WINTER-19 EXAMINATION

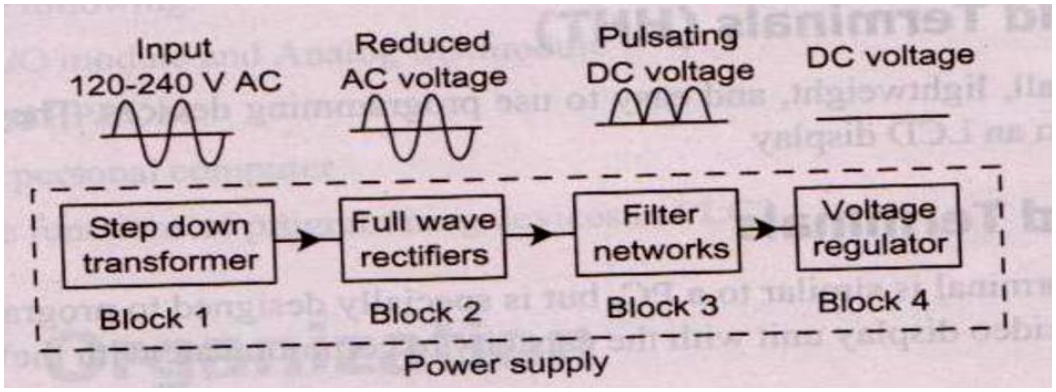
Subject Name: Industrial Automation **Subject Code** 22534

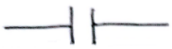
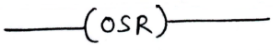
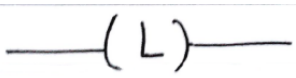
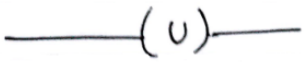
Model Answer:

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues 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.	Answers	Marking Scheme
1	**(A)**	**Attempt any FIVE of the following:**	**10- Total Marks**
	(a)	**State the need of Automation.**	**2M**
	Ans:	**Need of Automation in process :** a. To fulfill the demand of product at right time. b. To reduce the human errors and involvement of human being in the process. c. For better productivity. d. For better control of process. e. For better quality . f. For reducing man power. g. For reducing cost of product. **Note : Any other equivalent points should be considered**	**2M for correct points**

	(b)	**Draw neat block diagram of PLC power supply.**	**2M**
	Ans:	**Block diagram power supply of PLC :** 	**2M for correct diagram**
	(c)	**State the I/O module selection criteria with respect to PLC.**	**2M**
	Ans:	**I/O Selection criteria :** 1) Number of analog and digital inputs 2) Numbers of analog and digital outputs 3) Number AC/DC inputs 4) Number of AC/DC outputs 5) Discrete I/O. 6) Power supply voltage 7) Type of I/O signals –temperature, pressure, speed control etc.	**2M for correct points**
	(d)	**List the types of comparison instruction used in PLC.**	**2M**
	Ans:	Types of comparison instruction: 1)EQU(Value, Value) 2)NEQ(Value, Value) 3)LES(Value, Value) 4)LEQ(Value, Value)	**½ M for each correct type**

		5)GRT(Value, Value) 6)GEQ(Value, Value)	
	e)	**Give any two relay type instructions with their symbols.**	**2M**
	Ans:	**Relay type instructions : (Any TWO)** **1. Normally open (XIC) :** **Symbol :**  **2. Normally Close (XIO) :** **Symbol :**  **3. One Shot Instruction (OSR) :** **Symbol :**  **4. Output Instruction :** **Symbol :**  **5. Output latch instruction(L) :** **Symbol :**  **6. Output unlatch instruction(U) :** **Symbol :** 	**(1M for each correct type)**

	f)	**State the need of electric drives.**	**2M**
	Ans:	**Need of Electric drives :** a. The motion control is required in large number of industrial and domestic applications. These applications include sugar mills, paper mills, textile mills etc. b. The motors need to be operated at different speeds for which an electric drive is needed. c. To meet good overload capacity d. To improve the energy efficiency **e.** For operating in all four quadrants of speed torque plane.	**(1M for correct point)**
	g)	**List any four applications of SCADA.**	**2M**
	Ans:	**Applications of SCADA: (Any FOUR)** 1.Traffic light control 2. Water distribution 3. Pipeline control 4.Electric power system, operation and control 5. Manufacturing Industries or plants 6. Lift and Elevator controls 7. Telecom and IT based systems	**½ M for each correct point**

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total**

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			Marks
	a)	**Compare fixed and programmable automation on any four points.**	**4M**

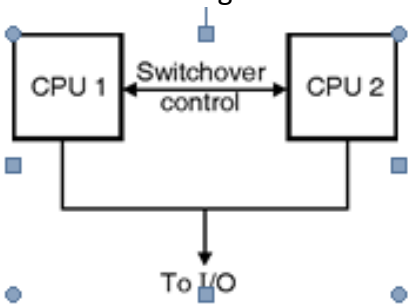
Ans:

Sr. No	Fixed Automation	Programmable Automation
1	Fixed automation is a type of automation where the automated application is used for a dedicated fixed purpose or use.	Programmable automation is type Of automation where the automated Application is used for multiple Purpose Or use.
2	In Fixed Automation, the number of inputs and outputs are fixed because I/O capabilities are decided by the manufacturer but not by the user.	In Programmable Automation , the number of inputs and outputs are not fixed. Can be added to the automated system PLC systems by the user.
3	To achieve fixed automation, generally Fixed PLCs are used.	To achieve Programmable automation Generally , Modular PLC is used.
4	Cost wise Fixed automation is relatively cheaper.	Programmable automation is Relatively Costlier.
5	It is useful for the smaller applications and most suitable for the domestic purpose.	It is used for industrial purpose and also for future industrial expansion and growth.

1M for each correct point

	b)	**Explain redundancy in PLC with suitable diagram.** **4M**
	Ans:	**Description of Redundancy :** a. Redundancy means extra system components or mechanisms added to decrease the chance of total system failure. b. Different types of redundancy are available in PLC like redundancy for a CPU module, power module, bases and communication module is available. c. CPU redundancy system is composed of separate bases for ideal redundancy structure. d. In case an error occurs in an active CPU module, a backup module is automatically converted to active one for continuous operation. **3M for explanation**

e. In these cases two processors can be tied into one I/O system and some 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.

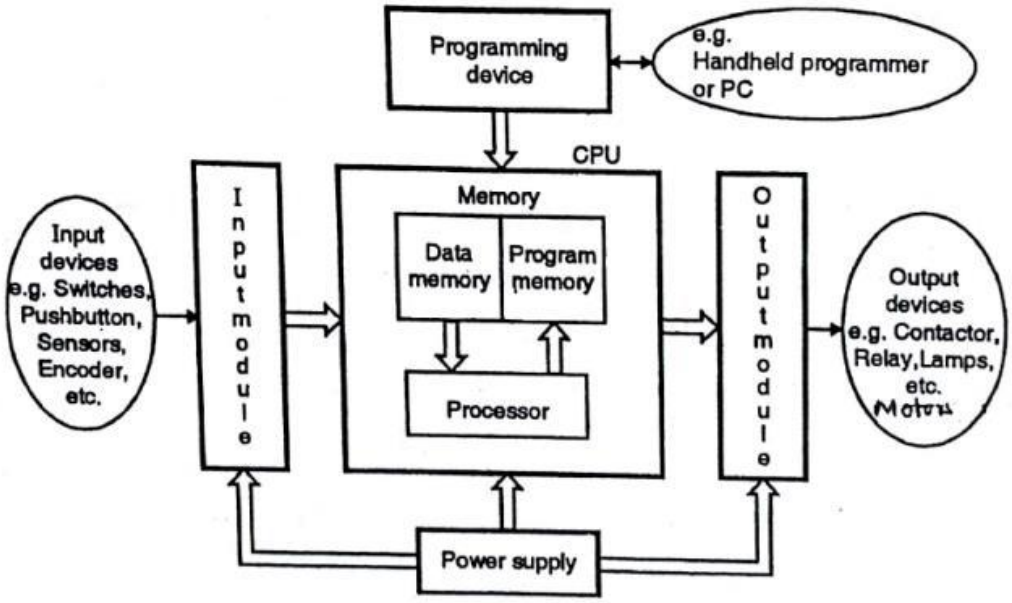


1M for diagram

f. The working of total system is reliability of its operation.
g. The safety of critical load is increased by transferring it from a failed power module to an alternative source of power.
h. Thus, reliability can be increased by selective use of redundancy.

