SCHEME OF VALUATION

(Scoring Indicators)

Revision : 2015 **Course Code : 6025**

Course Title : Industrial Automation & Mechatronics

Qst. No	Scoring Indicator	Split up score	Sub Total	Total
	PART – A			
I (1)	**Name the basic elements of an automated system.**			
	ANS: Actuator, Sensors, Controller, Mechanical system or Mechanism	2	2	2
I (2)	**Define sensors and transducers**			
	ANS: A **sensor** is defined as a device that produces an output signal for the purpose of sensing of a physical phenomenon.	1		
	A **transducer** is defined as a device that converts a signal from one physical form to a corresponding signal, which has a different physical form.	1	2	2
I (3)	**Define sensitivity of a sensor**			
	ANS: It is the property of the measuring instrument to respond to changes in the measured quantity. It is also expressed as the ratio of change of output to change of input. $S = \frac{\Delta O}{\Delta I}$	2	2	2
I (4)	**Define actuator.**			
	ANS: Actuators are output devices which convert energy from pressurized hydraulic oil or compressed air into the required type of action or motion.	2	2	2
I (5)	**Define PLC**			
	ANS: The Programmable Logic Controller (PLC) is a special form of microprocessor-based controller that uses programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting, and arithmetic in order to control machines and processes.	2	2	2

PART – B

II (1) **Differentiate between traditional mechatronic designs.**

Sl.No	Traditional design	Mechatronic design
1	It is based on traditional system such as mechanical, hydraulic and pneumatic.	It is based on mechanical, electronics, computer technology and control engineering.
2	Less flexible	More flexible
3	Less accurate	More accurate
4	More complicate mechanism in design	Less complicate mechanism in design
5	It involves more components and moving parts.	It involves fewer components and moving parts.

5 points | 6 | 6

II (2) **Explain the working of an inductive proximity sensor with neat sketch.**

ANS: Inductive proximity switches are basically used for detection of metallic objects. It has four components; 1. Sensor coil and ferrite core, 2. Detector circuit, 3. Oscillator circuit, 4. Solid state output circuit

The oscillator circuit generates a radio frequency electromagnetic field. The field is centered around the axis of the ferrite core, which shapes the field, and directs it at the sensor face. 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 a reduction in the amplitude of the oscillating signal. 4

The detector circuit detect the changes in the oscillator amplitude. The detector circuit will switch on at specific operating amplitude. This signal turns on the solid state output circuit. This is often referred to as the damped condition. As the target leaves the sensing field, the oscillator responds with increasing amplitude. As the amplitude increases above a specific value, it is detected by the detector circuit, which is switched off causing the output signal to return to the normal or off state.

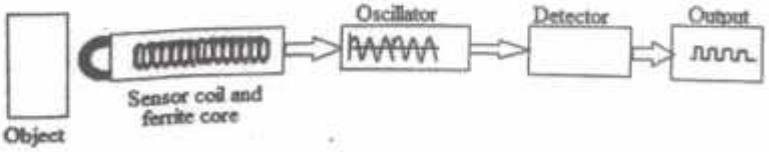
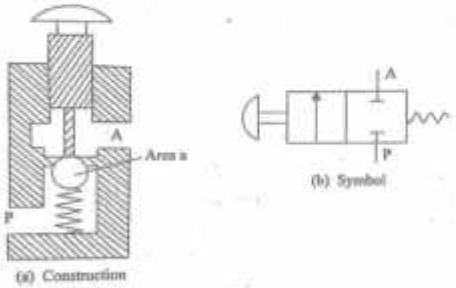
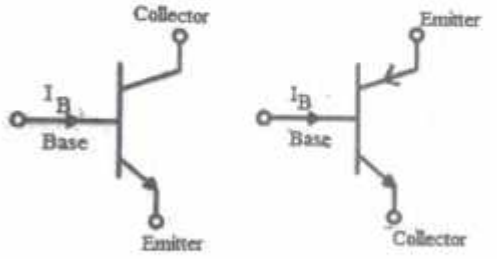
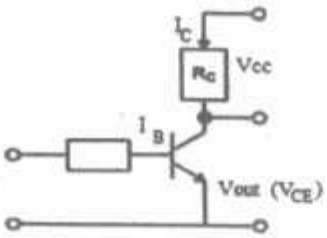


