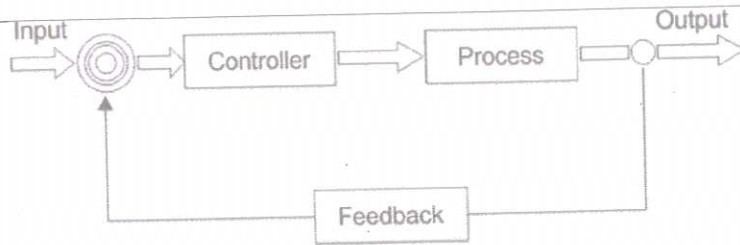


Scoring Indicators

Code: TED (15) 6025

INDUSTRIAL AUTOMATION & MECHATRONICS

Q No.	Scoring Indicators	Split Score	Total Score
PART A			
I.1	<ul style="list-style-type: none"> Defined as the synergistic integration of mechanical engineering with electronics and intelligent computer control in the designing, manufacturing process and production. 		2
I.2	Defined as the process of enabling machines to follow a predetermined sequence of operations with little or no human intervention and using specialized equipment and devices that perform and control manufacturing processes and operations.		2
I.3	Sensitivity is the property of the measuring instrument to respond to changes in the measured quantity. It also can be expressed as the ratio of change of output to change of input.		2
I.4	Control direction of flow		2
I.5	The programmable logic controller is a special form of microprocessor based controller that uses programmable memory to store instructions and to implement functions in order to control machines and processes.		2
PART B			
II.1	<p>1. <u>Fixed automation</u>: It is a system in which the sequence of processing operations is fixed by the equipment configuration</p> <p>2. <u>Programmable automation</u></p> <p>In this the production equipment is designed with the capability to change the sequence of operations to accommodate different product configurations</p> <p>3. <u>Flexible automation</u>: It is an extension of programmable automation. A flexible automated system is one that is capable of producing a variety of products.</p>		6
II.2	Closed-loop Control		6

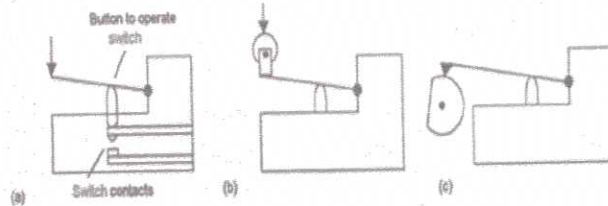


This sensor would monitor the actual dryness of the clothes and compare it with (or subtract it from) the input reference. The error signal (error = required dryness – actual dryness) is amplified by the controller, and the controller output makes the necessary correction to the heating system to reduce any error. For example if the clothes are too wet the controller may increase the temperature or drying time. Likewise, if the clothes are nearly dry it may reduce the temperature or stop the process so as not to overheat or burn the clothes, etc.

Then the closed-loop configuration is characterised by the feedback signal, derived from the sensor in our clothes drying system. The magnitude and polarity of the resulting error signal, would be directly related to the difference between the required dryness and actual dryness of the clothes.

Also, because a closed-loop system has some knowledge of the output condition, (via the sensor) it is better equipped to handle any system disturbances or changes in the conditions which may reduce its ability to complete the desired task.

Proximity switches



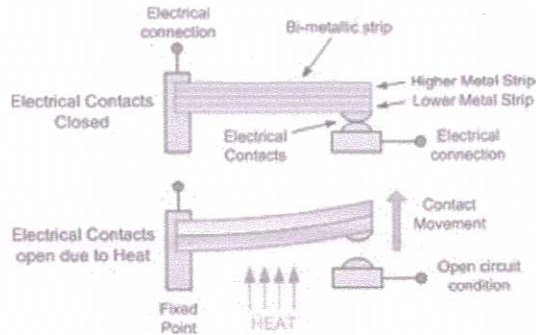
- a) lever operated switch
- b) Roller operated switch
- c) Cam operated switch