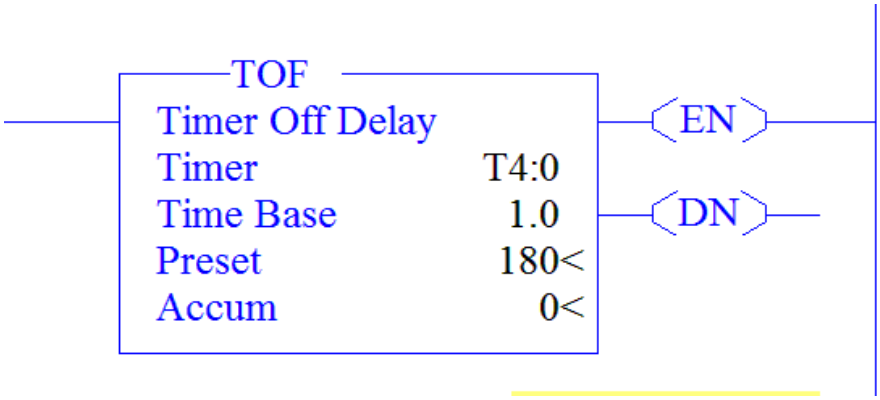
c) Draw a neat block diagram of PLC and explain the function of CPU and memory. **4M**

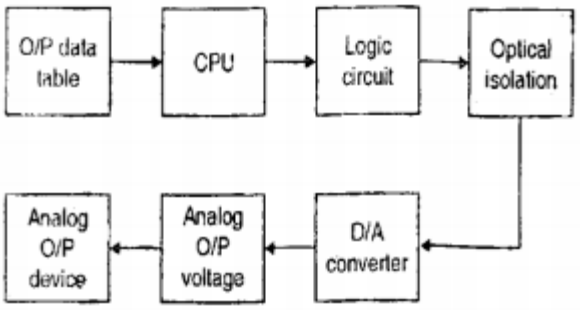
Ans:

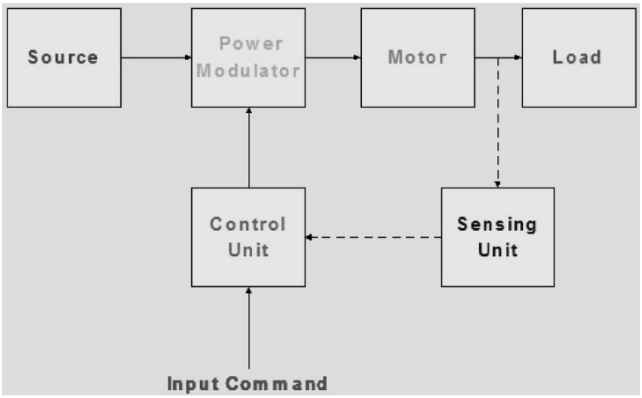


Block diagram of PLC

2M for diagram

		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.	**2M for explanation**
	d)	**Draw a symbol of OFF delay timer instruction. State the function of following:** **(i) Enable bit** **(ii) Done bit** **(iii) Timer timing bit**	**4M**
	Ans:	**Symbol of OFF Delay Timer :**  **Function :** **(i) Enable bit : 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 as follows: T #file: #element/EN, for example T4: 0 / EN. **(ii) Done bit : 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 as follows: T #file:#element/DN, for example T4: 0 / DN.	**1M for symbol** **3M for correct explanation**

		(iii) Timer timing bit : Timing timer bit is set in the time interval that occurs between the timer is disabled and when the accumulated value reaches the preset value. The rest of the time this bit is clear. The address for these bits is as follows: T #file:#element/TT, for example T4: 0 / TT.	
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	a)	**State the function of each block of analog output module with block diagram.**	**4M**
	Ans:	**Block diagram of analog output module:**  **Explanation**: Analog output modules accept 16 bit output status word, which they convert to an 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	**2M** **2M**

		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.	
	b)	**Draw a basic block diagram of electrical drive and explain each block in brief.**	**4M**
	Ans:	**Basic block diagram of electrical drive:** 	**2M**
		Explanation: The main parts of the electrical drives are power modulator, motor, controlling unit and sensing units. Their parts are explained below in detail. i. **Power Modulator** : The power modulator regulates the output power of the source. It controls the power from the source to the motor in such a manner that motor transmits the speed - torque characteristic required by the load. During the transient operations like starting, braking and speed reversing the excessive current drawn from the source. This excessive current drawn from the source may overload it or may cause a voltage drop. Hence the power modulator restricts the source and motor current. The power modulator converts the energy according to the requirement of the motor e.g. if the source is DC and an induction motor is used then power modulator convert DC into AC. It also selects the mode of operation of the motor, i.e., motoring or braking. ii. **Control Unit:**	**2M**

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The control unit controls the power modulator which operates at small voltage and power levels. The control unit also operates the power modulator as desired. It also generates the commands for the protection of power modulator and motor. An input command signal which adjusts the operating point of the drive, from an input to the control unit.

iii. **Sensing Unit :**

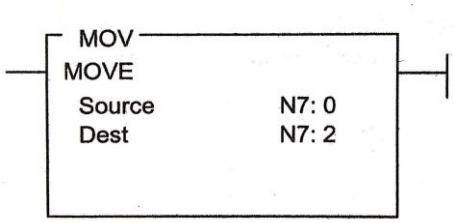
It senses the certain drive parameter like motor current and speed. It mainly required either for protection or for closed loop operation.

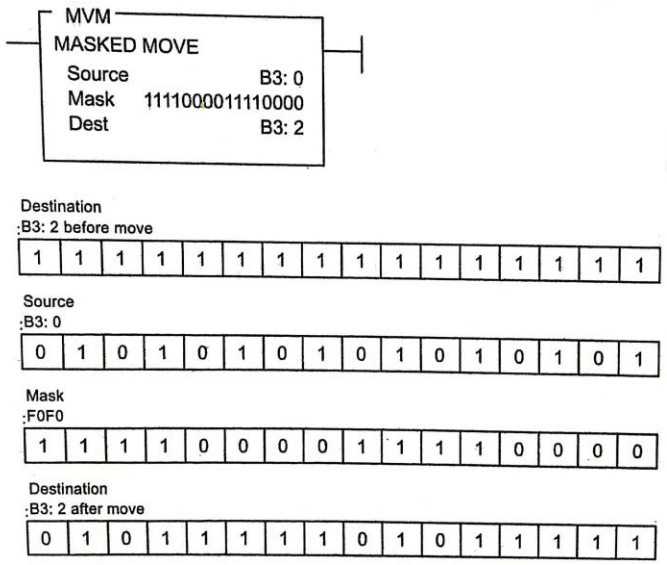
c) Compare PLC and SCADA on any four points. **4M**

Ans: **1M Each**

(Any four points)

Sr.No	Parameter	PLC	SCADA
1	Full form	*PLC* stands for Programmable logic controller	*SCADA* stands for Supervisory Control and Data Acquisition
2	Function	*PLC* is a controller i.e it takes inputs, executes the program and generates the output.	*SCADA* doesn't have its own controller it just monitors one or multiple controllers through software applications.
3	Use	PLC is a simple programming for the automation of the industry	SCADA is a visual and easy interface for automation of the industry.
4	Meaning	It is a solid state device which controls the output of the process through the program given in ladder diagrams.	It is a software. It is used to monitor, control and acquire data from field devices even from remote locations.
5	Input/Output	Input and output are represented in normal open (NO), normal close (NC) and coil contacts.	Input and output are represented in images.

