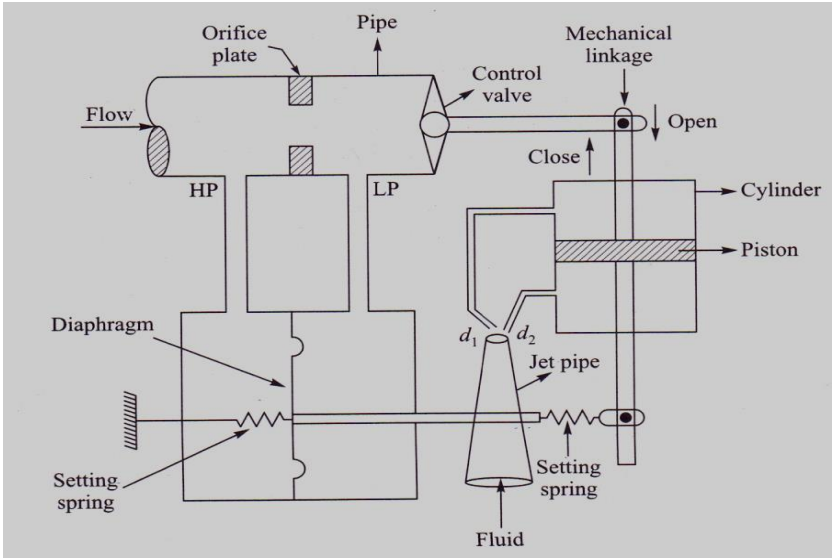
MODEL ANSWER
SUMMER-18 EXAMINATION

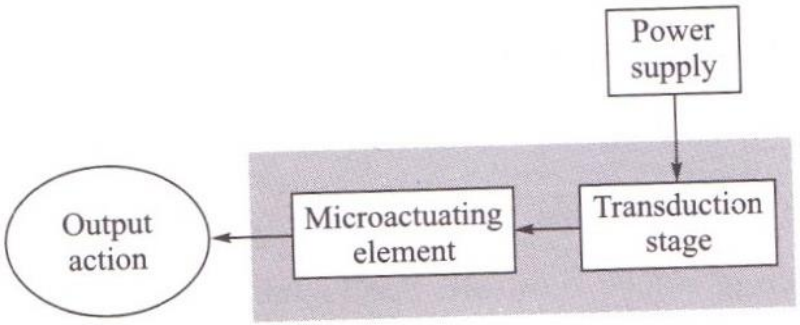
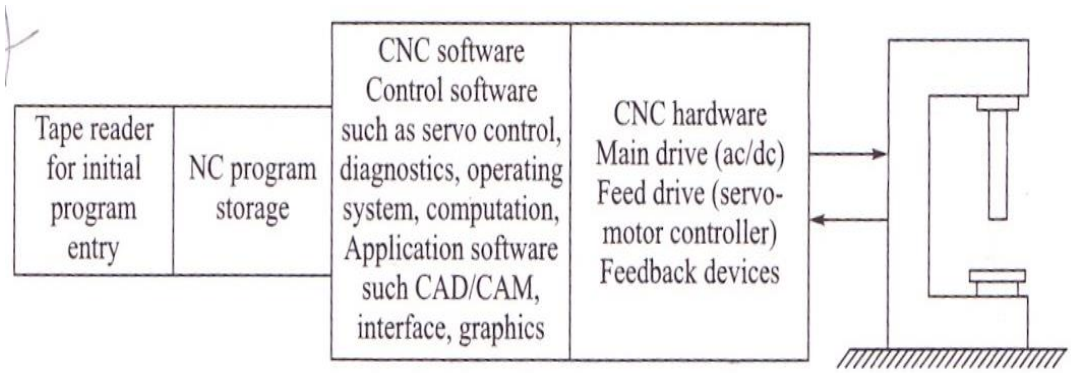
Subject Title:-Mechatronics **Subject Code:-** 17660