II.3

6

8. Temperature sensors

8.1 Bimetallic strips



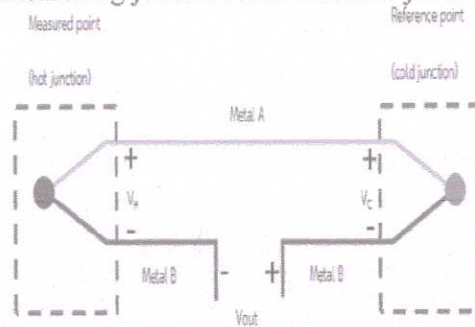
A bimetallic strip is used to convert a temperature change into mechanical displacement. It is composed of two or more metal layers having different coefficients of thermal expansion often brass and steel selected. The two pieces are welded or riveted together. When the bimetallic strip is heated the brass having the larger value of coefficient of linear expansion expands more than steel.

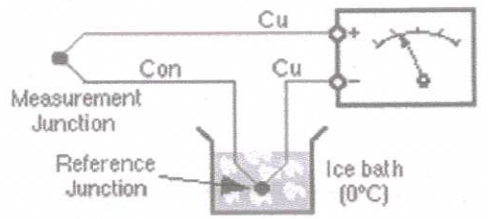
II.4

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8.2 Thermocouple

Two dissimilar materials in contact form a thermoelectric junction that produces a voltage proportional to the temperature of the junction. This is known as the Seebeck effect. Thermocouples are based on the principle that when two dissimilar metals are joined, a predictable voltage will be generated that relates to the difference in temperature between the measuring junction and reference junction.



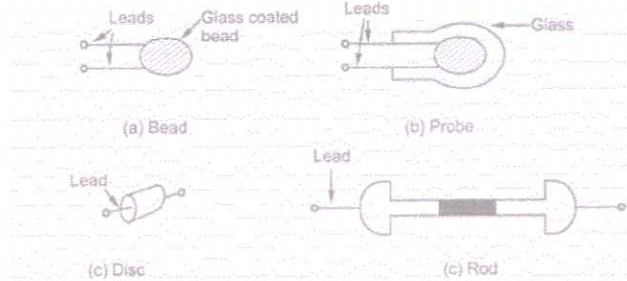


Traditional Thermocouple Measurement

Thermocouple circuit

8.3 Thermistors

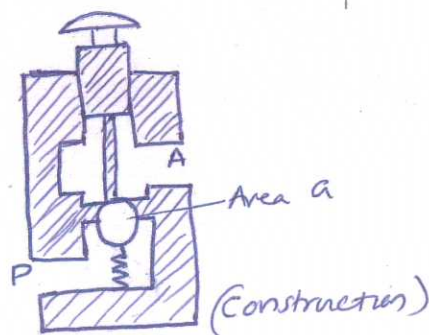
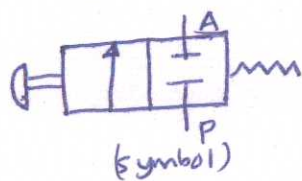
A thermistor is a temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors usually have negative temperature coefficients which mean the resistance of the thermistor decreases as the temperature increases.

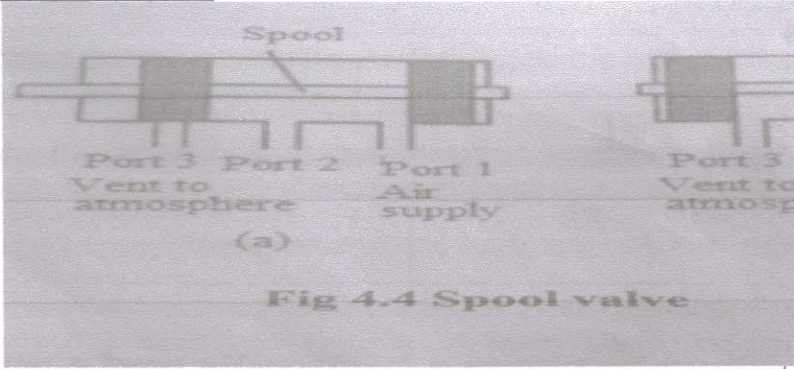


In a poppet valve, simple discs, cones or balls are used in conjunction with simple valve seats to control flow. The depression of the push button push down the ball off its seat & allows fluid to flow from port P to port A. when the button is released, spring and fluid pressure force the ball up again closing the valve.

