586

CONTROL OF ELECTRICAL MACHINES

PART-A

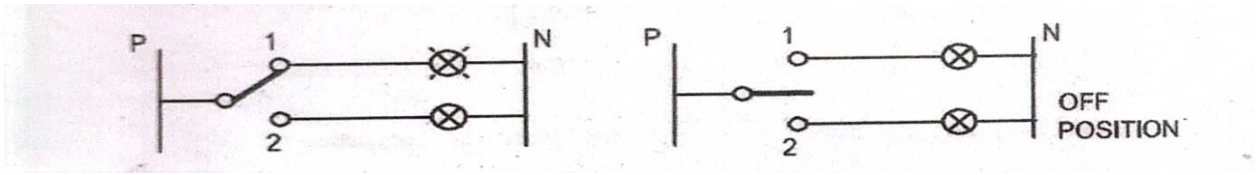
1. List out any four switches used in the control circuits. (3Marks)

1. Pushbutton switch
2. Selector switch
3. Drum switch
4. Limit switch
5. Temperature switch
6. Zero speed switch
7. Pressure switch
8. Float switch & Proximity switch

[Any 4 types of switches]

2. What is selector switch? Draw the symbol of selector switch. (3Marks)

- A selector switch is a manually operated multi-position switch. It provides options to theoperator to select a particular mode of operation.



3. What is field failure protection? (3Marks)

- At the time of starting, if the field is open then the motor will fail to start. During running condition if the field is fails, i.e. if it gets opened due to break in the field winding or opening of the field circuit terminals, the field flux gets weakened and may fall to zero. In such conditions, as the armature still gets supply, the motor continues to rotate and will reach dangerously high speed.
- This will also lead to destructive commutation. Hence has to prevent.
- This process of cutting off supply to a DC motor when its field winding gets opened is called as field failure protection.

4. Write a note on open circuit transition in autotransformer starter.

(3Marks)

- In this starter also starting current of the motor is reduced by reducing the applied voltage of starting of motor. The transition from start to run condition takes place automatically with the help of a timer.
- This starter cuts off supply to the stator winding for a small time during the transition. During this period a voltage is generated in the motor winding due to rotor flux which will result in insulation failure. This is avoided by closed circuit transition.

5. What is Skip Hoist Control? (3Marks)

- Skip hoist is used in industry for shifting material from floor level to some higher altitude. Skip hoist consists of a trolley which moves on rails on an inclined plane. On reaching the top of the incline the trolley tilts and drops the material into a large container called silos. The material from silos is then utilized as per requirement.
- The movement of trolley in the skip hoist is governed by a 3 phase induction motor. This induction motor is controlled by two contactors U and D. When contactor U is energized the motor runs in forward direction and the trolley is pulled up the incline. When contactor D is energized the motor runs in reverse direction and the trolley moves down in the incline. The motor is stopped quickly by anelectromagnetic brake.

6. Write about control of Conveyor System. (3Marks)

- In large plants, materials are shifted from the place of storage to near the machines for processing, through belt conveyors. Finished products from the machines are also carried away through conveyors.
- A conveyor system consists of a rubber belt about ¾ to 1m wide tightly fitted over two pulleys. One pulley is coupled to the motor. The pulley which is coupled with the motor is known as drive pulley while the other pulley is called tail pulley.
- Rotation of drive pulley will cause movement of the belt over the two pulleys. The number of conveyors in a system can be very large depending upon the requirement.

7. Write the types of automation. (3Marks)

- Manufacturing Automation
    1. Fixed automation
    2. Programmable automation
    3. Flexible automation
- Non -Manufacturing Automation
    1. Office automation
    2. Home automation
    3. Building automation

8. List out any three PLCs available. (3Marks)

[Any 3 PLC's]

1. ABB	4.SCHNEIDER AUTOMATION	7.OMRON
2. ALLEN-BRADLEY	5.SIEMENS	8.HITACHI
3. ROCKWELL AUTOMATION	6.MITSUBISHI	9.TOSHIBA &Etc.

*** There are many more PLC's available in the markets other than the above. (Consider some other brands of PLC's also)***

9. What is preset in timer instruction? (3Marks)

- It is the integer number. It denotes the number of time increments, that the timer to reach the desired time delay.
- The preset word is the set point of timer.
- For example: If the time baseis0.01sec and preset value is200,then the time delay is equal to (200 x0.01)=2 sec.

10. What are the major components of DCS? (3Marks)

[Any three components]

- RTU(Remote Terminal Unit)
- Controllers
- Field Devices
- High speed Data Bus
- Operator Station
- Communication networks
- Human-Machine Interfaces(HMI)
- Control Module and I/O module.

PART-B

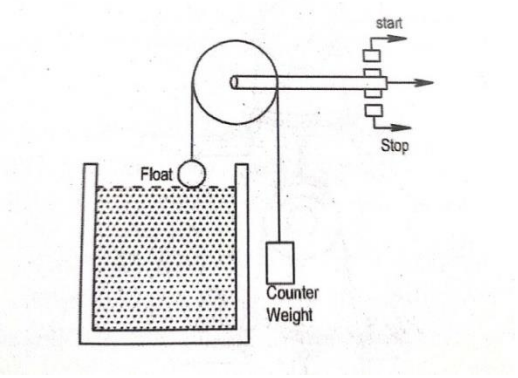
11. (a) i) Explain the construction and working of float switch with neat diagram.

(7MARKS)

- A float switch is used when a pump motor must be started and stopped according to changes in the water level in a tank or sump. The float switch allows for automatic operation of devices depending on the level of fluid, such as the operation of pumps, or the opening or closing of valves.

Construction:

- A float switch using a rod is shown in Figure. A float is attached to the lower end of the rod. The rod passes through a hole of a lever. Two stoppers fitted on two ends of the rod cannot pass through the hole. The float movement causes a rod operated to open or close electrical contacts. The float switch contacts may be either normally open or normally closed and may not be submerged.



Working:

- The operation of a float switch is controlled by the upward or downward movement of a float placed in a water tank. When the liquid level rises the float also rises and moves the rod up. At a certain level depending upon the position of lower stopper the lever gets tilted up and it in turn actuates the contact. When the water level starts falling the float and the rod also moves down. The lever, however, remains in the same position and keeps the contact actuated.
- At a certain lower level depending upon the position of the upper

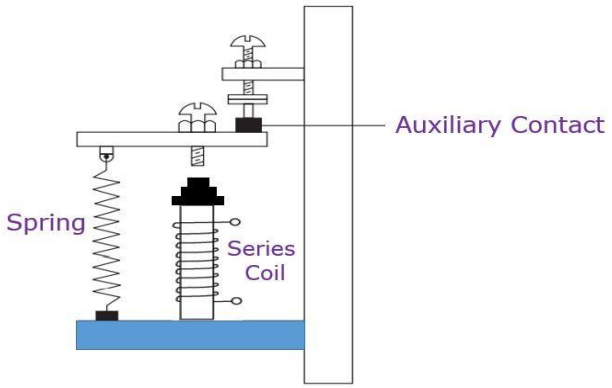
stopper the lever gets tilted down by the stopper and the contact gets deactivated.