Fig – 2 | 6 | 6

Schematic of Inductive Proximity Switch

II (3)	**What is a photo resister? Explain the applications of photo resister.** **ANS:** Photo resistor is also called as light dependent resistor (LDR). It has a resistor whose resistance decreases with increasing incident light intensity. **Applications of photo resistor** 1) Computers, wireless phones, and televisions, use ambient light sensors to automatically control the brightness of a screen. 2) Barcode scanners used in retailer locations work using light sensor technology. 3) In space and robotics: for controlled and guided motions of vehicles and robots. The light sensor enables a robot to detect light. Robots can be programmed to have a specific reaction if a certain amount of light is detected. 4) Auto Flash for camera 5) Industrial process control	1 5x1=5	6	6
II (4)	**Explain the working of simple ball type 2/2 poppet valve.** **ANS:** In a poppet valve, simple discs, cones or balls are used in conjunction with simple valve seats to control flow. Fig. shows the construction and symbol of a simple 2/2 normally- closed valve. The depression of the push-button push down the ball off its seat and allows fluid to flow from port 'P' to port 'A' . When the button is released, spring and fluid pressure forces the ball up again closing the valve. The Fig - (b) shows construction and symbol of a disc type 2/2 poppet valve. When the push-button released, ports A and R are linked via the hollow push-button stem.  **Simple ball type 2/2 poppet valve**	3 Fig – 3	6	6

II (5)	**Write short notes on bipolar junction transistor.** **ANS:** Bipolar transistors come in two forms, the npn and pnp. For the npn transistor, the main current flows in at the collector and out at the emitter, a controlling signal being applied to the base. The pnp transistor has the main current flowing in at the emitter and out at the collector, a controlling signal being applied to the base.  **(a) npn Transistor** **(b) pnp transistor** **Bipolar transistor**  **circuit** In npn type, the current flows in from the collector and goes out at the emitter. At the base the current supplied acts as a controlling signal. In a pnp type, the current flows in from the emitter and flows out at the collector. The controlling signal supplied at the base is opposite in direction. When the base current I_B is zero, the transistor is cut off in this state both and base-collector junctions are reverse biased. When the base current is increased, the collector current is increased and V_{CE} decreases as result of voltage drop at R_c. When V_{CE} reaches a value $V_{CE(sat)}$, the base-collector j unction becomes forward biased and collector current can increase no further, even if the base current is further increased. This is termed as saturation. By switching the base current between 0 and a value that drives a transistor into saturation, bipolar transistor can be used as a switch.	Fig - 3 3	6	6

II (6)	**List the features of PLC** **ANS:** 1. Compact and rugged in construction 2. PLC can be easily programmed 3. Reprogramming is very easy 4. It gives noiseless operation. 5. More reliable, low maintenance cost. 6. Interfacing of computers is possible for further processing and analysis. 7. Controlled outputs are available in different voltages 8. Inbuilt timers, counters and registers. 9. PLCs can store data and programs. 10. I/O channels are isolated hence interfacing with sensors and actuators are easy.	Any 6 points (6x1)	6	6
II (7)	**Discuss the common hardware faults.** **1) Sensors**:- If there are faults in a measurement system then the sensor might be at fault. A simple test is to substitute the sensor with a new one and see what effect this has on the results given by the system. if the results change then it is likely that the original sensors was faulty; if the result do not change then the fault is elsewhere in the system. It is also possible to check that the voltage/ current sources are supplying the correct voltage/currents, whether there is electrical continuity in connecting wires, that the sensor is correctly mounted and used under the conditions specified by the manufacturer's data sheet etc. **2) Switches and relays:-** Dirt and particles of waste material between switch are a common source of incorrect Functioning of mechanical switches. A voltmeter used across a switch should indicate the applied Voltage when the contacts are open and very nearly zero when they are closed. Inspection of a relay can disclose evidence of arcing or contact welding. The relay should then be replaced. If a relay fails to operate then a check can be made for the voltage across the coil. If the correct voltage is present then coil continuity can be checked with an Ohmmeter. If there is no voltage across the coil then the fault is likely to be the switching transistor used with the relay. **3) Motors:-** Maintenance of both d.c and ac. motors involves correct lubrication. With d.c. motors the brushes wear and can require changing .Setting of new brushes needs to be in accordance with the manufacturer's specification. A single phase	1.5 1.5 1.5		