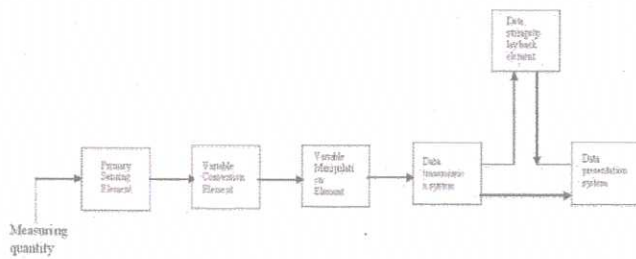
II.5

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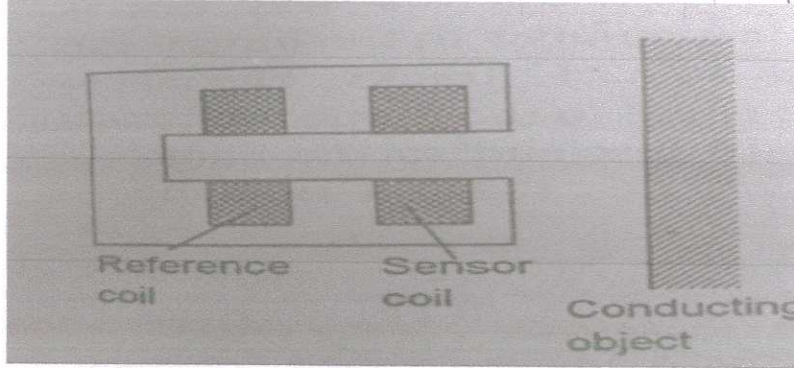
II.6	<p>The function of a DCV is to control the direction of fluid flow in any hydraulic system.</p> <p>SPOOL VALVE</p>  <p>Fig 4.4 Spool valve</p> <p>A common type of directional valve is the spool valve. Here a spool moves horizontally within the valve body to control the flow. Figure shows a spool valve where in (a) the air supply is connected to the port 1 and 3 is closed. Thus the device connected to the port 2 can be pressurized. When the spool is moved to left as shown in fig (b) the air supply is cut off and the port 2 is connected to port3.port3 is a vent to the atmosphere and so the air pressure in the system attached to port2 is vented.</p>		6
II.7	<ol style="list-style-type: none"> 1.instruction list(IL) programming 2.structured text(ST) programming 3.Function block diagram (FBD)programming 4.Ladder diagram (LD)programming 5.Sequential function charts(SFCs) 		6
III. a	<p>TRADITIONAL</p> <ul style="list-style-type: none"> • It is based on traditional systems such as mechanical, hydraulic and pneumatic • Less flexible • Less accurate • more complicate mechanism in design • involve more components and moving parts <p>MECHANICAL</p> <ul style="list-style-type: none"> • It is based on mechanical, electronics, computer technology <i>technology & control engineers</i> • <i>More flexible • More accurate</i> • <i>Less complicated design • involve fewer components & moving parts.</i> 		7

	<ul style="list-style-type: none"> • More accurate • Less complicated mechanism design • it involves fewer components and moving parts 		
III. b	<ul style="list-style-type: none"> • PRIMARY SENSING ELEMENT An element of an instrument which makes first the contact with the quantity to be measured In most cases a transducer follows primary sensing elements which converts the measurant into a corresponding electrical signal. • VARIABLE CONVERSION ELEMENT it may be necessary to convert the output into some other suitable forms for the instrument to perform suitable function. • VARIABLE MAIPULATION ELEMENT function of this element is to manipulate the signal presented to it preserving the original nature of the signal. eg. Amplifier • DATA TRANSMISSION ELEMENT when the elements of the system are physically separated, it is necessary to transmit the data from one stage to another. • DATA PRESENTATION ELEMENT Transmitted data may be used by the system finally for the monitoring, controlling or analyzing purpose. This function is done by data presentation element. 		8