- When the liquid level starts rising the contact remains unactuated till the higher level set by stopper position is reached. This actuation and deactivation of the contact are used to stop and start a pump motor for maintaining the desired liquid level in the tank.

11 a (ii) Explain the following (1) DC series current relay (2) Frequency response relay. (7Marks)

(1) DC series current relay

- This relay changes its contact position in response to current change in its coil. The relay coil is connected in series with the circuit in which current change is to be sensed.
- It changes its contacts position from NO to Close or NC to open when a current is flow through its coil. The relay coil is energized when the current flow through the coil reaches enough value to produce the necessary magnetic flux. This minimum value of current to energize the relay coil is known as pull in current.



- If the current is less than a predetermined value the operated contacts return to their unoperated position. This current is called as drop out current. DC series current relay is used as current limit accelerator in DC motor.

(2) Frequency response relay

- This type of relay changes its contacts position from operated position to unoperated position when the frequency of applied voltage falls below a predetermined value. The inductance of the relay and capacitor form a series resonant circuit. When the frequency falls below the resonant frequency, current through the relay coil falls and coil gets de-energized. The band width of the frequency range can be varied by changing the tapping of the potentiometer resistor.

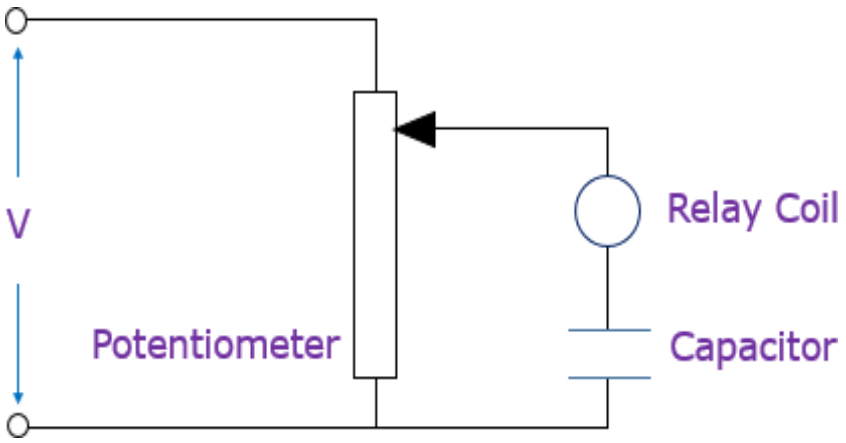


Figure: Frequency Responsive Relay

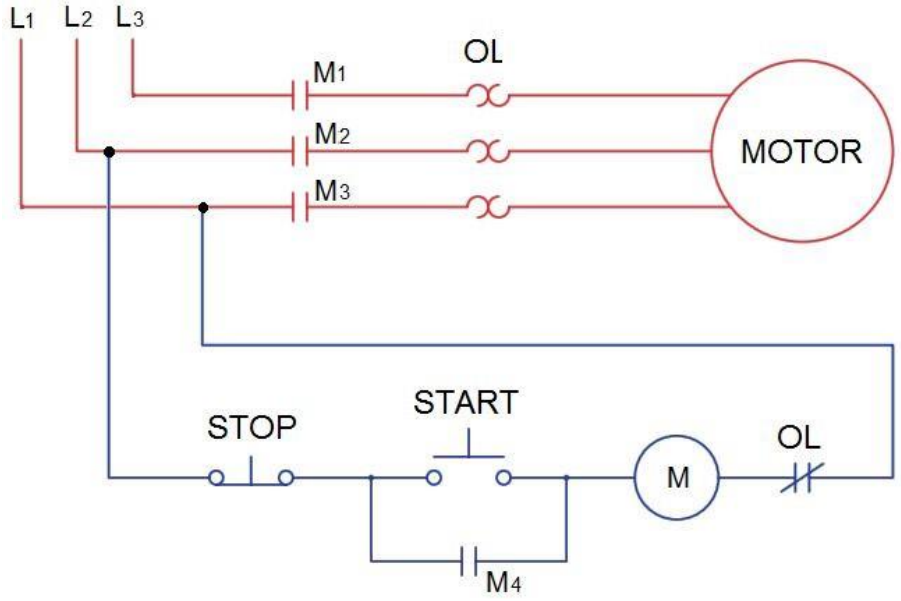
The frequency relays are used to apply field excitation to synchronous motors at the right instant and for acceleration control of wound rotor motors.

11. (b) Draw and explain Simple ON-OFF motor control circuit and Electrical Interlock. (14MARKS)

Simple ON-OFF motor control circuit (7 MARKS)

- Simple ON-OFF motor control circuit consists of power or main circuit and the control circuit. Main circuit consists of main contact M_1, M_2 and M_3 to control main supply.

- The control circuit consists of start push button, stop push button, sealing or holding contact and relay coil. The motor can be switched ON and OFF with the help of push buttons.



Sequence of operation:

1. When the Start push button is pressed, one of the terminal of Electromagnetic coil M is connected with supply through Stop push button and Start push button.
2. The other terminal of the coil is connected through Normally Closed Over load contact 'OL' to the supply terminal. The coil is thus energised and contactor closes its main contacts M_1, M_2, M_3 and the auxiliary contact M_4.
3. Closing of contact M_4 bypasses start push button. This contact M_4 is known as holding or sealing contact.
4. A bimetallic thermal over-load is also shown connected in the power circuit. If motor draws more current than its rated value, thermal relay contact OL opens and de-energises coil M.
5. When stop push button is pressed, coil M is de-energised and thus holding of supply through contact M_4 is broken.
6. Motor can be switched on again by pressing the START push button.

Electrical Interlock. **(7 MARKS)**

(Any one interlock: Sequential interlock (or) Preventive interlock)

- Let us take motors A and B.
- It is required that motor B should start only after motor A has started.
- It should however be possible to stop the motor independently.
- In order that contactor B should energize only when contactor A is energized we will have to insert a normally open contact of contactor A in series with the contactor coil B.
- Thus when contactor A is not energized the contact A_2 will be open. The contactor coil B can be energized only when contactor A is energized i.e., only when its contact A_2 is closed.