		6	Component/Object	Each component involved are defined using address.	Each object is defined using name.	
	d)	**Explain any four data handling instruction used in PLC.**				**4M**
	Ans:	Data Handling Instructions: 1. **MOV (Move):** The move instruction copies a value from a source address to a destination address. The source can be either a constant value or the address of a memory location. Figure represents the MOV instruction. The source is N7:0, and the destination is N7:2.  Symbol of MOV instruction As shown in figure, the following parameters are used in a MOV instruction. • Source: Represents the address from which the instruction reads the value. • Destination: Represents the data address to which the data from the source is to be moved. The MOV instruction can be used to transfer data between any two words. This instruction can also used to change the preset values of the timer, and the preset or accumulated values of counters, to fulfill programming requirements. The source value remains unchanged. **2. MVM (Masked Moved):** The MVM instruction copies the value from a source address to a destination address, allowing some portion of the data to be masked. The MVM instruction transfers data through the mask from the source address to the destination address. the bits set as 1 in the mask will pass the data from source to destination. For the bits set as 0 in the mask, the data in the destination address will remain in its last state. Figure shows the format of MVM instruction and its illustration.				**1M Each**



Symbol of MVM instruction

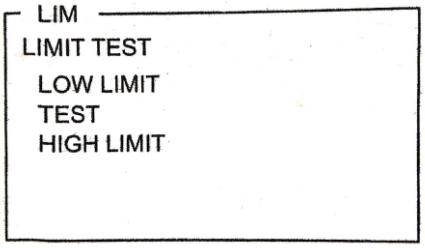
As show in the figure

- The source address is B3:0.
- The mask is F0F0 (HEX)
- The destination address is B3:2.

Mask word is F0F0, so bits 4 to 7 and bits 12 to 15 are set to 1. As a result, data get transferred from the source word to the destination word only in these bits. In the destination word, bits having 0s in the mask remain unchanged when the MVM instruction goes true.

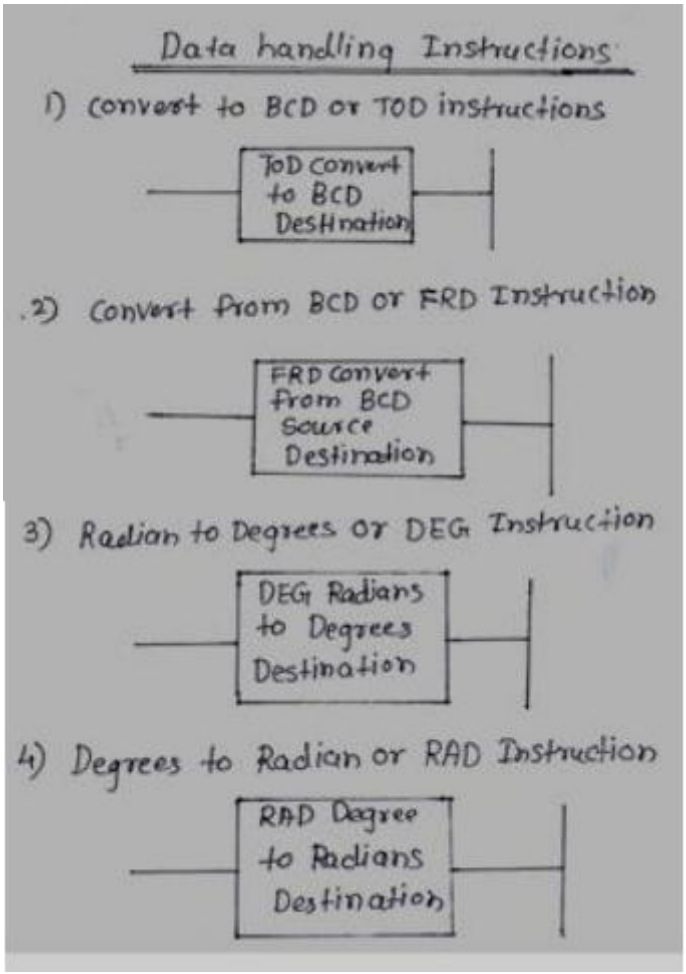
3. LIM (Limit Test):

The LIM instruction compares whether a given value lies within a specified range. The high and low limits are stored in different memory addresses as HIGH LIMIT and LOW LIMIT. The value to be tested is kept in another memory location, namely TEST. If the value stored in TEST is greater than or equal to the value in LOW LIMIT, and less than or equal to the value in HIGH LIMIT, then the rung output becomes TRUE, else the rung output is FALSE. Figure represents the block format of an LIM instruction.



Symbol of LIM instruction

4.Convert BCD ,Convert from BCD,Radian to Degree & Degree to Radian:



Q.	Sub	Answers	Marking

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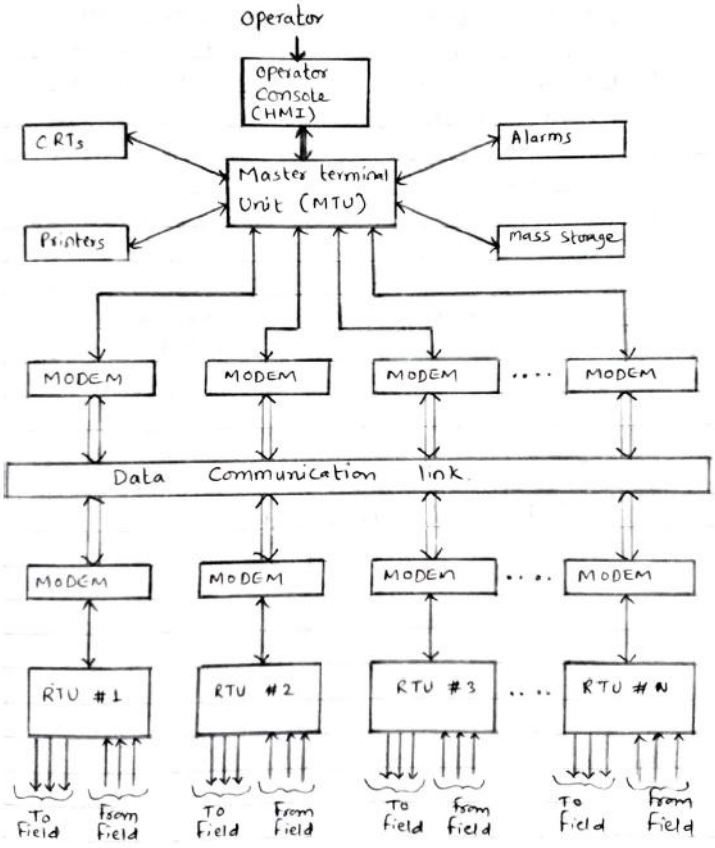
No.	Q. N.		Scheme
4		**Attempt any THREE of the following :**	**12- Total Marks**
	(a)	**Draw block diagram of SCADA system and explain its parts.**	**4M**
	Ans:	**Block diagram of SCADA:** 	**2M**

- **Master Terminal Unit (MTU)**

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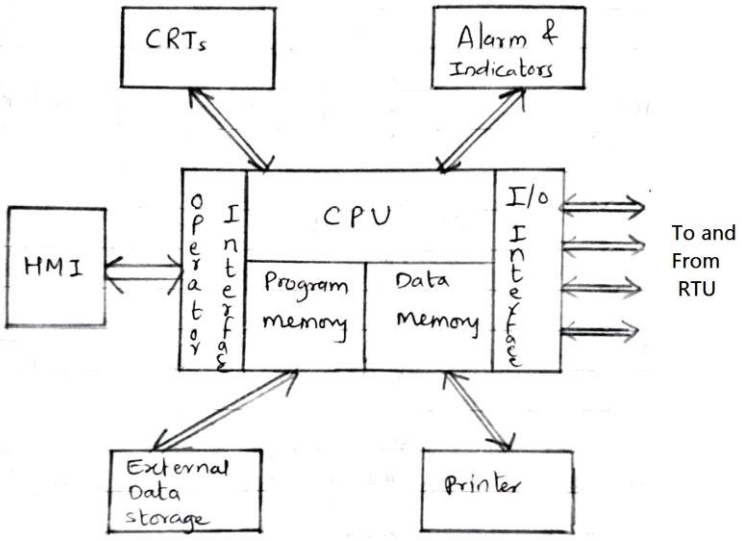


Block diagram of MTU

(i) Master terminal unit (MTU) is a system controller , which is sometimes called 'host computer'.
(ii) It can monitor and control the field devices even when the operator is not present. It does this by means of a built in scheduler that can be programmed to repeat instructions at set intervals.
(iii) Generally, MTU receives the signal from operator interface and after processing, this signal will be given to RTU for control of various field devices. It also receives the signal from RTU, which is received by RTU from field devices. This received signal is stored and processed by MTU according to program given by operator.