IV. a	Open Loop	Closed Loop	8
	Any change in output has no effect on the input. Example : Feedback does not exists	Changes in output, affects the input which is possible by use of feedback	
	Output measurement is not required for operation of system	Output measurement is necessary	
	Feedback element is absent	Feedback element is present	
	Error detector is absent	Error detector is necessary	
	It is inaccurate and unreliable	Highly accurate and reliable	
	Highly sensitive to the disturbances	Less sensitive to the disturbances	
	Highly sensitive to the environmental changes	Less sensitive to the environmental changes	
	Bandwidth is small	Bandwidth is large	
	Simple to construct and cheap	Complicated to design and hence costly	
Generally are stable in nature	Stability is the major consideration while designing		
Highly affected by non-linearity	Reduced effect of nonlinearities		
IV. b	<u>Analysis</u> <ul style="list-style-type: none"> Accept situations - Hence the designer decide on committing to the project and finding a solution to the problem Analyze - In this stage everyone in the team begins research. 		7
	<u>Concept</u> <u>Define</u> : This is where the key issue of the matter is defined - <u>Synthesis</u> → Ideate → Evaluate → select → Implement		

Eddy current proximity sensors



V. a

- When a coil is supplied with an alternating current an alternating magnetic field is produced
- If there is a metal object in close proximity to this alternating magnetic field then eddy currents are induced in it.
- The eddy currents themselves produce a magnetic field which distorts the magnetic field responsible for their production
- Consequently the impedance of the coil changes and so the amplitude of the alternating current.
- This change at some preset level can be used to trigger a switch.
- Used for the detection of non magnetic but conductive materials.

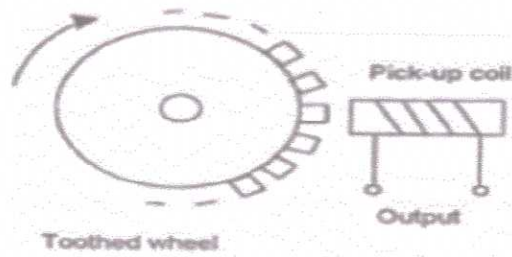
8

V. b

- It is used to measure angular velocity
- It consists of toothed wheel of ferromagnetic material which is attached to the rotating shaft
- As the wheel rotates, so the teeth move past the pickup coil and air gap between the coil and ferromagnetic material changes.

Flux linked with the pickup coil changes and produces emf in the coil

7



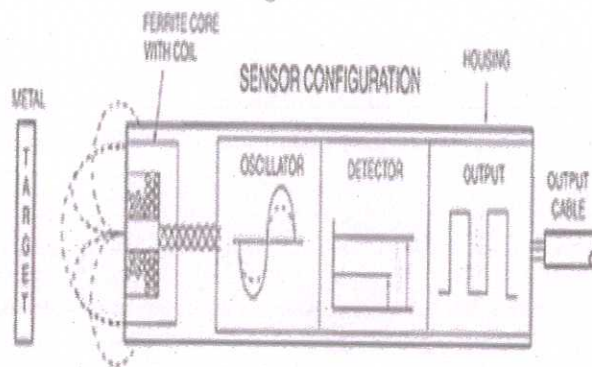
Variable reluctance tachogenerator

VI. a

1. The nature of measurement required
 - The variable to be measured
 - Its nominal value
 - The range of values
 - The environmental conditions under which the measurement is to be made
2. The nature of output required from the sensor
3. Linearity, speed of response, reliability, maintainability, life, power supply requirements, availability, cost
4. Accuracy, repeatability, size.....