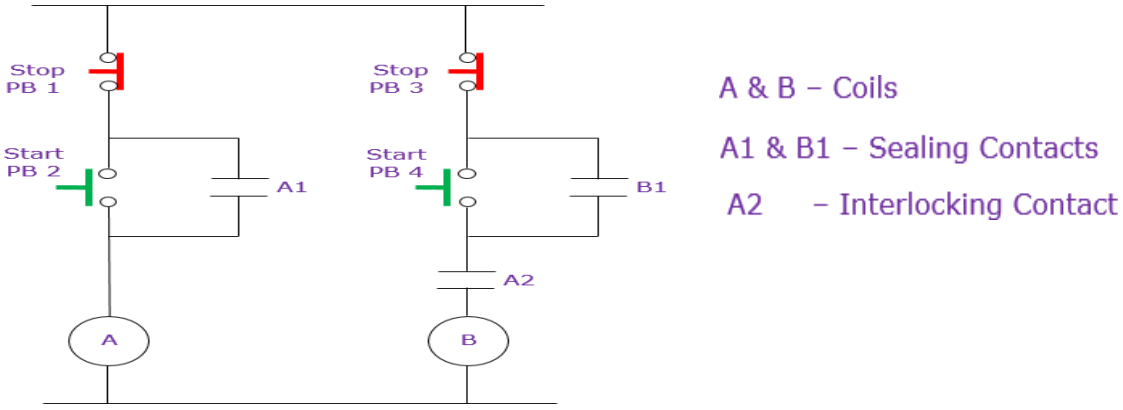


Figure: Sequential interlock

12. (a) With neat sketch, explain the operation of counter EMF starter.

(14MARKS)

[Control circuit-7 Marks& Operation-7Marks]

- In this type of starter the back EMF developed in the armature is used to energize voltage relays. The voltage at which the relay energised is called pick up voltage. Voltage relays with different pick up voltage are connected across armature and their NO contacts are connected across the rheostats in the armature circuit. A starter using such relays is shown in the fig.

Circuit construction

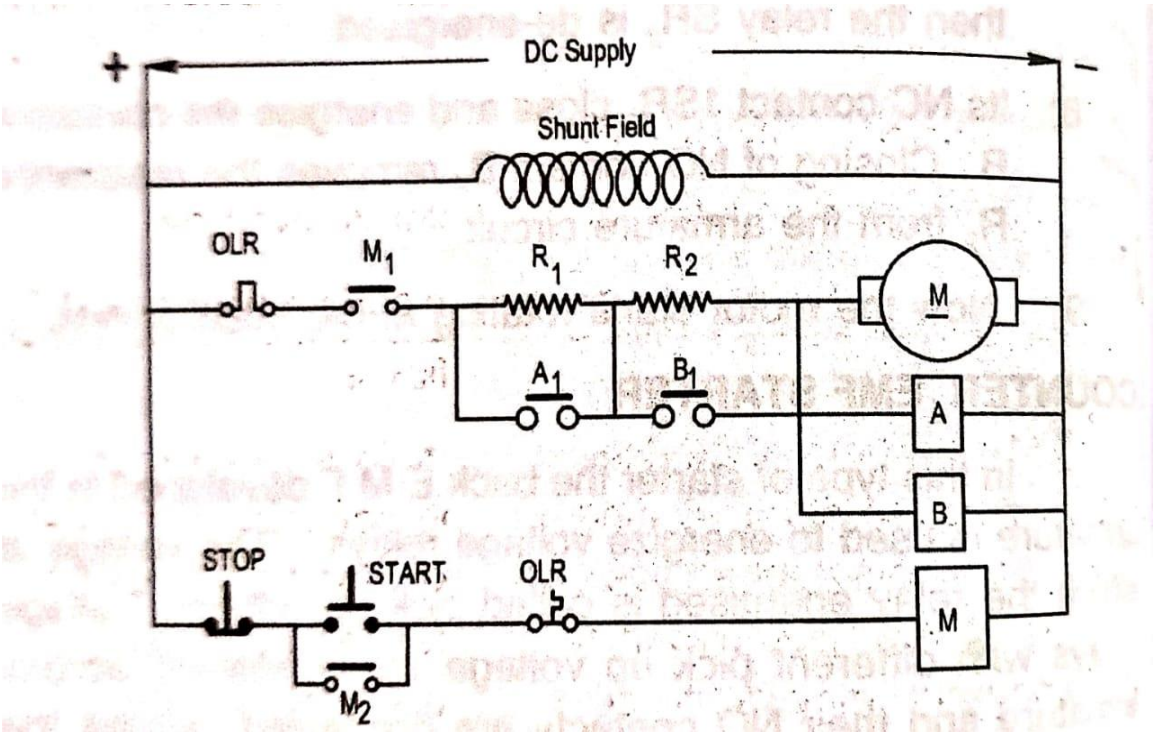
- A and B are two voltage relays. Pick up voltage of relay A is less than the pickup voltage of relay B. Their contacts A1 and B_1 are put across rheostats R1 and R_2 which are connected in series with the armature circuit. M is the main contactor with contacts M1 and M2.

Circuit operation

1) When the START push button is pressed, the M contactor coil gets energised and its NO contacts M1 and M_2 are closes.

2) Closing of the NO contact M1 gives the supply to the armature through the resistances R1 and R2

3) At the same time, closing of NO contact M_2 acts as a sealing contact and maintain the supply to the M contactor coil even though start push button is released.



4) Now motor starts rotating and value of induced emf (Back emf) gets increased.

5) When the value of back emf reaches the pick up voltage of relay A, then the relay A gets energised. Its NO contact A1 closes and it will short circuit and remove the resistance R, from the armature circuit.

6) Now speed further increases and back emf also increases. When the value of back emf reaches the pick-up voltage of relay B, then the relay B gets energised. Its NO contact B1 closes and it will short circuit the resistance R2.

7) Now motor gets full supply voltage and runs at a rated speed.

8) The voltage relays A & B remain in energised condition as long as the motor is rotating.

9) When the motor stops rotation, the voltage relays A & B gets de energised and NO contacts A1 and B_1 becomes open and the system is ready for fresh starting.