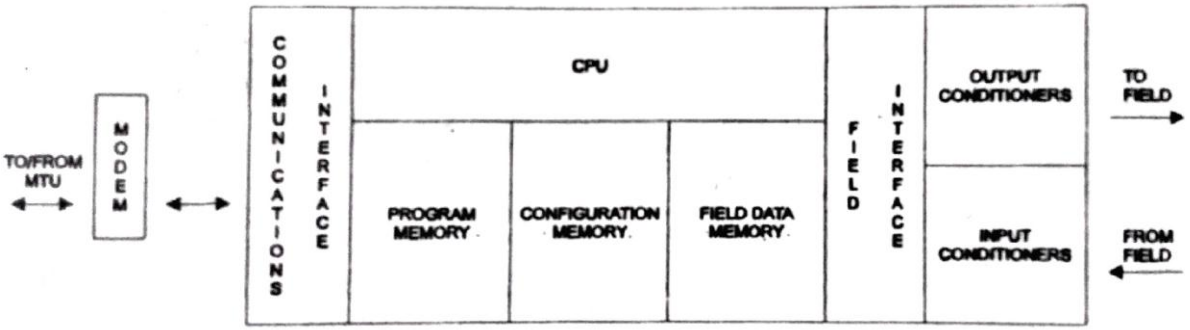
the general functions of MTU:-
1. Collects the data from different RTU's placed at remote locations.
2. Stores required information into internal and external storage devices.
3. Passes other information on to the associated system.
4. Interfaces with the people which operator the process.
5. Issues commands or control signal to various RTU's.

- **Remote Terminal Unit (RTU):**

Block diagram of RTU:

1M

(Diagram optional)



(i) RTU stands for Remote terminal unit. Modern RTU's are essentially microcomputer or programmable controllers (PLC) which is interfaced with the MTU and various field devices.

(ii) RTU gathers information from the field . i.e. analog values, various ON-OFF status signals etc.It keeps this information in the memory until the MTU asks for required information, it then codes and transmits the information using modem through communication link to the MTU.

(i) When master terminal unit sends the control signal, RTU receives that signal and follows the commands given by MTU. Following diagram shows the various signals that are entering and leaving the Remote terminal unit.

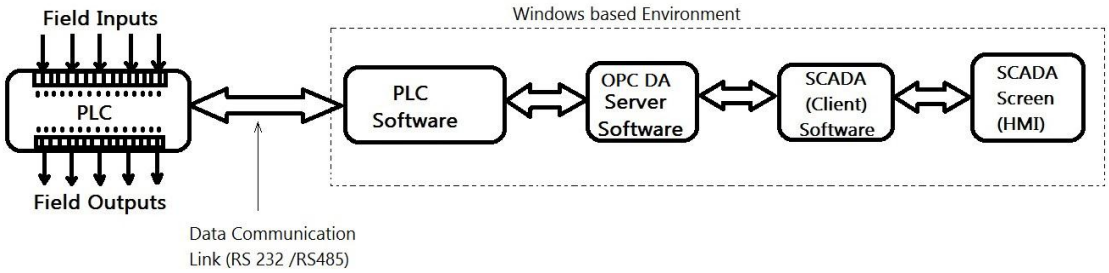
1M(Diagram is optional)

(b) **Describe the steps involved in interfacing of PLC based application to a SCADA system.** **4M**

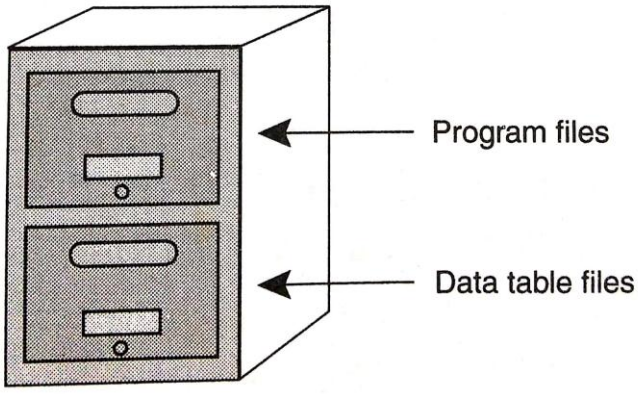
Ans: **Diagram:**

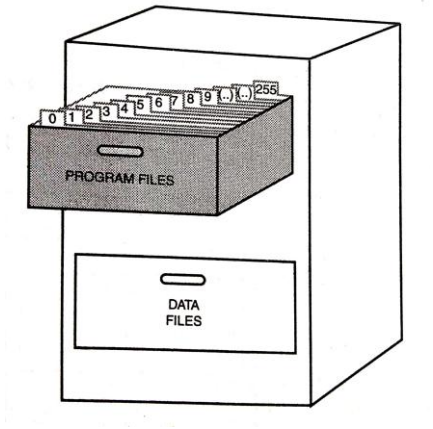
The communication between PLC software and SCADA is achieved through an OPC DA Server. Open Platform Communications (OPC) is a standard defined for industrial communication.

2M



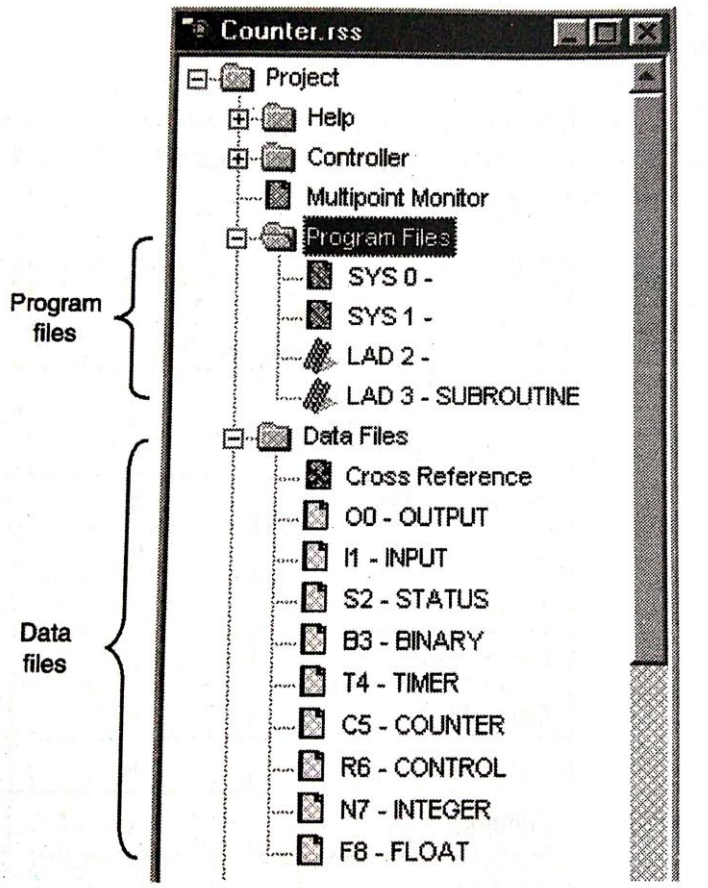
The Figure shows the typical connection diagram or interfacing diagram of PLC hardware with SCADA software. It is cleared from the figure that PLC hardware is operated through a appropriate PLC software.

