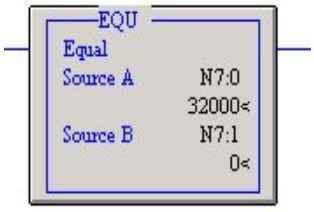
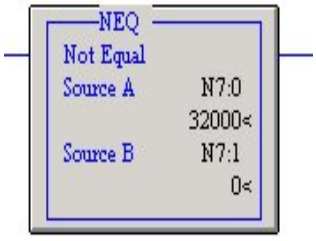
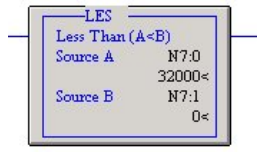
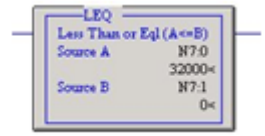
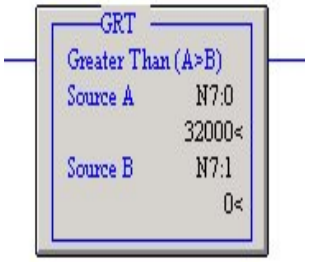
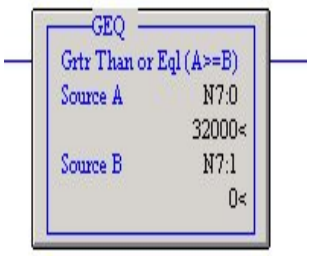
If the output module receives the command to turn ON from the processor yet the module's output status does not turn ON accordingly, then the output module is faulty. If the indicator turns ON but the field device does not energize, check for voltage at the output terminal to ensure that the switching device is operational. If no voltage is present, then the module should be replaced.

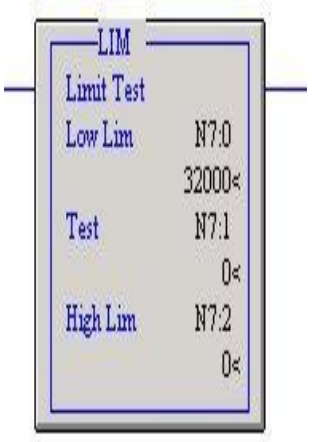
Output device troubleshooting guide

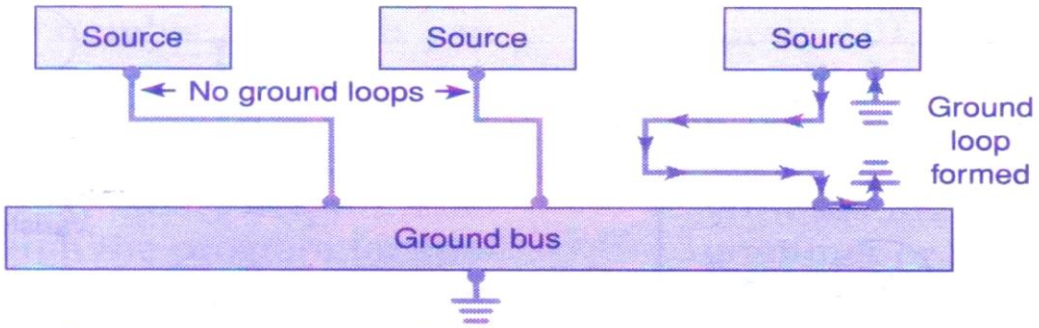
Output device condition	Output module status indicator	Monitor display status indicator	Possible problem source(s)
Energized — ON	ON	True	None, correct status indication
De-energized — OFF	OFF	False	None, correct status indication
De-energized — OFF	ON	True	1. Wiring to output device 2. Output device
De-energized — OFF	OFF	True	1. Blown fuse — output module 2. Output module malfunction

Fig. Output Module troubleshooting

d)	**Explain any two comparison instruction of PLC.**	**4 Marks**
Ans:	**The following is a list of the comparison instructions in SLC 500:** • EQU - Equal • NEQ - Not Equal • LES - Less Than • LEQ - Less Than or Equal • GRT - Greater Than • GEQ - Greater or Equal • MEQ - Masked Comparison for Equal • LIM - Limit Test	**Proper format with explanation 2mark each**

Instruction	Format	explanation
EQU - Equal		If source A and Source B are equal, the instruction is logically true. Source A must be an address. Source B can either be a program constant or an address. Negative integers are stored in two's complement.
NEQ - Not Equal		If Source A and Source B are not equal, the instruction is logically true otherwise false. Source A must be an address. Source B can be either a program constant or an address. Negative integers are stored in two's complement.
LES - Less Than		If Source A is less than the value at source B the instruction is logically true. Otherwise false.Source A must be an address. Source B can either be a program constant or an address. Negative integers are stored in two's complement.
LEQ - Less Than or Equal		If value at source A is less than or equal to the value at source B, the instruction is logically true. Otherwise False
GRT - Greater Than		If the value at source A is greater than the value at source B, the instruction is logically true else false. Source A must be an address. Source B can either be a program constant or an address. Negative integers are stored in two's complement.
GEQ - Greater or Equal		If the value at source A is greater than or equal the value at source B, the instruction is logically true. Else false. Source A must be an address. Source B can either be a program constant or an address. Negative integers are stored in two's complement.

			MEQ - Masked Comparison for Equal		Use the MEQ instruction to compare data at a source address with data at a compare address. Use of this instruction allows portions of the data to be masked by a separate word. Source is the address of the value you want to compare. Mask is the address of the mask through which the instruction moves data. The mask can be a hexadecimal value.
			LIM - Limit Test		The Low limit, Test, and High Limit values can be word addresses or constants, restricted to the following combination: If the Test parameter is a program constant, both the Low Limit and High Limit parameters must be word addresses. If the Test parameter is a word address, the Low Limit and High Limit parameters can be either a program constant or a word address.
		Note: Any two should be considered.			
	e)	**Explain need of grounding in PLC installation.**			**4 Marks**
	Ans:	Proper grounding is an important safety measure in all electrical installations. The authorative source on grounding requirements for a PLC installation is the National Electrical Code. The code specifies the type of conductors, color codes, and connections necessary for safe grounding of electrical components. According to the code, the grounding path must be permanent (no solder), continuous, and able to conduct safely the ground-fault current in the system with minimal impedance. In the event of a high value of ground current, the temperature of the conductor could cause the solder to melt, resulting in interruption of the ground connection. In addition to the grounding required for the controller and its enclosure, you must also provide proper grounding for all controlled devices in your application. The following grounding practices will help reduce electrical noise interference: 1. Ground wires should be separated from power wiring at the point of entry to the enclosure. 2. All ground connections should be made with star washers between the grounding wire and lug and metal enclosure surface. 3. Paint or other nonconductive material should be scraped away from the area where a chassis makes contact with the enclosure. 4. The minimum ground wire size should be No.12 AWG stranded copper for PLC		**Diagram 1mark Explanation 3 mark**

		equipment grounds and No.8 AWG stranded copper for enclosure backplate grounds. The enclosure should be grounded properly to the ground bus. 5. The machine ground should be connected to the enclosure and to earth ground. The ground connection should have a very low resistance. A rule of thumb would be less than 0.1Ωdc resistance between the device and ground. Figure shows formation of ground loops. 6. All PLC equipment and enclosure back plates should be grounded individually to a central point on the enclosure frame.  Certain connections require shielded cables to help reduce the effects of electrical noise coupling. Ground each shield at one end only. A shield grounded at both ends forms a ground loop, which can cause a processor to fault.	