12.(b) With neat sketch, explain the principle of secondary frequency acceleration starter. (14MARKS)

[Control circuit-7 Marks& Operation-7Marks]

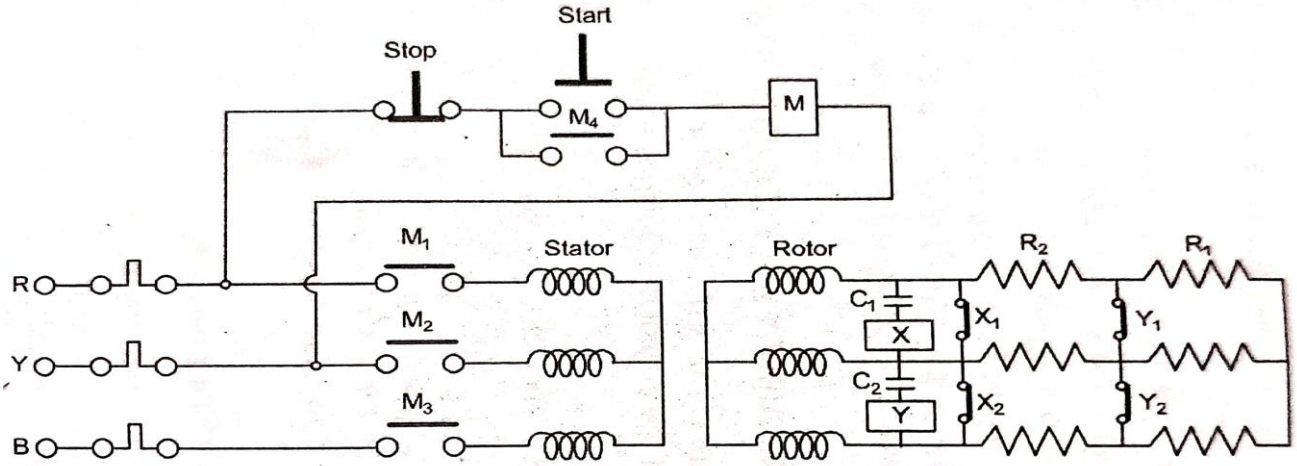
- The frequency of EMF induced in the rotor of an induction motor at the instant of starting is equal to the stator supply frequency.But this frequency changes from 50Hz to 2 or 3 Hz at full speed.
- The starting resistance used in this rotor circuit may be cut out based on the rotor frequency. Therefore slip ring induction motor can also be started using secondary frequency relays.

CONTROL CIRCUIT OPERATION:

The fig. shows the power and control circuit for automatic starting of slip ring induction motor using secondary frequency relays.

1. When the START push button is pressed, the M contactor coil gets energised and it's NO contacts M1, M2, M3 and M4 are closed.

2. Closing of main contacts M1, M_2 and M3 gives the supply to the stator winding and the motor starts running in one direction.



3. At starting, the frequency of rotor induced emf is about 50 Hz.

4. For this frequency the reactance of the capacitors C1 and C2 are very low. So large current flow through the secondary frequency relays X and Y.

5. So both the relays are energised and its NC contacts X1, X2, Y1 and Y_2 are open and maximum resistances (R1 + R_2) are included in the rotor circuit.

6. Now the motor accelerates and the value of rotor frequency is reduced. So the capacitive reactance of the capacitor C_2 will increase and current through the relay 'Y' is not enough to hold the relay Y in energised condition.

7. Therefore the relay Y is de-energised. Its NC contacts Y1 and Y2 closes and the resistance R1 is cutting out from the rotor circuit.

8. When the motor speed is nearing about synchronous speed the rotor frequency becomes 1 or 2 Hz.

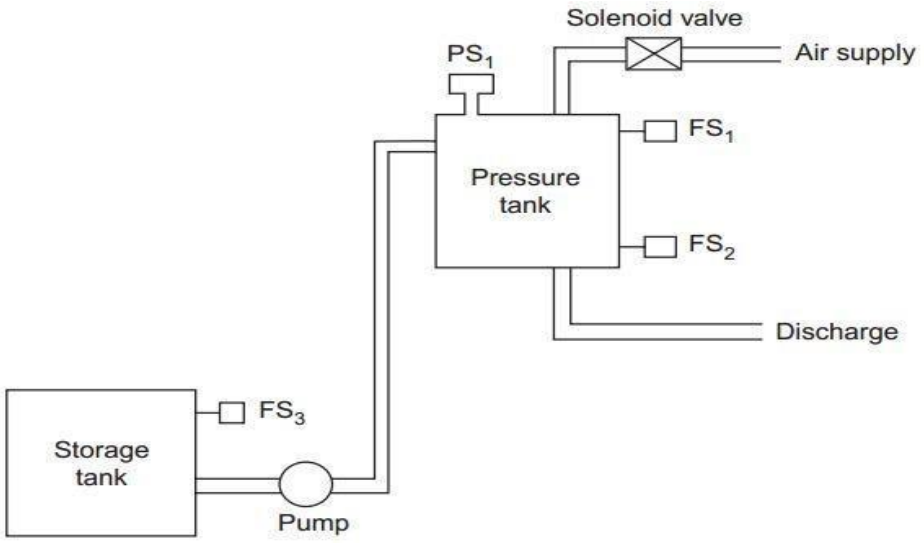
9. Now the capacitive reactance of C1 is very high and current through the coil X is negligible. Therefore the relay X is de-energised and its NC contacts X1 and X_2 are closed and the resistance R2 is cut off.

10. Now the motor runs normally without starting resistances.

13. (a) Draw the automatic control circuit of water pump and explain its operation. (14marks)

[Schematicarrangement&Controlcircuit-7Marks&Operation-7Marks]

- The water pump which pumps water from a storage tank into a pressure tank. The pump is allowed to run until the tank is full up to a certain level. Float switch FS_1 will actuate when water of the tank would reach its upper most level H. Under such limiting position the float switch will stop the pump. Float switch FS_2 would sense the lowest level (L) of water in the tank.
- When this float switch actuates, it would start the pump to raise the water level up to the upper limit. The **schematic arrangement** of the pump and the two tanks along with the control components are shown in Figure.



- To let pressurized air enter the tank above the water level, a solenoid valve has been provided. When the coil is energized the valve opens and air enters the tank. When sufficient pressure is built up inside the tank, pressure switch PS_1 actuates and supply to

solenoid valve is cut off.

- Float switch FS_3 in the storage tank has been provided to sense a very low level of water. If the water level in the storage tank would reach a very low level the switch would put off the pump.

Manual Operation:

- The pump is run on manual mode when there is some fault in the circuit for automatic operation. To run the pump in manual mode, the selector switch is put on manual position 'M' and line 1 is energized. Contactor M of the pump motor gets energized and is held through its own contact M_1 when the START-push button is pressed. The operator has to watch and see that when the tank is nearly full, the pump is stopped by pressing the STOP pushbutton.