8

Inductive proximity (sensor) switch



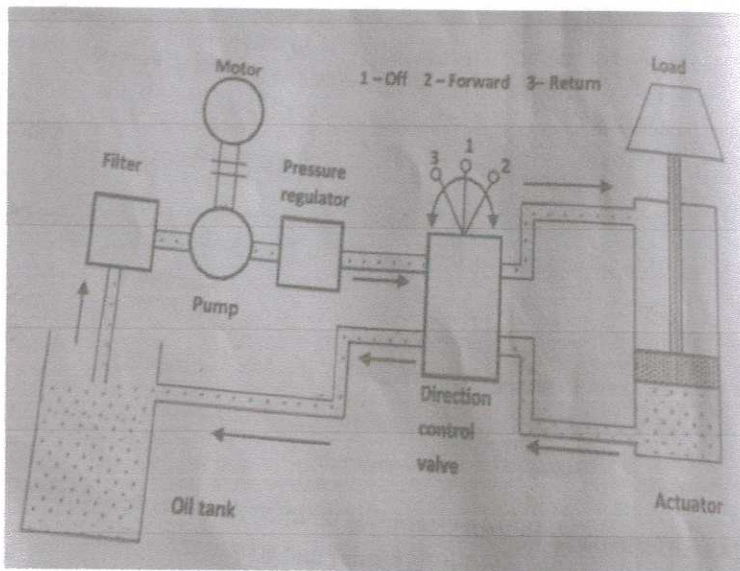
VI. b

- Oscillator circuit generate a radio frequency

7

- When a metal target approaches the face and enters the field eddy currents are induced into the surface of the target
- This results in a loading or damping effect that causes changes in the amplitude of the oscillating signal.
- Detector will switch on at a specific operating amplitude

HYDRAULIC SYSTEM



VII. a

8

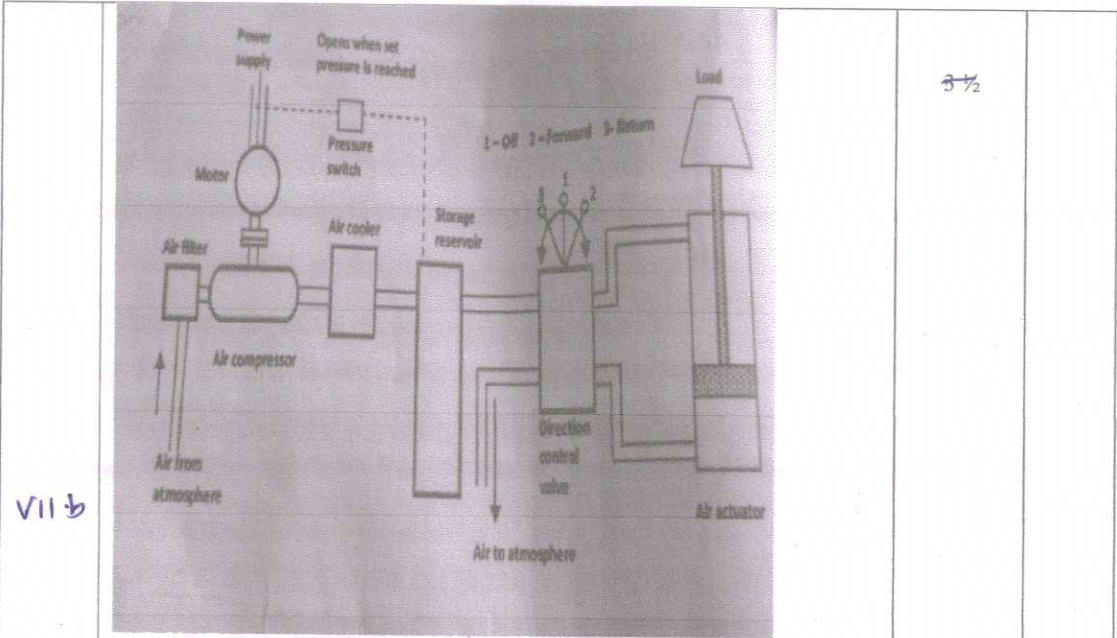
Fig shows a simple circuit of a hydraulic system with basic components.