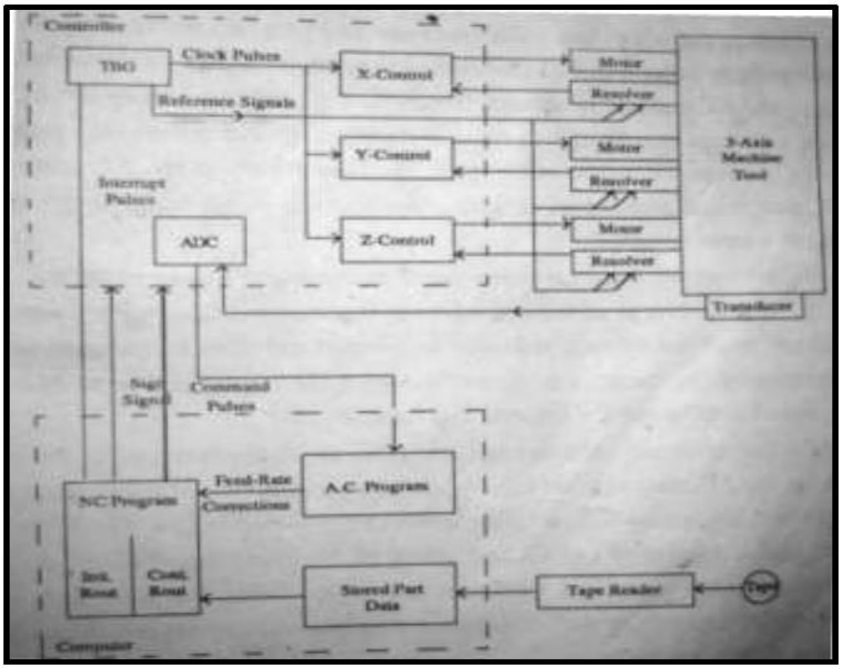
Important Instructions to examiners:

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

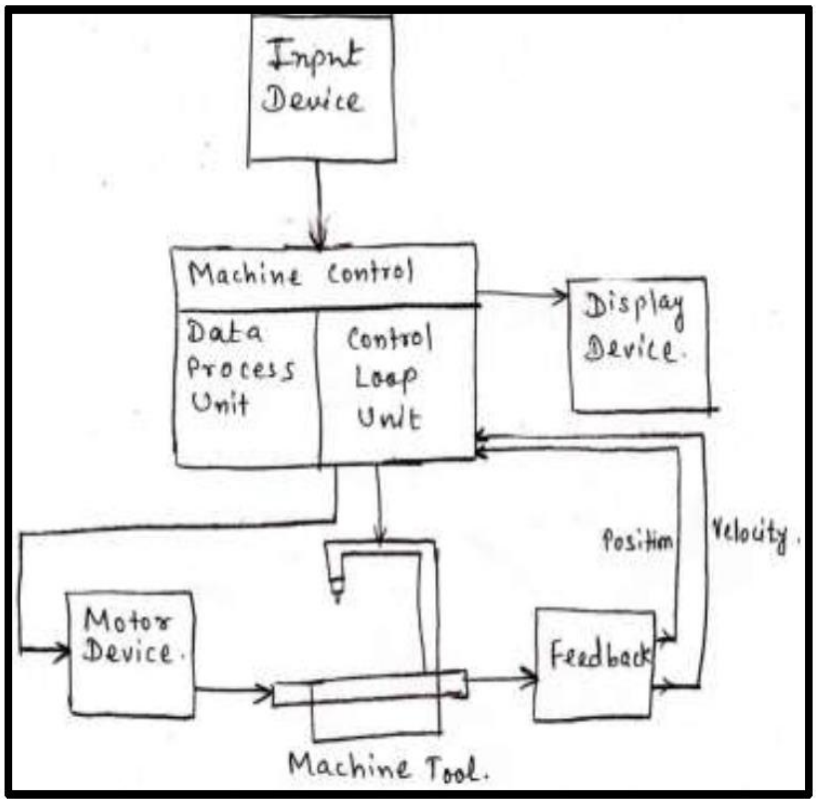
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	**Attempt any five:**	**20 Marks**
	a)	**State and elaborate importance of mechatronics in various fields of engineering.**	**4 Marks**
	Ans:	**Mechatronics** Mechatronics is the synergistic integration of mechanical engineering with electronics and intelligent computer control in designing, manufacturing processes and production. It helps to develop atomized, reliable and efficient in manufacturing/production systems to produce high quality products. **Importance of Mechatronics in various engineering fields:** **Mechanical System:** These system deal with behaviour of matter under the action of forces. Mechanical system like hydraulic, pneumatic, rotational or translational, thermal, Fluid etc. are used in Mechatronics applications. These systems are interfaced with computer through sensors, actuators and electronic systems. **Electrical Systems:** Electrical components mostly used are electrical motors (ac and dc} generators, relays, circuit breakers, switches and so forth. **Electronic Systems:** Analog electronics involves as action and passive components such as resistor, capacitor, inductor, diodes and transistors digital circuits contain logic, gates, counters, Flip- flops, memories, microcontroller and process. Instrumentation & control system:	**Any 4 Fields – 2M ,Importance in 4 fields- 2M**