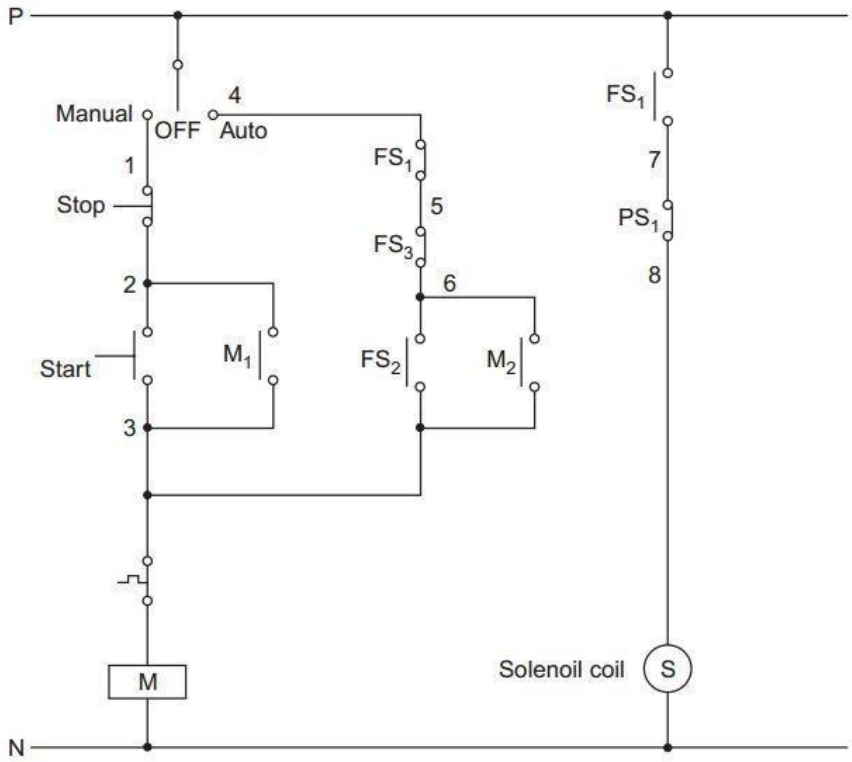


Figure: Control circuit for a pressurized overhead tank

AutoOperation :

- For automatic operation of the pump, the selector switch is put on Auto mode. On Auto mode of the selector switch, control supply reaches line 6 through normallyclosedcontactsFS_1 and FS_3.

i) When the water level falls below the lowest level (L) in pressure tank, FS_2 is actuated and contactor M gets energized. Sealing effect is provided bynormallyopencontactM_2.

ii) Float switch FS_2 then loses control and the pump continues to run even when water rises above the lower limit (L).

iii) When the upper limit float switch FS_1 is actuated and its normally closed NC contact opens to disconnect supply at line 5, contactor M will get de-energized and the pump would stop.

iv) Contactor M is also de-energized if FS_3 actuates and opens its normally closed, NC contact when water level in the storage tank goes below the lowest level.

v) From the circuit it is seen that the coil of the solenoid valve is energized when thenormallyclosedcontactPS_1ofthepressureswitchis closed.

vi) Another condition for allowing the air to enter the tank is that water level should be above the upperlevellimitsetbyfloatswitchFS_1.

vii) When the water level will fall below this level, FS_1 will open and air supply will be cutoff. When the pressure of air inside the tank increases above the setting, contact PS_1opensto de-energize the solenoid S.

13. (b) Write the general procedure for trouble shooting in control circuits.

(14 MARKS)

General procedure for trouble shooting:

Fault: A circuit which has just been wired but is not working as per the design.

1. To analyse the control circuit and ascertain that it has been properly designed as per the control function requirements;
2. To run the machine and follow the operation through the expected sequence until one finds the section of control circuit which is not operating;
3. After locating the faulty section, wiring should be checked. If wiring is as per drawing, then control components of this section should be checked thoroughly;
4. When trouble in the faulty section is located and removed, the machine should be started again to run successfully throughout the complete cycle. In case of fault existing in any other section of the control circuit, one should now try to locate the fault of that section

Fault: Existing circuit which was working properly before the occurrence of a fault.

Troubleshooting procedure:

a. The first step is to understand the operation and control circuit of the machine.

b. With the help of the operator, start with the section of the circuit that does not function.

c. When the faulty circuit section has been identified, first a careful check of the circuit and components involved in that section should be done. A careful visual inspection may help to detect a faulty component or an open wiring. If nothing is found out in the visual inspection, then go to next step.

d. Find out which operation is not taking place and identify the corresponding contactor/solenoid valve.

e. Check the voltage across the coil of the contactor/solenoid valve coil. If proper voltage is available across the coil, then check the continuity of coil with ohm meter.

f. Working of the contactor or solenoid valve should be checked before replacing the burnt coil. If it is suspected that contactor closing mechanism or solenoid valve is defective, a new contactor or a new solenoid valve should be installed.

g. Suppose that in the step discussed above voltage is found to be not reaching the contactor coil. In such a case control circuit drawing should be referred, to find out components whose contacts should close to energize the coil.

h. To find out contact of which particular component is not making, supply should be checked at various points leading to the contactor coil.

i. If the contact is not making due to a copper oxide film or dirt, cleaning should be done and if contact is not closing properly, adjustment can be done. If, contact is badly pitted it should be replaced. The other possibility during this checking can be detection of open circuit due to a broken or burnt wire.

j. Having eliminated the fault, the machine should be started again and if the machine does not operate successfully throughout the complete cycle of operation, the above procedure should again be applied to the next section of the control circuit which is faulty.

k. Quite frequently, grounding of a wire going from control panel to the machine may be the cause of trouble. A check should be made for detection of ground fault, by putting off the power supply.

l. Resistance to ground of the wires should be checked with an ohm meter, or alternatively, a test lamp can be used to detect ground, where 230 V supply with neutral earth is available.

14. (a) Explain the working principle of PLC with block diagram. (14MARKS)

[Blockdigram-7 Marks & Principle, explanation-7Marks]

PLC consists of three basic sections:

1. Central processing unit
2. Input/output Modules
3. Programming Device

1. CPU:

The Central Processing Unit (CPU) Module is the brain of the PLC. The Primary functions are to read inputs, execute the control program, and update outputs.