		Steps involved in interfacing of PLC based application to a SCADA system: • PLC is interfaced with OPC DA server.OPC DA server works on the server-client mechanism, which provides access to the live and historic data of process variables. OLE for process control (OPC) is a standard that provides interoperability between the devices of different manufacturers for secure and reliable exchange of data. The various PLC parameters are acquired in real time in OPC server by configuring OPC with device, channel and groups. Several tags are defined to indicate PLC input and output parameters. • This which is aquired by an OPC is then can be accessed using SCADA application which acts as client for OPC server. • SCADA application (HMI screen) is developed that, allows reading and writing data to and from SCADA to OPC DA server in real time.	**2M**
	(c)	**Describe memory organization of PLC with neat sketch.**	**4M**
	Ans:	MEMORY Organisation in PLC: To understand the organisation of memory in PLC, think of program files and data files like a two drawer file cabinet, where, program files are in one drawer and data files are in the other drawer as shown in figure  PLC memory as two drawer cabinet **Program files**: The PLC processor stores system information, configuration information and user program in one group of files called program files. Figures illustrates a grouping of program files.	**4M**



There are 256 program files available per project file. As shown in figure all 256 files (i.e. file 0 to file 255) are orderly arranged in program file folder. Program file consists of following information in individual files

- File 0 (Sys 0) - Contains system configuration information.
- File 1 (Sys 1) - Contains system configuration information.
- File 2 (LAD 2) - Contains main Ladder program.
- File 3 to _le 255 (LAD 3 to LAD 255) - Contains subroutine



programs.

Figure:RS logix 500 project tree

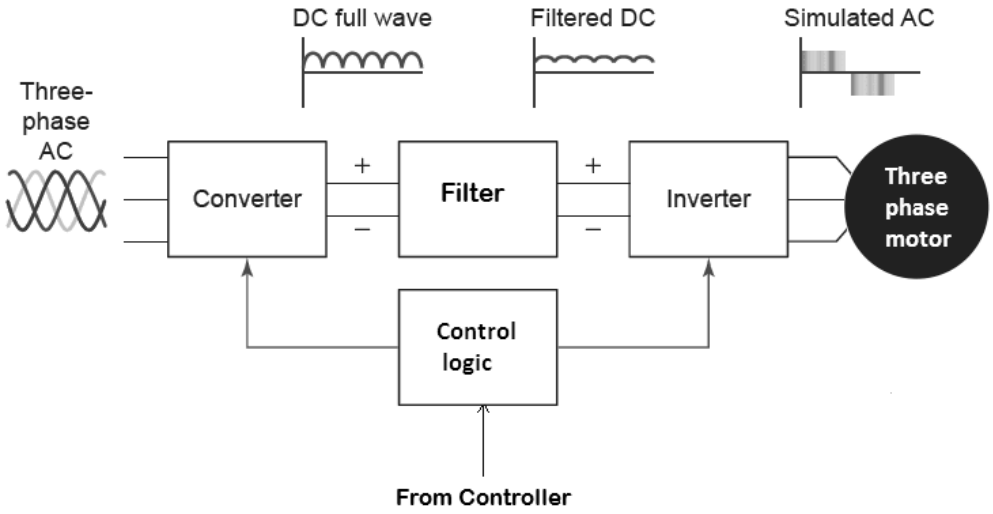
Data files: The PLC memory stores data which is required to solve the user program in one group of files called Data files. Figure illustrates the grouping of data files in a two drawer file cabinet.

There are 256 data files available per project file. As shown in figure all 256 files (i.e. file 0 to file 255) are orderly arranged in data file folder. Data file consist of nine (9) default data files (i.e. file 0 to file 8) and 247 user defined data files (i.e. file 9 to file 255).

(d)	**Explain (V/f) control method of AC drive with suitable diagram.**	**4M**
Ans:	**Variable Frequency Drive(VFD):** AC drives are used to drive the AC motor especially three phase induction motors because these are predominant over other motors in most of the industries. In industrial terms, AC drive is also called as variable frequency drive (VFD),	**1M**

variable speed drive (VSD), or adjustable speed drive (ASD).
Though there are different types of VFDs (or AC drives), all of them work on same principle that converting fixed incoming voltage and frequency into variable voltage and frequency output. The frequency of the drive determines the how fast motor should run while the combination of voltage and frequency decides the amount of torque that the motor to generate.
A VFD is made up of power electronic converters, Filter, a central control unit (a microprocessor or microcontroller) and other sensing devices. **1M**

The block diagram of a typical VFD



Principle **2M**

Operation of Variable Frequency Drive (VFD) :
The speed of an induction motor is proportional to the frequency of the supply (N = 120f=p)
and by varying the frequency we can obtain the variable speed. But, when the frequency is decreased, the torque increases and thereby motor draws a heavy current. This in turn increases the flux in the motor. Also the magnetic field may reach to the saturation level, if the voltage of the supply is not reduced. Therefore, both the voltage and frequency have to be changed in a constant ratio in order to maintain the flux within the working range. Since the torque is proportional to the magnetic flux, the torque remains constant throughout the operating range of v/f.

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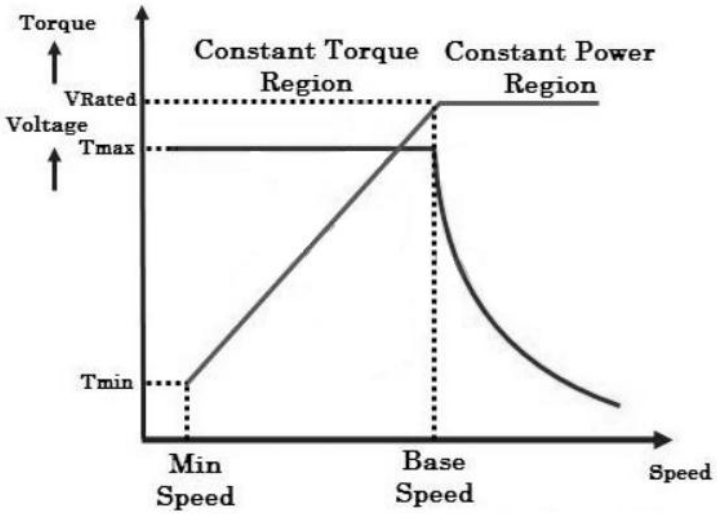
Model Answer:



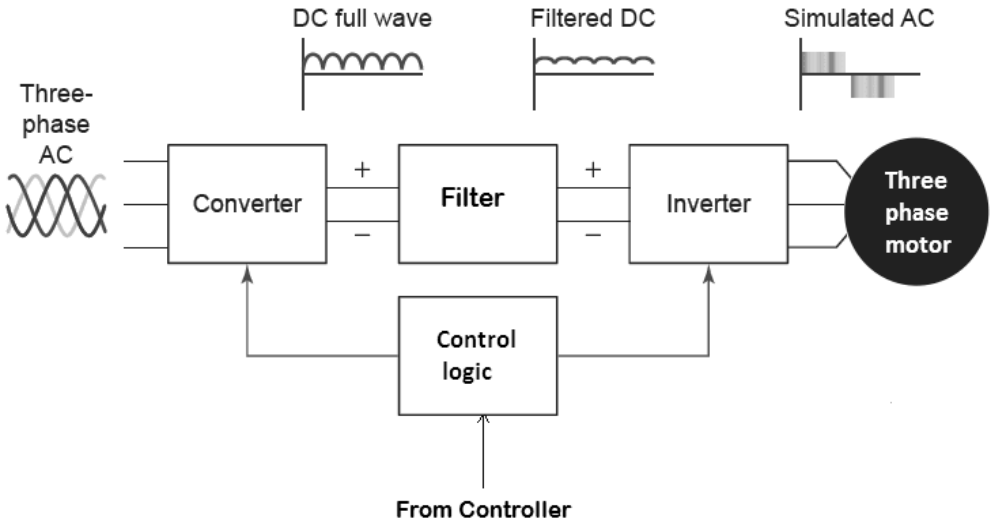
The figure shows the torque and speed variation of an induction motor for voltage and frequency control. In the figure, voltage and frequency are changed at a constant ratio up to the base speed. Thus the flux and thereby torque remain almost constant up to the base speed. This region is called as a constant torque region.