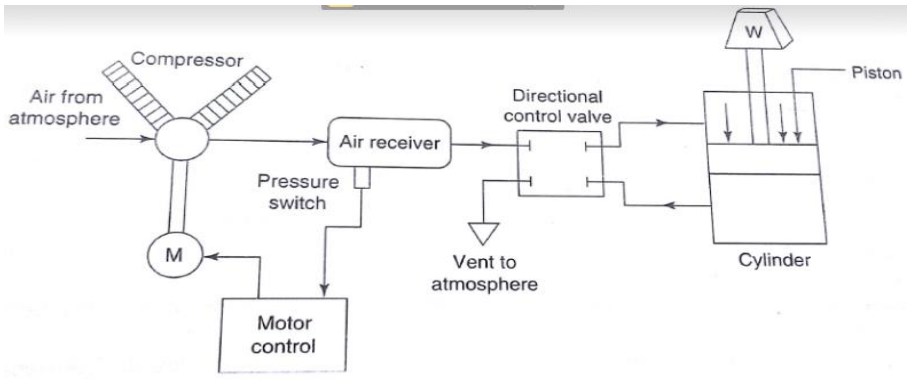
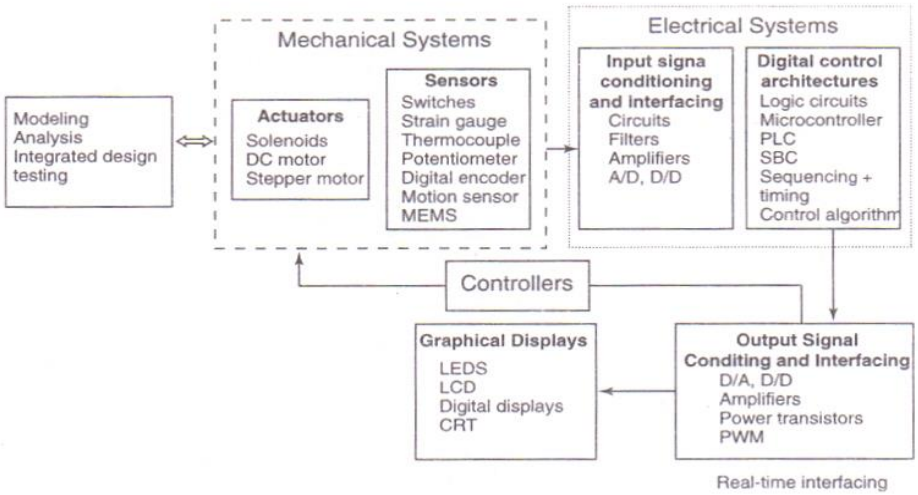
		It includes transducer, signal conditioning, output device such as analog meters, display devices recorders and printers. **Information Systems:** It related with all the aspects regarding information transmission from signal processing to control system and analysis techniques. It is a combinational of communication systems, signal processing, control systems and numerical methods. **Computer System:** It is combinational of hardware and software. In mechatronic applications hardware is computer specific circuit like flip-flops, computer registers, memories software is nothing but system and application.	
	b)	**List any four applications of hall effect sensor.**	**4 Marks**
	Ans:	(1) It is used as a magnetic switch for electric transducer . (2) It is used for the measurement of the position , displacement And proximity . (3) It is used for measurement of current . (4) It is used for the measurement of power . (5) To determine the correct alignment of permanent magnets rotor with the windings on the stator in brushless dc motors . (6) Monitor angular and linear velecoties and detect motion in security systems , cash machine screens etc.	**Any 4 applications-4M**
	c)	**Describe implementation of hydraulic controller (proportional).**	**4 Marks**
	Ans:		**Diagram-2M , description-2M**

		• When the jet pipe is moved towards right by the deviation the signal, the position moves to the right along with the feedback linkage whose motion acts to bring the jet pipe back to its neutral position. • Thus for every unit deviation there is some fixed piston position that actuates the final element to certain opening that brings about the necessary correction in the measurement which is nothing but "P" action control.	
	d)	**Draw and explain MEMS Microactuators.**	**4 Marks**
	Ans:	 • Actuator is a mechanical device used for controlling or moving something. • It is an element that converts electric signals into physical signals. • The transduction unit converts into power supply into the form like voltage to the actuating element. • The driving supply for actuator varies depending upon the application. • Micropumps, microswitches, microvalves and microgrippers are different types of Microactuators.	**Diagram- 2M, explanation- 2M**
	e)	**Draw the block diagram of CNC based drilling machine.**	**4 Marks**
	Ans:	 **OR**	**Proper relevant diagram- 4M**