	capacitor start a.c. motor that is sluggish in starting probably needs a new starting capacitor. The three -phase induction motor has no Brushes, commutator, slip rings or starting capacitor and, short of a severe overload, the only regular maintenance that is required is periodic lubrication. **4) Hydraulic and Pneumatic systems:-** A common cause of faults with hydraulic and pneumatic systems is dirt. Small particles of dirt can damage seals, block orifices, causes valve spool to jam, etc. Thus filters should be regularly checked and cleaned, components should only be dismantled in clean conditions, and oil should be regularly checked and changed.	1.5	6	6
	PART – C			
III (a)	**List the advantages and disadvantages of automation.** **Advantages** 1. Increased labour productivity 2. Reduce the labour and skilled workers 3. Provides safety to workers and reduced accidents 4. Reduced scrap and wastages and thus saving material cost. 5. Reduced manufacturing lead time (Time between customer order and product delivery) 6. Reduced in-process inventory by reducing the time a work part spends in the factory. 7. Consistent product quality 8. Lower product price and better products. 9. Automation increase standard of living. 10. Lesser floor space 11. Machining of advanced materials can be easily done **Disadvantages** 1. It reduces the labour force especially skilled employees, so that the employment opportunity reduces. 2. Automation may treat the human as a machine. 3. It reduces the purchasing power since the market is saturated with products that the people cannot afford to purchase. 4. Initial expenses are more. 5. Setting time of machine takes more. 6. Breakdown or shut down of at any point may idles the entire system.	Any 8 adv– 4 7disad v – 4	8	8

7. Servicing requires more skill.

III (b) **Compare open loop and closed loop control system**

Sl No	Open loop system	Closed loop system
1	Any change in output has no effect on the input, ie. Feedback does not exist.	Changes in output affect the input implemented by use of feedback.
2	So long as the calibration is good, the performance of the system is accurate.	Due to feedback the performance of closed loop system is accurate.
3	Operation is normally stable.	Stability is major consideration while designing.
4	Simple construction and operation.	Complicated design and operation.
5	Highly affected by non-linearities.	Reduced effect of non-linearities.

7 | 7 | 7

IV (a) **Explain the major building blocks of mechatronic system with the help of a block diagram.**

Major building blocks of any mechatronic System are:

1) Measurement and actuation module:- It receives signals from external environment and feedback signal. This module uses several actuators and sensors such as - solenoids, AC/DC and stepper motor, switches, strain gauge, temperature/pressure/photo sensors. These sensors can be adjusted manually.

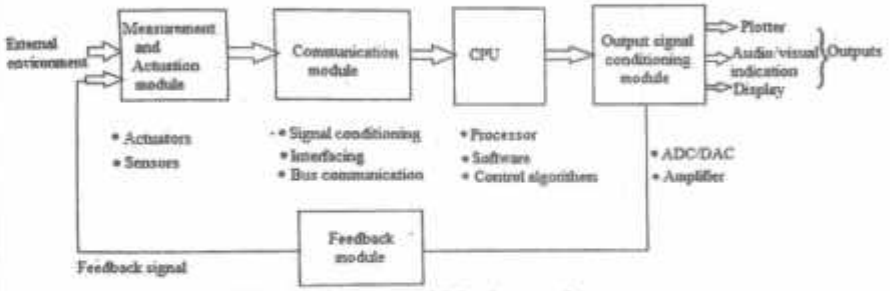


Fig -3

Block diagram of Mechatronic system

2) Communication module:- The position of sensors and the relative position of actuators are measured and corresponding signals are generated. These signals are feed to CPU through a communication module. The communication module includes

8 | 8

	signal conditioning circuits, interfacing circuits and communication. **3) CPU:-** CPU with a processor and necessary software performs the logical and arithmetic operations on the signal received, CPU then generates suitable control signal. **4) Output signal conditioning module:-** Output signal conditioning module consists of ADC/ DACs, amplifiers, to drive plotter, audio-visual indicators, displays etc. The output signal is given to feedback module. It may be noted that the sensor is able to generate some form of signal, generally an analog signal in the form of a voltage level or waveform. This analog signal is sent to an analog-to-digital converter (ADC). Commonly using a process of successive approximation, the ADC maps the analog input signal to a digital output. A digital-to-analog converter (DAC) is then often used to convert the digital value into an analog signal. The analog signal is used by an actuator to control a physical device or affect the physical environment. **5) Feedback module:-** The feedback module generates proportionate signal to the output signal which is given to the measurement and actuation module. The measurement and actuation module compares the external environment and feedback signal.	1 mark for each point (5x1= 5)	7	7
IV (b)	**Explain the elements of mechatronics design procedure.** **1) The need** The design process begins with a need from, perhaps, a custom or client. This may be identified by market research being used to establish the needs of potential customers. **2) Analysis of the problem** The first stage in developing a design is to find out the true nature of the problem, i.e. analysing it. This is an important stage in that not defining the problem accurately can lead wasted time on designs that will not fulfil the need. **3) Preparation of specification** Following the analysis a specification of the requirement can be prepared. This will state the problem, any constraints placed on the solution, and the criteria which may be used to judge the quality of the design. In stating the problem, all the functions required of the design, together with any desirable features, should be specified. Thus there might be a statement of mass, dimensions, types and range of motion required, accuracy, input and output requirements of elements, interfaces, power requirements, operating environment, relevant standards and codes of practice.	1 mark for each point	8	8