Since the supply voltage can be changed up to the rated value only and hence the speed at rated voltage is the base speed. If the frequency increased, beyond the base speed, the magnetic flux in the motor decreases and thereby torque begins falling off. This is calledfl ux weakening or constant power region.

OR

Diagram:

2M

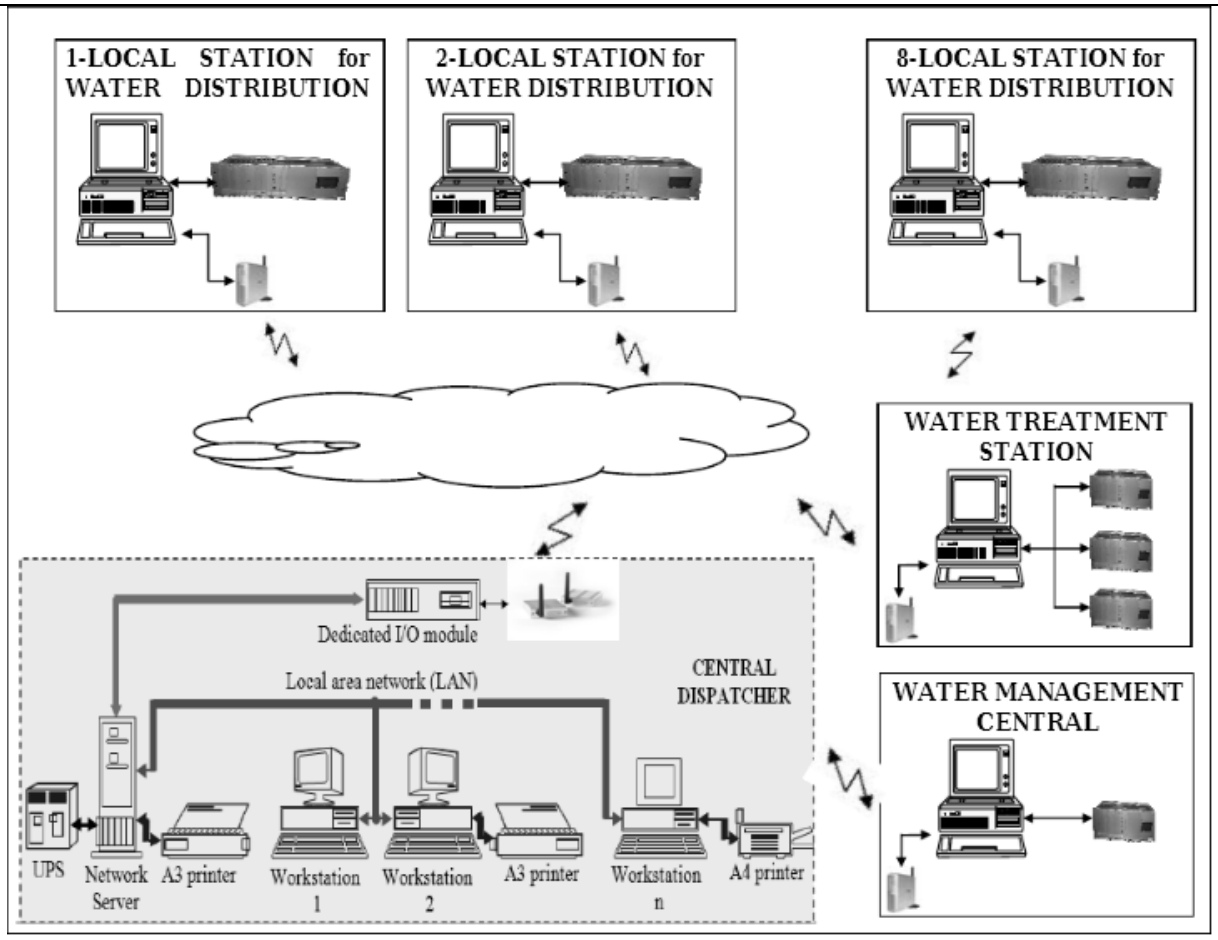


Explanation:

- **Rectifier and Filter section** converts the AC power into DC power with negligible ripples. Mostly, the rectifier section is made with diodes that produce uncontrollable DC output. The filter section then removes ripples and produces the fixed DC from pulsating DC. Depends on the type of supply number of diodes is decided in the rectifier. For example, if it is three phase supply, a minimum of 6 diodes are required and hence it is called as six pulse converter.
- **The inverter** takes the DC power from the rectifier section and then converts back to the AC power of variable voltage and variable frequency under the control of microprocessor or microcontroller. This section is made with series of transistors, IGBTs, SCRs, or MOSFETs and these are turned ON/OFF by the signals from the controller. Depends on the turn ON of these power electronic components, the output and eventually the speed of the motor is determined.
- **The controller** is made with microprocessor or microcontroller and it takes the input from sensor (as speed reference) and speed reference from the user and accordingly triggers the power electronic components in order to vary the frequency of the supply. It also performs overvoltage and under voltage trip, power factor correction, temperature control and PC connectivity for real time monitoring.

2M

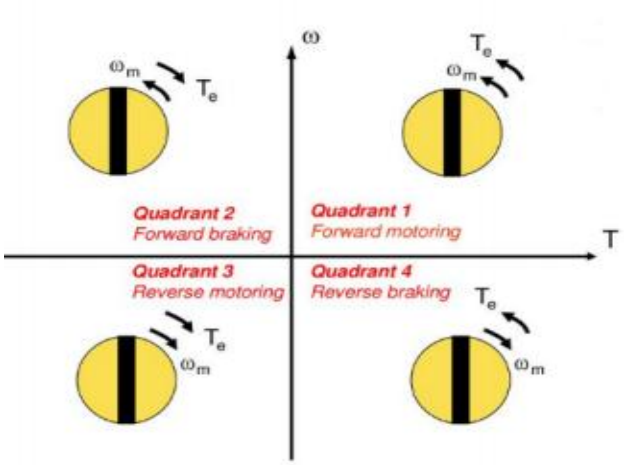
	(e)	**Explain how SCADA is used in water distribution system with diagram.**	**4M**
	Ans:	**Block Diagram of SCADA in water distribution System:**	**2M**



Use of SCADA:

The SCADA system assures the acquisition from the transducers of the characteristic parameters of the functioning of the technological installations within the water distribution stations, the monitoring and command of the pumps at the local stations level, the taken of the acquisitioned data, sending the data to the central dispatcher level, monitoring the stations functioning through the synoptic schemes, elaborating the monitoring bulletin and stations balance sheets, sending the results to the decision factors. In this way, each station has its own data acquisition and command local equipment which has associated a local PC and which communicates with the dispatcher PC. The equipment is questioned at a constant period of time fixed by the local PC and so all the analogical/digital inputs and outputs are registered at the level of the local computer. The equipment realizes the drive of the pumps driving engines within the respective station, through soft- starters/invertors.