The CPU consists of following three components:

i) Processor
ii) ii) Memory system
iii) iii) Power supply

i) Processor:

The processor executes the user program stored in the memory system in the form of ladder diagrams. The processor accepts input data from various sensing devices, executes the stored program from memory and sends appropriate output commands to control devices. It can also perform arithmetic functions, data manipulation and communication between the local I/O, remotely located I/O and other networked PLC.

ii) Memory system:

The memory system is the area in the CPU where all the *programs*, are stored and executed by the processor to provide the desired control of field devices.

iii) Power supply:

Power supply is necessary to convert 120V or 240V a.c into the low voltage d.c (+5V & - 5V) required for processor and internal power required for the I/O modules. This power supply unit does not supply power for the actual input or output devices. This can be built into the PLC or be an external unit. Common voltage levels required by the PLC are 24Vdc, 120Vac, 220Vac etc.,

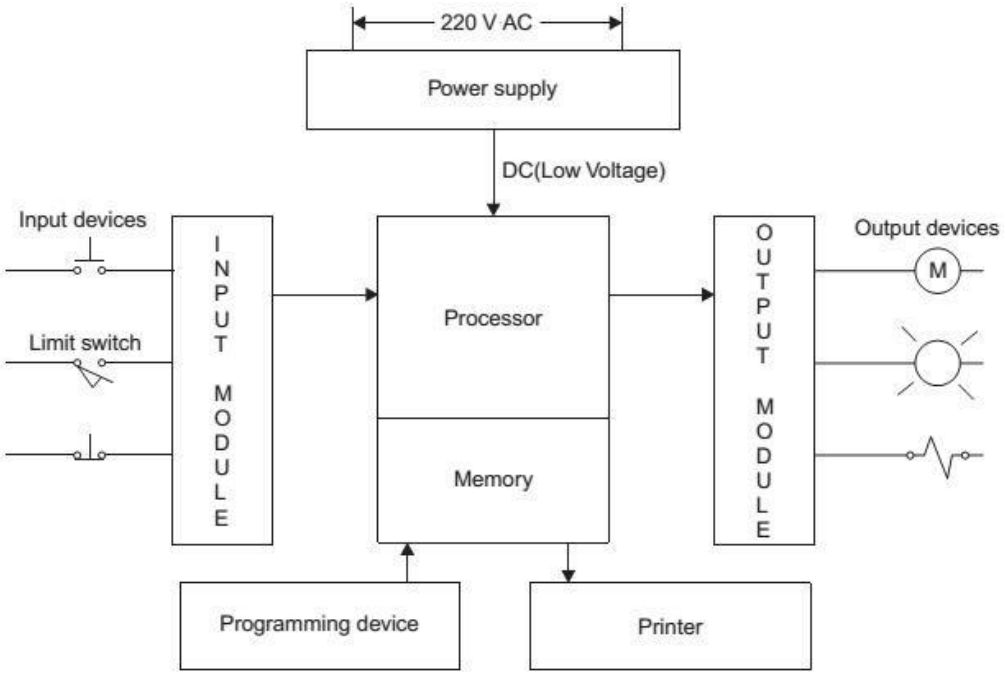


Figure : Block Diagram of a PLC

2. Input/output Section:

Input modules:

- It senses the presence or absence of an input signal at each of its input terminals.
- It accepts signal from the machine or process and convert them into signals that can be used by the controller.
- The input module provides isolation between the input signal and the PLC.
- The status of input signals are stored in the input image table.

Output Modules:

- It receives the signal from the CPU.
- It converts the controller signals into external signals used to control the machine or process.
- It switches ON or OFF the outputs.
- It provides isolation between CPU and output stage.
- The status of output signals are stored in the output image table.

3. Programming device:

The programming unit allows the engineer or technician to enter and edit the program to be executed. The programming device must be connected through cable to the controller when entering or monitoring the control program.

Principle of Operation:

- The CPU accepts input signal from sensors like push buttons, limit switches, analog sensors, selector switches, and thumbwheel switches.
- Stores the status of input in the memory area called input image table.
- Execute the stored user program from memory and sends appropriate output commands to control devices like lamp, motor starters, solenoid valves, pilot lights, and position valves through output image table.
- Update the content of output image table.
- The system power supply provides all the voltages required for the proper operation of the various central processing unit sections.

14.(b) (i) List any seven distinct advantages that PLCs offer over conventional relay-based control systems. (7MARKS)

(Any seven points)

S.NO	PLC	RELAY
1	Very less wiring when compared to relay logic	It requires a lot of wiring
2	Logic can be easily changed by changing the program	Rewiring is required to change the logic
3	Easily replaced	Relay won't handle the environmental conditions as well as the PLC
4	It can handle environmental conditions	Relay won't handle the environmental conditions as good as the PLC
5	Compact size	It's not compact and due to this it would take a lot of space
6	PLC's have memory	Relays don't have memory

7	Faults can be easily cleared	It would take a lot of time to find out the faults so faults can't be easily cleared
8	Computational capability is high	Very less computational capability
9	PLCs can handle vibrations, temperature, humidity etc.	Relays can't handle humidity, vibrations, and temperature as good as PLC's

14 b (ii) How the I/O modules connect to the processor in a modular-type PLC Configuration? Explain. (7MARKS)

- A modular PLC is built with several components that are plugged into a common rack with extendable I/O capabilities. It consists of a rack, power supply, CPU and I/O modules. On a rack these modules are fixed as separate hardware items. Modular PLCs are further divided into small, medium and large PLCs based on the program memory size and the number of I/O features.
- Example: Siemens: S7-300 and S7-400
  Allen Bradley: SLC 5/01, SLC 5/02 etc.,

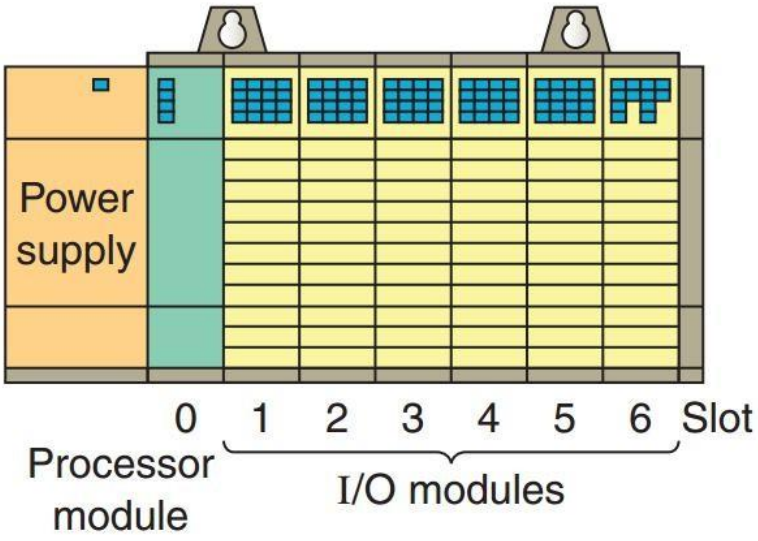


Figure: Modular I/O PLC

Input Types:

1. Logic 2. Analog

Logic:

- PLC can only understand a signal that is ON or OFF. Binary 1 indicates that a signal is present, or the switch is ON. Binary 0 indicates that the signal is not present or the switch is OFF.
- The logic concept exists only in two predetermined states. In logic input (digital) systems, these two-state conditions can be thought of as signals that are present or not present, activated or not activated, high or low, on or off, etc.
- Here, binary 1 represents the presence of a signal, while binary 0 represents the absence of the signal. In digital systems, these two states are actually represented by two distinct voltage levels, +V and 0V. One voltage is more positive than the other. Often, binary 1 (or logic 1) is referred to as TRUE, ON, or HIGH, while binary 0 (or logic 0) is referred to as FALSE, OFF, or LOW.
- Digital Inputs include push-buttons, limit switches, relay contacts, proximity switches, photo sensors (On/Off), pressure switches and more. Digital inputs devices are available in both DC as well as AC and some are voltage independent such as a switch contact.