	4) Generation of possible solutions This is often termed as the conceptual stage. Outlineo1ut1ons are prepaid which are worked out in sufficient detail to indicate the means of obtaining each of the required functions. e.g. approximate sizes, shapes, materials and costs. It also means finding out what has been done before for similar problems; there is no sense in reinvesting the wheel. **5) Selection of a suitable solution** The various solutions are evaluated and the most suitable one selected. **6) Production of a detailed design** The detail of the selected design has now to be worked out. This might require the production prototypes or mock-ups in order to determine the optimum details of a design. **7) Production of working drawing** The selected design is then translated into Working drawings, circuit diagrams, etc. so that the item can be made. It should not be considered that each stage of the design process just flows on stage by stage. There will often be the need to return to an easier stage and give it further consideration. Thus when at the stage of generating possible solutions there might be a need to go back and consider the analysis of the problem.		7	7
V (a)	**What is a tachogenerator? Explain the working with a neat sketch.** **ANS:** The tachogenerator is used to measure angular velocity. Two types. 1) Variable reluctance tachogenerator, 2) A.C tachogenerator **1) Variable reluctance tachogenerator:-** It consists of a toothed wheel of ferromagnetic material which is attached to the rotating shaft. A pickup coil is wound on a permanent magnet. As the wheel rotates, so the teeth move past the coil and the air gap between the coil and the ferromagnetic material changes. We have a magnetic circuit with an air gap which periodically changes. Thus the flux linked by a pick-up coil changes. The resulting cyclic change in the flux linked produces an alternating e.m.f in the coil.	1 1.5		

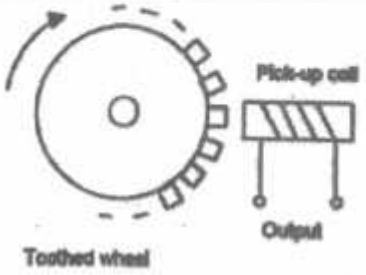


Fig -2

Variable reluctance tachogenerator

A.C tachogenerator consists of a coil , termed the rotor, which rotates with the rotating shaft . This coil rotates in the magnetic field produced by a stationary permanent magnet or electromagnet and so an alternating e.m.f. is induced in it. The amplitude or frequency of this alternating e.m.f. can be used as a measure of the angular velocity of the rotor. The output may be rectified to give a d.c. voltage which is proportional to the angular velocity.

1.5

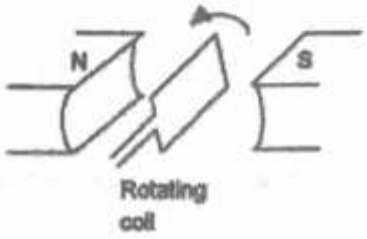


Fig -2

A.C tachogenerator

8

8

V (b) **What are the factors to be considered when choosing sensors?**

1) The nature of measurement required, e.g.

- The variable to be measured,
- Its nominal value,
- The range of values,
-The environmental conditions under which the measurement is to be made.

1

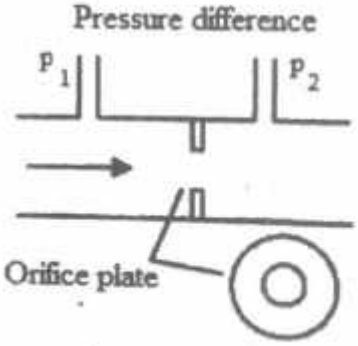
2) The nature of the output required from the sensor, this determining the signal conditioning requirements in order to give suitable output signals from the measurement.

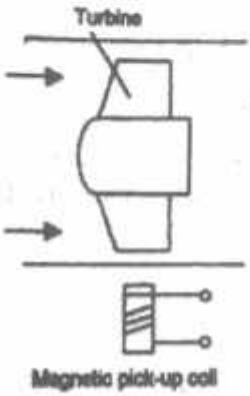
1

3) The possible sensors can be identified, taking into account such factors as their range, linearity, speed of response, reliability, maintainability, life, power supply requirements, ruggedness, availability, and cost.