2M

Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Select device that can be used with PLC to control the speed of DC motor. Explain how.**	**6M**
	Ans:	The device that can be used with PLC to control the speed of DC motor is Electric drive **Four Quadrant Operation of Drives:** Four Quadrant Operation of any drives means that the machine operates in four quadrants. They are Forward motoring, Forward braking, Reverse motoring and Reverse braking. A motor operates in two modes- Motoring and Breaking. A motor drive capable of operating in both directions of rotation and of producing both motoring and regeneration is called a Four Quadrant variable speed drive. In motoring mode, the machine works as a motor and converts the electrical energy int o mechanical energy, supporting its motion. In braking mode, the machine works as a generator, and converts mechanical energy into electrical energy and as a result, it opposes the motion. The Motor can work in both, forward and reverse directions, i.e., in motoring and braking operations. Figure 4.2 shows the four quadrant operation of electric drive.  	**Device : 1M** **Diagram : 2.5 M** **Explanation: 2.5M**

1. First quadrant operation - Forward motoring : In this quadrant the direction of rotation (speed) is positive and torque is positive so, quadrant power developed is positive and the machine is working as a 'motor', supplying mechanical energy. (Power is positive means power flow is from source to load.)
2. Second quadrant operation - Forward Braking : In this quadrant the direction of rotation (speed) is positive, but the torque is negative, and thus,the machine operates as a 'generator' developing a negative torque, which opposes the motion. (Power is negative means power flow is from load to source.)
3. Third quadrant operation - Reverse motoring: In this quadrant The motor works in the reverse direction. Both the direction of rotation (speed) and the torque are negative, while the power is positive. (Power is positive means power flow is from source to load.)
4. Fourth quadrant operation - Reverse braking : In this quadrant the motor works in the reverse direction. In This the direction of rotation (speed) is negative and the torque is positive, therefore, the power is negative. (Power is negative means power flow is from load to source.)

Function	Quadrant	Speed	Torque	Power Output
Forward Motoring	I	+	+	+
Forward Braking	II	+	-	-
Reverse Motoring	III	-	-	+
Reverse Braking	IV	-	+	-

b) Draw ladder diagram for stepper motor control in clockwise direction. **6M**

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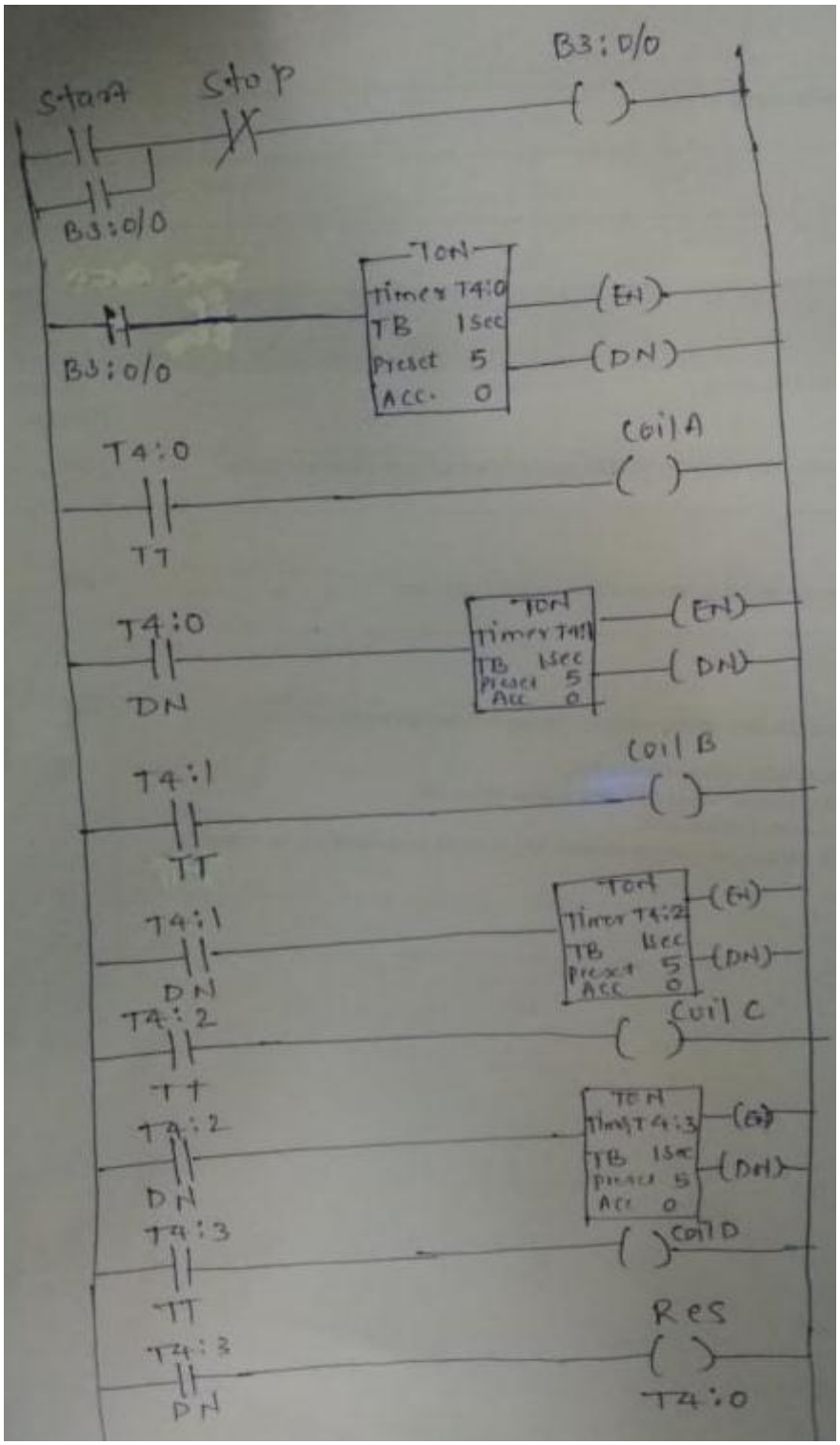
	Ans:		**6M**

		(Any other correct programming logic should be given marks)	
	c)	**Explain special I/O modules used in PLC.**	**6M**
	Ans:	Different types of speciality I/O modules: 1) Communication module 2) RTD input module 3) High speed encoder 4) Stepper motor control 5) Thermocouple input module 6) Remote I/O sub scanner 1) Communication module: - The communication modules are used to communicate with programming devices, displays, plant computers, other PLC's. The four common communication modules are ASCII modules, local I/O adapter modules, the serial data modules, network interface modules. 2) RTD input module: - This module interfaces RTD's to a PLC and other types of resistance input devices such as potentiometers. It consists of bridge circuit filter, amplifier, and isolator circuits. 3) High speed encoder:-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 encoder to a PLC. 4) Stepper motor control:-A stepper motor module is a intelligent module that resides in a PLC chassis and provides a digital output pulse train for microstepping stepper motor applications. 5) Thermocouple input module:- The thermocouple input module converts input from various thermocouple or millivolt devoces into values that can be input and stored into PLC data tables. 6) Remote I/O subscanner:-A subscanner scans the remote I/O chassis and the respective I/O chassis points. After the subscanner has scanned all remote I/O points, their I/O status is stored in a build in buffer(storage area).	**(1mark each module explanation)**

Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any TWO of the following :**	**12- Total Marks**

	a)	**Describe the steps involve developing SCADA application with an simple system.**	**6M**
	Ans:	Steps required to develop a SCADA based application are given as below: • Creating new I/O server and I/O Device: In Citect project editor, communication express wizard is used to create new I/O server which is linked with KEPServerEX.V4 driver. A new I/O device is created which is linked with Allen bradley PLC driver. This linking of I/O server and I/O device enables the SCADA to access the real time data from PLC through OPC server. • Creating variable tags and graphics: In Citect project editor a variable tags are created with specific tag name and data types. These are linked with an I/O device and I/O server. The variable tags holds real time data acquired from PLC. To develop a required graphics, Citect SCADA graphic builder platform is used. The required objects are selected from object library and linked with appropriate tags already created. The behaviour of individual graphics object in runtime is set by editing properties of each object. • Configuring OPC DA: KEPServerEX is an OPC server, acts as a link between SCADA client and PLC based application. It serves live data to a SCADA client whom it had acquired from PLC. KEPServerEX is configured, setting channel, device, groups and tags with appropriate data type.	**Each step: 2M**
	b)	**State the types of programming languages and explain any two.**	**6M**
	Ans:	PLC programming languages: This standard specifies five languages divided into two parts namely graphical languages and text-based languages. **A) Graphical languages :** i) Ladder Logic Diagram (LD) ii) Function Block Diagram (FBD) iii) Sequential Function Chart or Grafcet (SFC) **B) Text-based languages :**	**State types: 2marks** **Any two types explanation :2 marks each**

i) Instruction List (IL)

ii) Structured Text (ST)