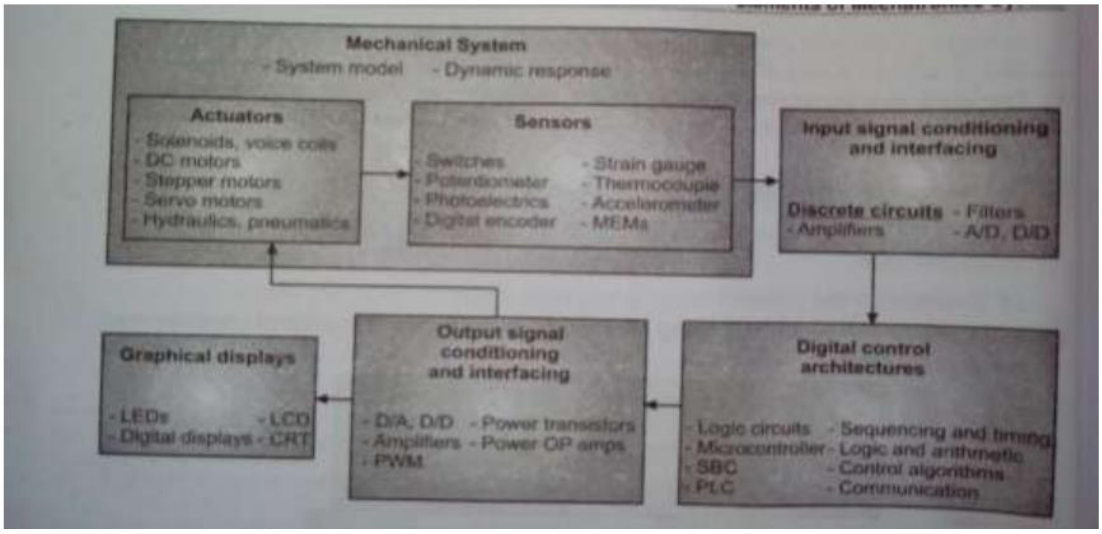

Controller
TBG
Clock Pulses
Reference Signals
X-Control
Y-Control
Z-Control
Motor
Resolver
3-Axis Machine Tool
Transducer
Interrupt Pulses
ADC
Command Pulses
Feed-Rate Corrections
A.C. Program
NC Program
Stored Part Data
Tape Reader
Tape
Computer

OR


Inpnt Device
Machine Control
Data Process Unit
Control Loop Unit
Display Device.
Position
Velocity.
Motor Device.
Feedback
Machine Tool.

	f)	**Explain the basic components of pneumatic system with neat sketch.**	**4 Marks**
	Ans:	 ▪ **Air filter**:-These are used to filter out the contaminants from the air ▪ **Compressor:**-The compressor is a mechanical device which converts mechanical energy into fluid energy. ▪ **Air cooler:** - During compression operation air temperature increases. Therefore callers are used to reduce the temperature of the compressed air. ▪ **Dryer:** - The water vapor or moisture in the air is separated from the air by using a dryer. ▪ **Control valve:** - control and regulates the direction of flow and pressure etc. ▪ **Air actuator:** - Air cylinders and motors are used to obtain the required movements of direction flow.	**Diagram- 2M, explanation- 2M**
	g)	**Draw the block diagram of mechatronic system and explain key elements of mechatronics system**	**4 Marks**
	Ans: -		**Diagram- 2 M, explanation of key elements- 2M, Diagram- 2 M, explanation of key elements- 2M.**

OR



Element of Mechatronics System: (Any Other Element can be Consider) A typical mechatronics system consist of mechanical system, electrical system and computer /information technology

Basic element of Mechatronics system are

Mechanical: Actuator,solenoids ,motors,switch, sensor,transducer,gear, driveand so on

Electrical system/Electronics: Capacitor,semiconductor device,Amplifier, Filter, Digital and analog devices,accerometer