1

4) Other factors are ,

	a. **Accuracy** - How precise the measurement is, compared to real time value b. **Repeatability** - How often does the data come out to be the same c. **Long- term stability** - how long the sensor would give an accurate output d. **Resistance to chemical and physical contaminants** e. **Size** — Depends on the project. f. **Weight**—Also depends on the device g. **Cost**—the price should be truly considered h. **Effectiveness** — Capable of producing an intended result. i. **Long term usage** — how long would the sensor give data j. **Response Time** — how fast the sensor would response to an issued command	(8x0.5 = 4)	7	7
VI (a)	**Explain the working of an orifice plate and turbine meter with suitable sketches.** **ANS:** Depending on the type of obstruction, we can have different types of flow meters. **Orifice plate:-** An orifice plate which is simply a disc, with a central hole, which is placed ¡n the tube through which the fluid is flowing, as shown in Fig. lf d1 and d2 are the diameters of the pipe line and the orifice opening, then the flow rate can be obtained by measuring the pressure difference (p1 - p2).  **Orifice Plate** **Turbine meter:-** Turbine type flow meter is a simple way for measuring flow velocity. A rotating shaft with turbine type angular blades is placed inside the flow pipe. The fluid flowing through the pipeline will cause rotation of the turbine whose speed of rotation can be a measure of the flow rate. The turbine blades are made of ferromagnetic material. The rate of revolution of the rotor can be determined by the magnetic pickup. The pulses are counted and number of revolutions of the rotor can be determined.	2 Fig- 2 2		



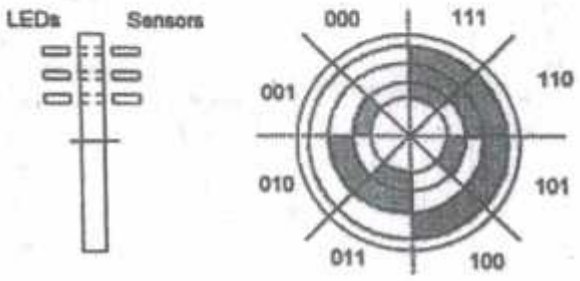
Turbine meter

Fig -2 | 8 | 8

VI (b) **Explain the working of absolute encoder with a neat sketch.**

ANS: An absolute encoder is used for the measurement of angular displacement. This gives an output in the form of a binary number of several digits, each such number representing a particular angular position. The rotating disc has three concentric circles of slots and three sensors to detect the light pulses. The slots are arranged in such a way that the sequential output from the sensors is a number in the binary code. Typical encoders tend to have up to 10 or 12 tracks. The number of bits in the binary number will be equal to the number of tracks. Thus with 10 tracks there will be 10 bits and so the number of positions that can be detected is 2^{10}, i.e. 1024, a resolution of $360/1024 = 0.35^0$.

2

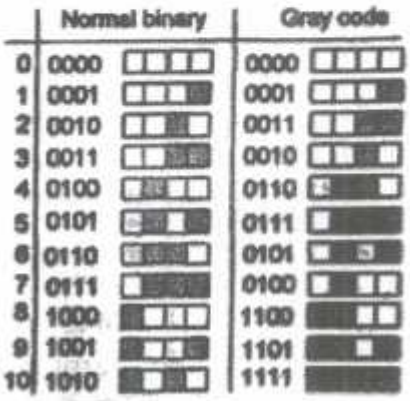


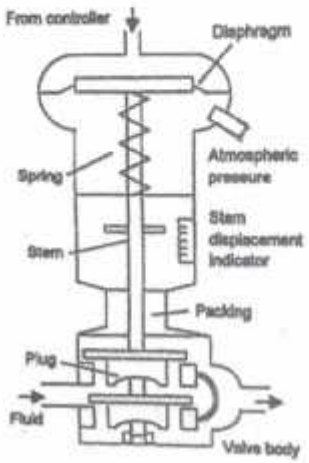
2

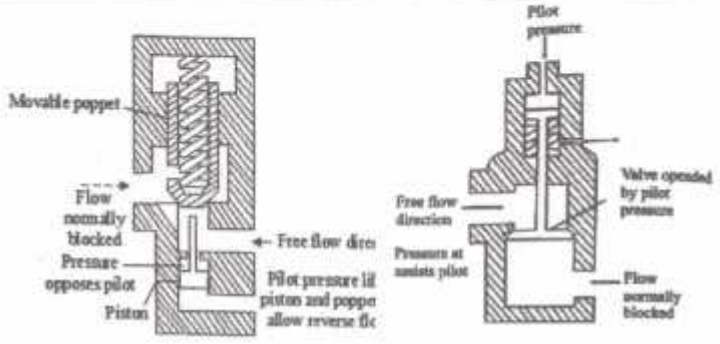
Absolute encoder

The normal form of binary code is generally not used because changing from one binary number to the next can result in more than one bit changing and if, through some misalignment, one of the bits changes fractionally before the others