Explanation of PLC programming languages:

i) Ladder logic diagram(LD):

It is a type of graphical language having the instructions in graphical symbol format. Ladder program is very similar to electrical wiring diagram, so it is easy to understand. Fig. Ladder logic diagram

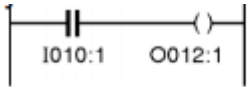
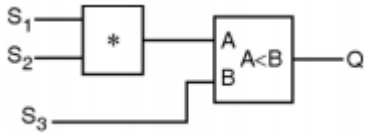
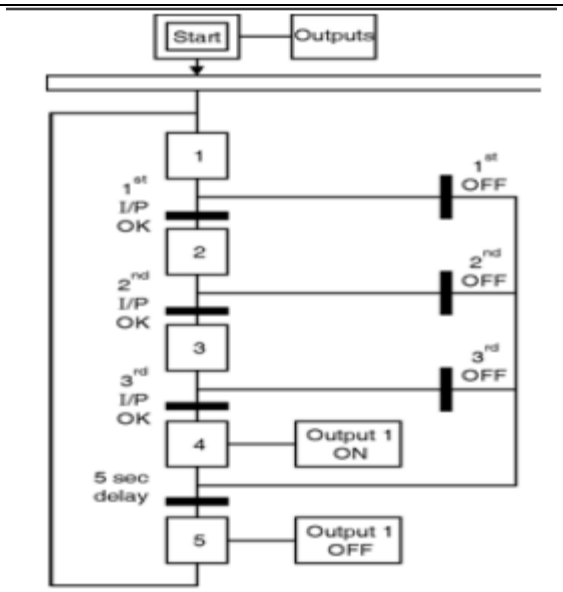


Fig. Ladder logic diagram

ii) Function Block Diagram (FBD): The primary concept behind FBD is data flow in this instructions are composed of operational blocks, Each block has one or more inputs and outputs. Fig. Simple comparison example



iii) Sequential Function Chart or Grafcet (SFC): This language is used for performing simultaneously operations required for controller in complex machine process



Process for output 1

iv) Instruction List (IL): It is similar to assembly language programming, in this low level computer language like mnemonic codes are used to specify the operation of each rung of ladder diagram.

Lable	Instruction		Comment
Start :	LD	$I_{0.0}$	Load input $I_{0.0}$
	AND	$I_{0.1}$	First logically OR inputs $I_{0.1}$ and
	OR	$I_{0.2}$	$I_{0.2}$ and the logically AND with input $I_{0.0}$
	ST	$Q_{0.0}$	Store output $Q_{0.0}$ depending on result.

v) Structured Text (ST): It is a high level computer type language like Basic or C. It is capable to perform calculations on values other than binary.

```
PROGRAM main
        VAR
        x : INT ;
        END_VAR
        x : = 0 ;
        REPEAT
        x = x + 1 ;
        UNTIL x > = 20 ;
        END_REPEAT ;
         END_PROGRAM.
```

	c)	**Draw a ladder diagram for two motor system having following condition:** **(i) Start push button, starts motor M1.** **(ii) After 10 sec, motor M1 is OFF and motor M2 is ON.** **(iii) After 5 sec motor M2 is OFF.** **(iv) STOP push button, stop both motors M1 and M2 if pressed any time during process.**	**6M**

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Model Answer:

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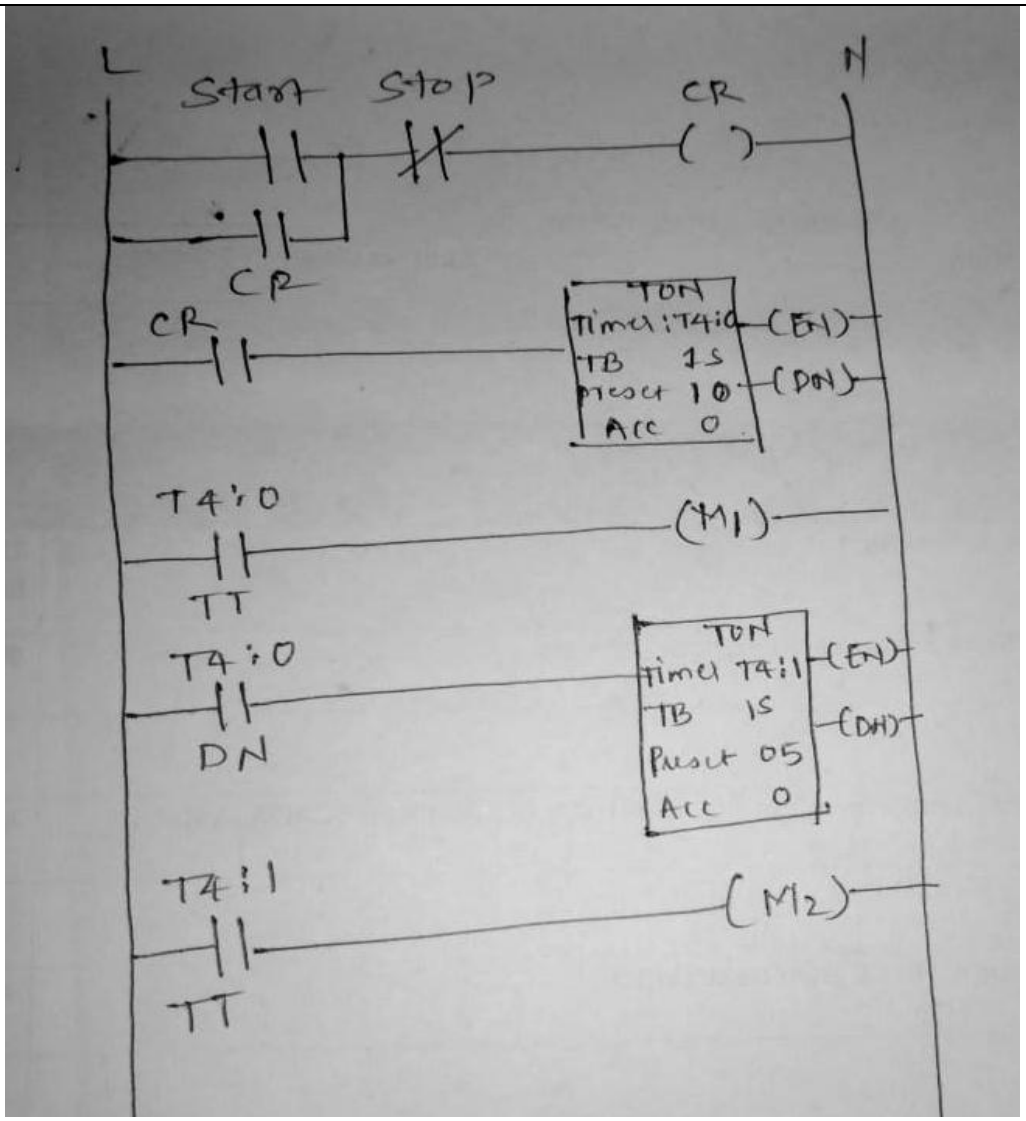
	Ans:	 **(Any other correct programming logic should be given marks)**	**correct ladder diagram : 06 marks**