Hydraulic actuator is a device used to convert the fluid power into mechanical power to do useful work.

The hydraulic pump is used to force the fluid from the reservoir. valves are used to control the direction, pressure and flow rate of a fluid flowing through the circuit. External power supply (motor) is required to drive the pump. Piping system carries the hydraulic oil from one place to another. Filters are used to remove any foreign particles. pressure regulator regulates the required level of pressure in the hydraulic fluid.

When the piston of the valve is changed to upper position, the pipe pressure line is connected to port A and the load is raised.

When the position of the valve is changed to lower position, the pipe pressure line is connected to port B and thus load is lowered.

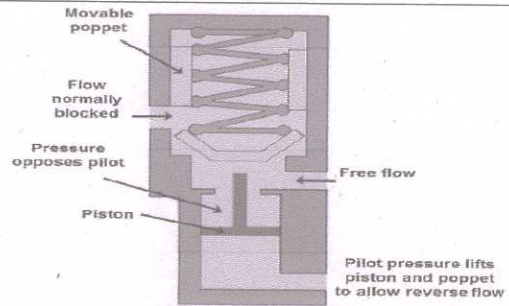


3 1/2

The pneumatic actuator converts the fluid power into mechanical power to perform useful work. The compressor used to compress the fresh air drawn from the atmosphere. The storage reservoir is used to store a given volume of compressed air. The valves are used to control the direction, flow rate and pressure of compressed air. External power supply (motor) is used to drive the compressor. The piping system carries the pressurized air from one location to another. Air is drawn from the atmosphere through an air filter and raised to required pressure by an air compressor. Air cooler is provided to cool the air with some preliminary treatment to remove the moisture. The treated pressurized air then needs to get stored to maintain the pressure. With the storage reservoir a pressure switch is fitted to start and stop the electric motor when pressure falls and reaches the required level respectively. The three-position change over the valve delivering air to the cylinder operates in a way similar to its hydraulic circuit.

7

VIII. a

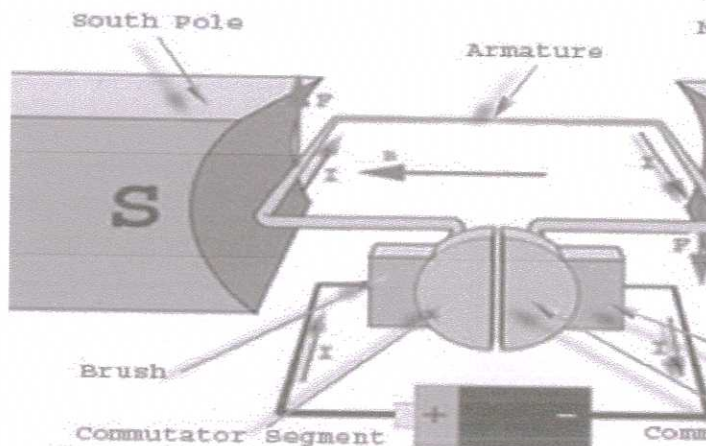


Pilot operated check valves work by allowing free flow from the inlet port through the outlet port - supplying a

8

pilot pressure to the pilot port allows flow in the opposite direction. Air pressure on top of the poppet assembly opens the seal allowing air to flow freely. When the air flow stops, the poppet check the trapped air. When the valve is piloted, the trapped air is allowed to flow back out of the control valve.

DC MOTOR



A device that converts DC electrical energy to a mechanical energy. DC or **direct current motor** works on the principle, when a current carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. This is known as motoring action. The direction of rotation of a this motor is given by Fleming's left hand rule.