1

	then an intermediate binary number is momentarily indicated and so can lead to false counting. To overcome this, gray code is generally used. With this code only one bit changes in moving from one number to the next. An absolute encoder with 7 tracks on its code disc. Each track will give one of bits in the binary number and thus we have 2 position specified, i.e. 128.  **Binary and Gray code**	2	7	7
VII (a)	**Sketch and explain the working of diaphragm operated process control valve.** **ANS:** Process control valves are used to control the rate of fluid flow and are used where, the rate of flow of liquid into a tank has to be controlled. The basis of such valves in an actuator being used to move a plug into the flow pipe and so alter the cross-section of the pipe through which the fluid can flow. A common form of pneumatic actuator used with process control valve is the diaphragm actuator. It consists of a diaphragm with the input pressure signal from the controller on one side and the atmospheric pressure on the other, this difference m pressure being termed the gauge pressure. The diaphragm is made of rubber which is sandwiched in its centre between two circular steel discs. The effect of changes in the input pressure is thus to move the central part of the diaphragm. This movement is communicated to final control element by a shaft which is attached to the diaphragm. Figure shows a cross-section of a valve for the control of rate of flow of a fluid. The pressure change in the actuator causes the diaphragm to move and so consequently the valve Stem. The result of this ¡s a movement of the inner-valve plug within the valve body. The plug restricts the fluid flow and so its position determines	4		

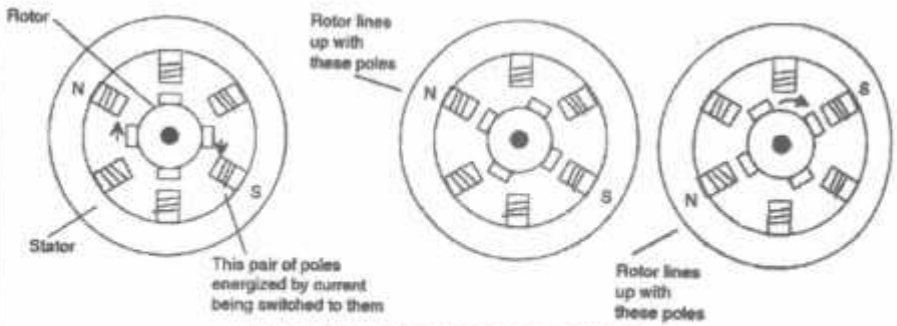
	the flow rate.  **Diaphragm operated process control valve**	4	8	8
VII (b)	**Explain the working of pilot operated check valve.** ANS: The operation of a pilot valve is illustrated by a pilot operated check valves in two different methods as described below. A pilot operated check valve is similar to a basic check valve but can be held open permanently by application of an external pilot pressure signal. There are two basic forms of pilot operated check valves shown in Fig. They operate in a similar manner to basic check valves, but with pilot pressure directly opening the valves. The Fig (a) shows a two way check valve. It should be noted that a pilot operated check valve is a design which allows free flow in one direction, but prevents reverse flow until a pilot pressure is applied at the pressure port of the valve as shown. From the Fig (a) it is seen that when the system pressure through the free flow port exceeds the spring force of the poppet, the poppet is moved up and it allows one way free flow. The reverse flow is prevented because the fluid pressure pushes the poppet into the closed position. When we require a free reverse flow, a pilot pressure pushes the pilot piston, which in turn pushes the poppet from its seat and thus free flow is obtained in the reverse direction. Inlet pressure opposes the pilot opening in Fig (a) where as in the Fig (b) the inlet pressure assists the pilot. So the pilot pressure lifts the piston and poppet from its seat and allows the reverse flow in Fig (a).	3		



(a) Check valve type-I (b) Check valve type-II

VIII (a) **With the help of a neat sketch explain the three phase variable reluctance DC stepper motor.** 4 7 7

ANS: It consists of a soft iron multi-toothed rotor and a wound stator. When the stator windings are energized with DC current, the poles become magnetized. Rotation occurs when the rotor teeth are attracted to the energized stator poles. Both the stator and rotor materials must have high permeability and be capable of allowing high magnetic flux to pass through even if a low magneto motive force is applied.