Output Types:

i) Logic (Discrete) output
ii) Analog Output

Digital Output:

- A discrete output can either turns a device ON or OFF such as lights, LEDs, small motors, and relays. Some examples are motors that need just be ON or OFF, Lighting, solenoid valves, door locks. Digital output modules are available for DC output, AC output or a mix.

Typical digital output devices are:

i) Motor starter coils
ii) Pilot lights
iii) Solenoids
iv) Alarms
v) Control relays
vi) Horns
vii) Start / stop signals to VFD/VSD

15. (a) Explain the various types of programming methods to program a PLC. (14Marks)

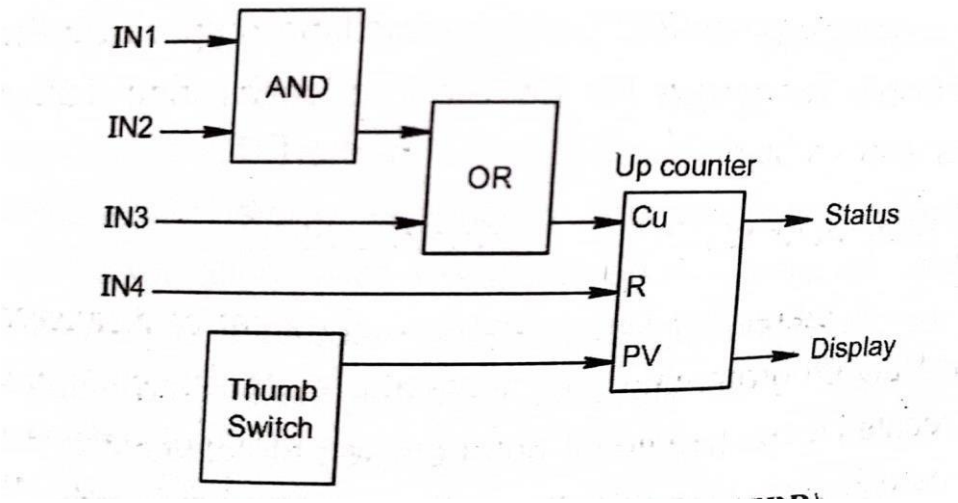
- The IEC (International Electro technical Commission) has created a standard (ICE1131-3) for five programming languages for PLC.
- These five languages are known as:

1. Function Block Diagram(FBD)
2. Instruction List (IL)
3. Ladder diagram(LD)
4. Sequential Function Chart(SFC)
5. Structured Text (ST)

1. Functional Block Diagram:(FBD)

- It is a graphical language for depicting signalanddataflowsthroughfunctionalblocks.AFBDprogramisconstructedusingfunctionblocksthatareconnectedtogethertodefinethedataexchange.Thisprogramminglanguageisagraphiclanguage that uses a library functions in combination with custom functions to create programs. The inputs and outputs of function block scan be inverted.

Example:



2. Instruction List(IL):

- It is a low level 'assembler like' language using text. It includes jump, call, and sub like instructions which uses labels. A complete instruction is made up of an operator followed by one or more operands. It is best suited for small applications and fast execution.

Example:

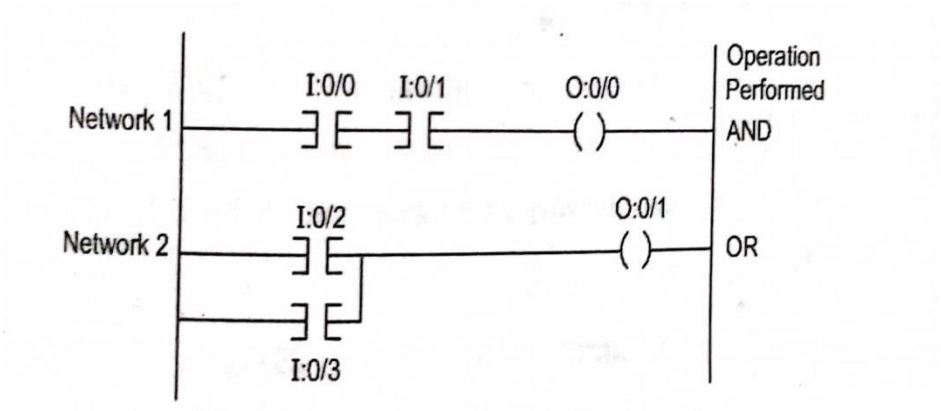
Label	Operator	Operand	Comment
	LD	FF	(*LoadcurrentvalueinAcc)
	SUB	H1	(*Decrementbyone)
Loop	NE	0	(*Testifnotequaltozero)
	JMP	Loop	(*Jumpbacktothelabel'Loop'
	END		whilenotequalto0)

3. Ladder Diagram(LD):

- Ladder programming has evolved from the wiring diagrams that are used in the car industry for describing the relay control schemes. This method is easy tounderstandbypeoplewhoarefamiliarwithsimpleelectronico relectricalcircuits. Also it is well accepted by electrician and plant technician. Faults can be quickly traced is the advantage of this method. The ladder symbols andfacilitiesvarybetweendifferentPLCproducts.Ithaslimited facilitiesforbuilding complex sequences.
- Ladder diagram are very similar to ladder schematics. A ladder diagram is a symbolic representation of an electrical circuit.

- A very commonly used method of programming PLCs is based on the use of ladder diagrams. Writing a program is then equivalent to drawing a switching circuit. The ladder diagram consists of two vertical lines representing the power rails. Circuits are connected as horizontal lines, i.e. the rungs of the ladder, between these two verticals.

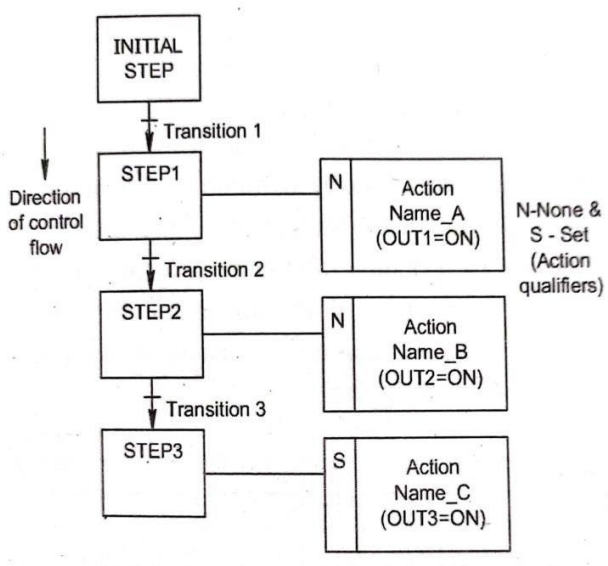
Example:



4. Sequential Function Charts(SFC):

- It is a graphical language for depicting sequential behavior of a control system. It is used for defining control sequences that are time and event driven. While providing structure and coordination of sequential events, alternative and parallel sequences are supported as well. It contains Flowchart of steps and transitions.