Basic constructional parts of a DC machine are described below

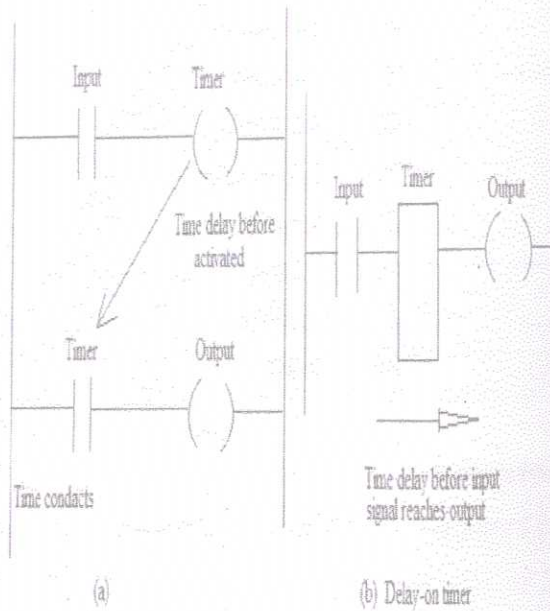
1. **Yoke:** The outer frame of a dc machine is called as yoke.
2. **Poles and pole shoes:** Poles are joined to the yoke with the help of bolts or welding. They carry field winding and pole shoes are fastened to them. Pole shoes serve two purposes; (i) they support field coils and (ii) spread out the flux in air gap uniformly.
3. **Field winding:** They are usually made of copper. Field coils are former wound and placed on each pole and are connected in series.
4. **Armature core:** Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding
5. **Armature winding**
It is usually a former wound copper

VIII.
b

7

	<p>coil which rests in armature slots.</p> <p>6.Commutator and brushes: Physical connection to the armature winding is made through a commutator-brush arrangement. The function of a commutator, in a dc generator, is to collect the current generated in armature conductors.</p> <p>Working Principle of a DC Generator:</p> <p>According to <u>Faraday's laws of electromagnetic induction</u>, whenever a conductor is placed in a varying magnetic field (OR a conductor is moved in a magnetic field), an emf (electromotive force) gets induced in the conductor. The magnitude of induced emf can be calculated from the <u>emf equation of dc generator</u></p>		

5.10 TIMERS



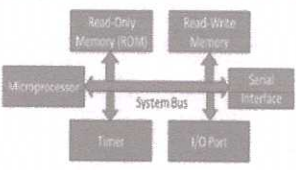
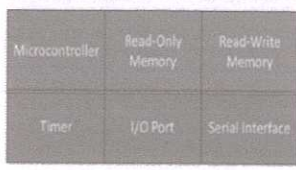
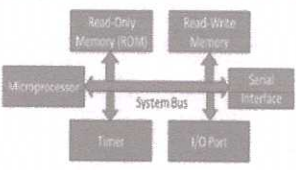
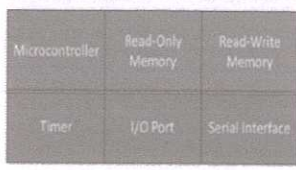
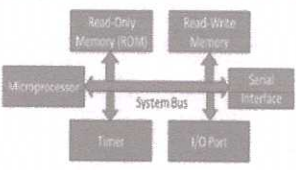
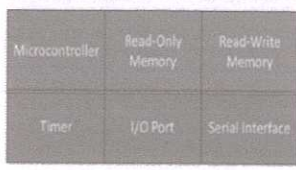
IX. a

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Fig 5.12 Timer Ladder diagram

A motor or pump need to be controlled to operate for a particular interval of time or to be switched on after some time interval. PLC thus have timers as built in devices. Timers count seconds using the internal CPU clock. A common approach is to consider timer to behave like relays with coils that when energized, results in the closure or opening of contacts after some pre-set time. The timer is thus treated as an output for a rung, with control being exercised over