Variable reluctance stepper motor 4

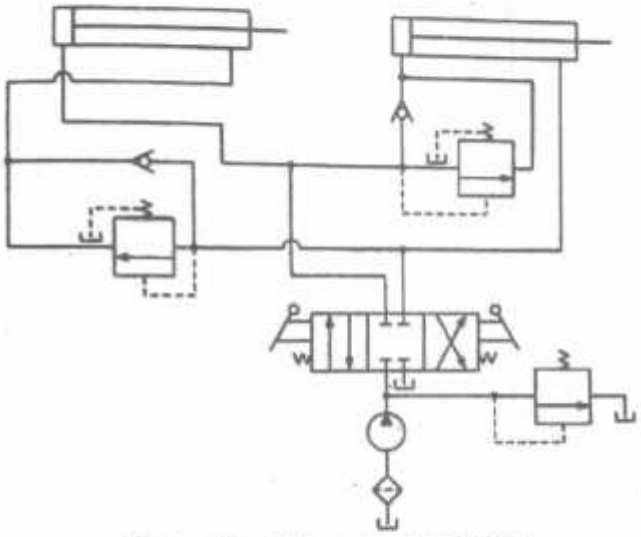
Fig shows the basic principle of the variable reluctance type stepper motor. The rotor is made of steel and has a number of teeth, the number being less than the number of poles on the stator. The stator has pair of poles, each pair of which is activated and made into an electromagnet by a current being passed through the coils wrapped round it. When one pair of poles is activated, a magnetic field is produced that attracts the nearest pair of rotor teeth so that the teeth and poles line up. This is known as the position of minimum reluctance. By then switching the current to the next pair of poles, the rotor can be made to rotate to line up with those poles. 4 8 8

Sequentially switching the current from one pair of poles to the next, the rotor can made to rotate in steps

VIII (b) **With the help of a neat sketch explain the double acting hydraulic cylinder sequence circuit.**

ANS: A sequence valve causes operations in a hydraulic or pneumatic circuit to be sequentially. Figure shows an example where two sequence valves are used to control the sequence of operations of two double acting hydraulic cylinders. When the Direction control valve (DCV) is shifted to its left envelop mode, the left cylinder extends completely, and then the right cylinder also extends. If the DCV is shifted to its right envelop mode, the right cylinder retracts fully, and then the left cylinder retracts. This sequence of operation is controlled by the sequence valves. The spring-cantered position of the DCV locks both cylinders in place.

3



4 7 7

Hydraulic cylinder sequence circuit

IX (a) **Explain the working of shift register with the help of suitable sketches.**

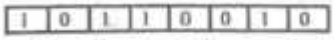
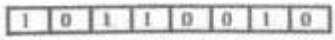
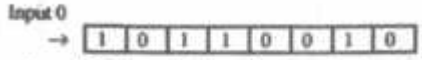
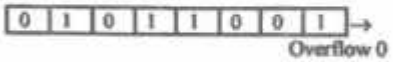
ANS: A register is a number of internal relays grouped together, normally 8, 16 or 32. Each internal relay is either effectively open or closed, these states being designated as 0 and 1. The term bit is used for each such binary digit. Therefore, if we have eight internal relays in the register we can store eight 0/1 states. Thus we might have:

Internal relays

1	2	3	4	5	6	7	8

and each relay might store an on-off signal such that the state of the register at some instant is:

2

	 ie, relay 1 is on, relay 2 is off, relay 3 is on, relay 4 is on, relay 5 is off, etc. Such an arrangement is termed an 8-bit register. Registers can be used for storing data that originate from input sources other than just simple, single on-off devices such as switches. With the shift register it is possible to shift stored bits. Shift registers require three inputs, one to load data into the first location of the register, one as the command to shift data along by one location and one to reset or clear the register of data. To illustrate this, consider the following situation where we start with an 8-bit register in the following state:  Suppose we now receive the input signal 0. This is an input signal to the first internal relay  If we also receive the shift signal, then the input signal enters the first location in the register and the entire bits shift along one location. The last bit overflows and is lost.  Thus a set of internal relays that were initially on, off, on, on, off, off, on, off are now off, on, off, on, on, off, off, on. The grouping together of internal relays to form a shift register is done automatically by a PLC when the shift register function is selected. With the Mitsubishi PLC, this is done by using the programming code SFT (shift) against the internal relay number that is to be the first in the register array. This then causes a block of relays, starting from that initial number, to be reserved for the shift register.	3 3	8	8
IX (b)	**Explain input-output processing.** **ANS:** A PLC is continuously running through its program and updating it as a result of the input signals. Each such loop is termed a cycle. There are two methods that can be used for input/output processing: continuous updating and mass input/output copying. **1) Continuous updating** Continuous updating involves the CPU scanning the input channels as they			