Example:



5. Structured Text(ST):

- It is a high level textual language that encourages structured programming. It has a language structure (syntax)that strongly resembles PASCALSTisan excellent language for complex processes or calculations that are not graphic friendly.

Example:

PROGRAM

Prog.follow

nameVAR_INPUT

(*list each input variable and its data type*)

VAR_OUTPUT

(*list each output variable

and its data type*)END_VAR

VAR

(*list each internal variable and function block used with in the program*)

END_VAR

(*list each internal variable and function block used with in the program*)

END_VAR

(*main program body*)

END_PROGRAM

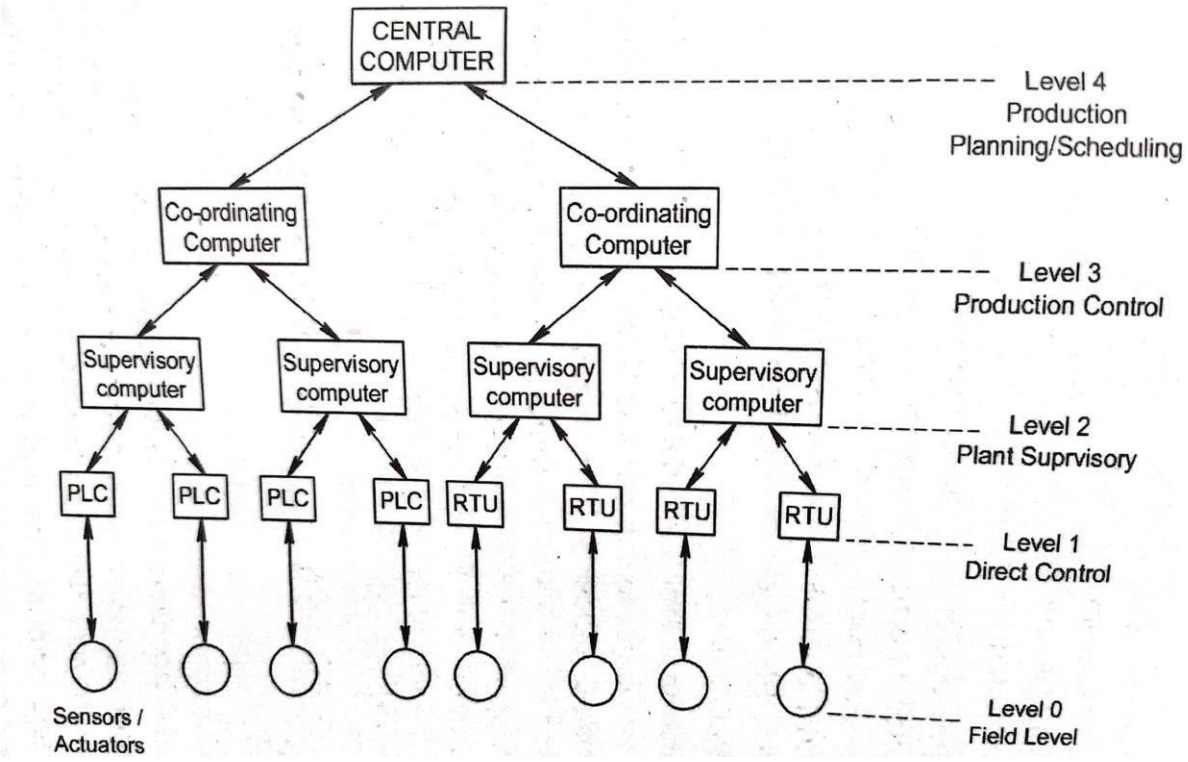
(*Comments are given in between(**)

15. (b) With a neat block diagram explain the operation of SCADA.

(14Marks)

- SCADAStandsforSupervisoryControlAndDataAcquisition.SCADAisacomputer based system for gathering and analysing real time data to monitor and control parameters such as temperature, pressure water flow etc.

BLOCK DIAGRAM OF SCADA



- The block diagram of SCADA is shown in figure above. The whole system can be divided into five levels to understand the working of each part of the SCADA system.

Level 0 (Sensors and Actuators)

- Thegroundleveldevicesthatactuallyinteractwiththephysicalenvironmentortechnicians in a supervision system. Different types of sensors and actuators comeUnderthislevel.Asensorisdevicethatcansensethephysicalchangesarounditandgenerateappropriateelectricalorelectronicsignals.Foranexamplewecanmeasurethetemperatureusing a Thermostat.Flowsensor,pressuresensor,LDRand many more sensors are used in a SCADA system.
- Theactuatorisadevicethatmakesphysicalchangeswhenanelectricalorelectronic signal is applied to it. For example, if we want to control the flow of a liquid solenoid can be used.

Level 1 (Programming Devices)

- The programming devices such as PLC (Programmable Logic Controller), RTU(Remote Terminal Unit) come under this level. These programming devices directly control the ground level devices such as sensors and actuators. A SCADA system can be built with only Local Area Network (LAN) or a combination of the local and WideAreaNetworks(WAN).ThePLChelpstocommunicatewiththeLAN.Ontheotherhand RTU helps to communicate with the WAN.

Level 2 (Local ControlandHMI)

- The supervisory computers come under this level. All the programming devices that operate the ground level devices are connected to this computer. SCADA software starts working from the supervisory computers.
- ThesecomputersprovidetheactualinstructionsandCommandsto dotheoperations. The Supervisory computer may be connected to a particular machine or multiple same types of machines or a whole manufacturing plant. These Computers are operated by machine operators, plant Supervisors and technician sofa manufacturing plant. The main functions of these computers are to observe and control the production, errors etc.

Level 3 (Co-ordination)

- Co-ordinating computers come under this level. Generally these computers are connected to multiple plants. So, it can help to gather data from different plants from one place. At this level, the production planning, scheduling, event timing management are done by the plant in-charge, managers etc.

Level 4 (Central Control)

- It is the top level of the SCADA system. At this level, a central computer is connected to all the plants and machinery. Generally, this is operated and controlled by the management team. All the data and information are collected and stored here. Using these data and information they can take any decision. From this computer the management team can see all the actions and operations etc.

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