IX. b	<p>5.7 PLC PROGRAMMING</p> <p>Programming devices can be a hand-held device, a desktop console or a computer. Only when the program has been designed on the programming device and is ready is it transferred to the memory unit of the PLC.</p> <ol style="list-style-type: none"> 1. Hand-held programming devices will normally contain enough memory to allow the unit to retain programs while being carried from one place to another. 2. Desktop consoles are likely to have a visual display unit with a full keyboard and screen display. 3. Personal computers are widely configured as program development work-stations. Some PLCs only require the computer to have appropriate software; others require special communication cards to interface with the PLC. A major advantage of using a computer is that the program can be stored on the hard disk or a CD and copies easily made. <p>PLC manufacturers have programming software for their PLCs. For example, Mitsubishi have MELSOFT. Their GX Developer supports all MELSEC controllers from the compact PLCs of the MELSEC FX series to the modular PLCs including MELSEC System Q and uses a Windows based environment. It supports the programming methods of instruction list (IL), ladder diagram (LD) and sequential function chart (SFC) languages. You can switch back and forth between IL and LD at will while you are working. You can program your own function blocks and a wide range of utilities are available for configuring special function modules for the MELSEC System Q – there is no need to program special function modules, you just configure them. The package includes powerful editors and diagnostics functions for configuring MELSEC networks and hardware, and extensive testing and monitoring functions to help get applications up and running quickly and efficiently. It offers off-line simulation for all PLC types and thus enables simulation of all devices and application responses for realistic testing.</p>		7
X. a	<p>5.20 MICROPROCESSOR AND MICROCONTROLLER APPLICATIONS</p> <p>Some of the application areas of microprocessor and microcontroller-based system include,</p> <ul style="list-style-type: none"> - Instrumentation - Machine control and multilevel supervisory systems - Robotics - Industrial control - Safety applications - Fire protection systems. - Home appliances - Radiation interlock systems - Motion control - Manufacturing equipments - Web-based process monitoring and control applications, etc. <p>Microcontrollers are intended for embedded devices, in comparison to the micro-processors which are used in PCs or other all-purpose devices. Microcontrollers are employed in automatically managed inventions and appliances like- power tools, implantable medical devices, automobile engine control systems, , office machines, remote controls appliances, toys and many more embedded systems. By dipping the size and expenditure in comparison to a design that make use of a different micro-processor, I/O devices and memory, micro-controllers formulate it inexpensive to digitally control more & more appliances and operations. Mixed signal microcontrollers are general; putting together analog constituents required controlling</p>	1 mark for each point	8

X. b	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #444; color: white; padding: 5px;">Microprocessor</th> <th colspan="3" style="background-color: #444; color: white; padding: 5px;">Micro Controller</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; padding: 10px;">  </td> <td colspan="3" style="text-align: center; padding: 10px;">  </td> </tr> <tr> <td style="padding: 5px;">Microprocessor is heart of Computer system.</td> <td colspan="3" style="padding: 5px;">Micro Controller is a heart of embedded system.</td> </tr> <tr> <td style="padding: 5px;">It is just a processor. 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Hence it is not suitable to used with devices running on stored power like batteries.</td> <td colspan="3" style="padding: 5px;">Since external components are low, total power consumption is less and can be used with devices running on stored power like batteries.</td> </tr> <tr> <td style="padding: 5px;">Most of the microprocessors do not have power saving features.</td> <td colspan="3" style="padding: 5px;">Most of the micro controllers have power saving modes like idle mode and power saving mode. This helps to reduce power consumption even further.</td> </tr> <tr> <td style="padding: 5px;">Since memory and I/O components are all external, each instruction will need external operation, hence it is relatively slower.</td> <td colspan="3" style="padding: 5px;">Since components are internal, most of the operations are internal instruction, hence speed is fast.</td> </tr> <tr> <td style="padding: 5px;">Microprocessor have less number of registers, hence more operations are memory-based.</td> <td colspan="3" style="padding: 5px;">Micro controller have more number of registers, hence the programs are easier to write.</td> </tr> <tr> <td style="padding: 5px;">Microprocessors are based on von Neumann model/architecture where program and data are stored in same memory module</td> <td colspan="3" style="padding: 5px;">Micro controllers are based on Harvard architecture where program memory and Data memory are separate</td> </tr> <tr> <td style="padding: 5px;">Mainly used in personal computers</td> <td colspan="3" style="padding: 5px;">Used mainly in washing machine, MP3 players</td> </tr> </tbody> </table>	Microprocessor	Micro Controller							Microprocessor is heart of Computer system.	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