	occur in the program instructions. Each input point is examined individually and its effect on the program determined. There will be a built-in delay, typically about 3 micro seconds, when each input is examined in order to ensure that only valid input signals are read by the microprocessor. This delay enables the microprocessor to avoid counting an input signal twice, or, more frequently, if there is contact bounce at a switch. A number of inputs may have to be scanned, each with a 3 micro seconds delay, before the program has the instruction for a logic operation to be executed and an output to occur. The outputs are latched so that they retain their status until the next updating. **2) Mass input / output copying** Because with continuous updating, there has to be 3 micro seconds delay on each input, So the time taken to examine several hundred input / output points can become comparatively long. To allow a more rapid execution of a program, a specific area of RAM is used as a buffer store between the control logic and the input/output unit. Each input/output has an address in this memory. At the start of each program cycle the CPU scans all the inputs and copies their status into the input/output addresses in RAM. As the program is executed the stored, input data is read, as required, from RAM and the logic operations carried out. The result is stored in the reserved input/output section of RAM. At the end of each program cycle all the outputs are transferred from RAM to the output channels. The outputs are latched so that they retain their status until the next updating. The sequence is: 1. Scan all the inputs and copy into RAM. 2. Fetch and decode and execute 11 program instructions in sequence, copying output instructions to RAM. 3. Repeat the sequence. A PLC takes time to complete a cycle of scanning inputs and updating outputs according to the program instructions and so the inputs are not watched all the time but only examined periodically. A typical PLC cycle time is of the order of 10 to 50 ms and. so the inputs and outputs are updated every 10 to 50 ms.	3 4	7	7

X (a) **Make a comparison between Microprocessor and Microcontroller.**

ANS:

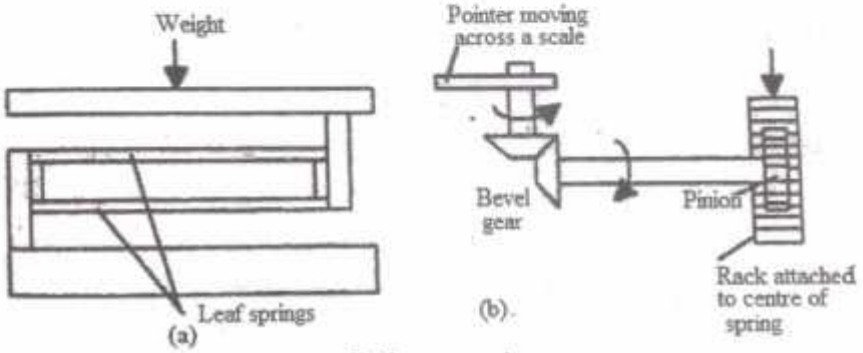
Sl. No	Microprocessor	Microcontroller
1	Contains ALU, control unit (clock and timing circuit), different registers and interrupt circuit.	Contains microprocessor, memory (ROM and RAM), I/O interfacing circuit and peripheral devices such as A/D converter, serial I/O, timer etc.
2	Many instructions to move data between memory and CPU.	One or two instructions to move data between memory and CPU.
3	One or two bit handling instructions.	Many or two bit handling instructions.
4	Access time for memory and I/O devices are more.	Less access time for built-in memory and I/O devices.
5	Requires more hardware.	requires less hardware reducing the PCB size and increasing the reliability.
6	More flexible in design point of view.	Less flexible in design point of view.
7	Single memory map for data and code.	separate memory map for data and code.
8	Less number of pins is multifunctioned.	More number of pins is multifunctioned.

(8x1= 8) | 8 | 8

X (b) **With the help of a neat sketch discuss the Bathroom scale and mechatronic solution of it.**

ANS: Consider the simple weighing machine which is used to indicate the weight of a person standing on it. The important requirement of this weighing machine is to indicate the weight of the person with reasonable speed and accuracy and be independent of where on the platform the person stands. The traditional mechanical system for this problem is to use the weight of the person on the platform to deflect

2

	an arrangement of two parallel leaf springs as shown in Fig (a).The deflection of the leaf spring is transferred to the rack and pinion arrangement where the linear movement of rack is converted into rotary motion of the pinion about the horizontal axis. The rotary motion is transferred to the movement of a pointer across a scale through bevel gears (Figure (b)).With this arrangement the deflection is independent of where on the platform the person stands.  **Bathroom scale**	3		
	Another possible solution involves the use of a microprocessor. The platform can be mounted on load cells employing electrical resistance strain gauges. When the person stands on the platform the gauges suffer strain and change resistance. If the gauges are mounted in a four - active-arm Wheatstone bridge then the out-of-balance voltage output from the bridge is a measure of the weight of the person. This resulting analogue signal can then be fed through a latched analogue-to-digital converter for inputting to the microprocessor.	2	7	7