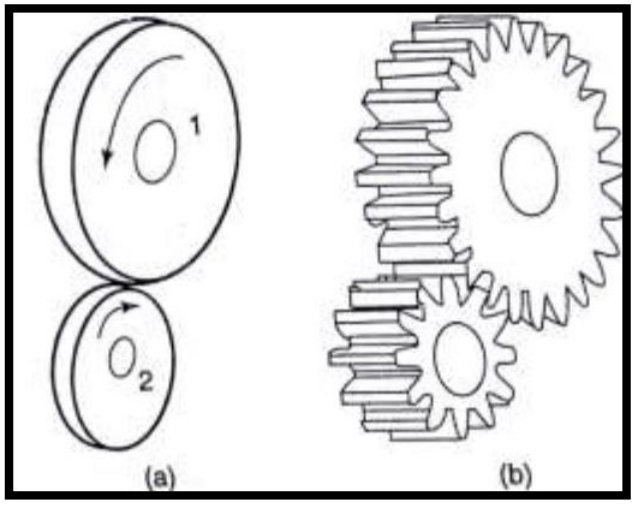
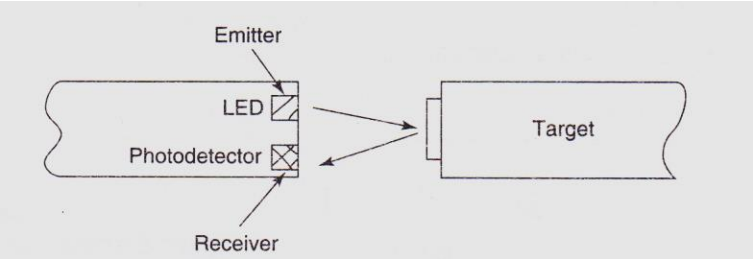
InformationTechnology: Certain Software,System Engineering,Part programming,Artificial Intelliance, CAD,CAM

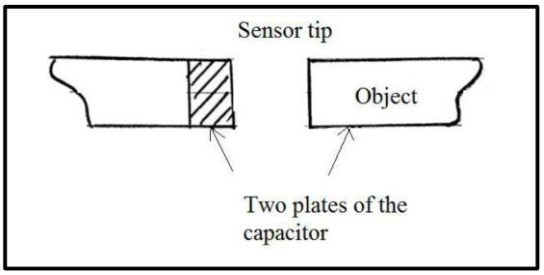
Digital control architectures: PLCs are industrial devices used for interfacing and controlling analog and digital devices. Microcontrollers are low cost, versatile, small size and easy programming device.

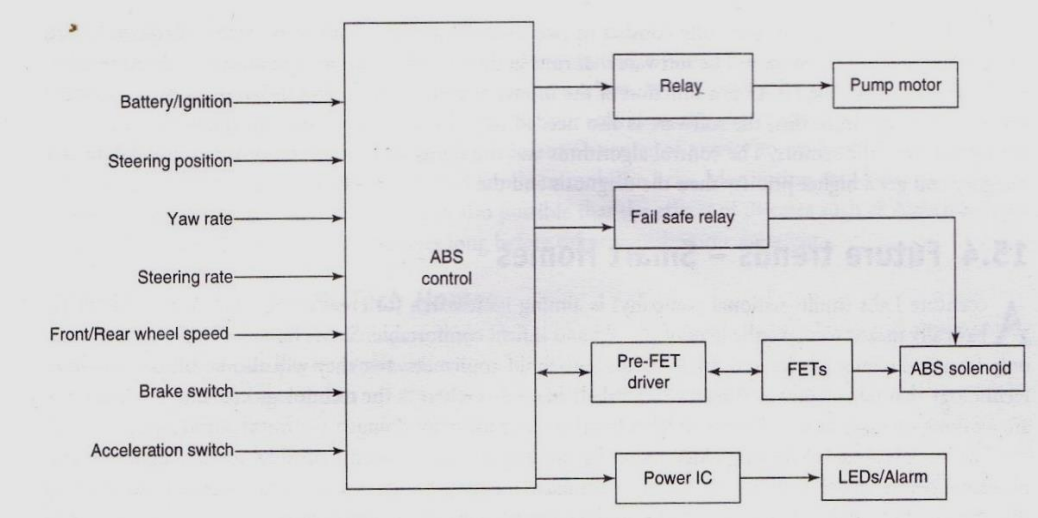
Graphical Displays: Various types of graphical displays are used for displaying measured variable, outputs, voltages etc. waveforms can be displayed for various analyses by CRT.

Controllers: It takes input from output signal conditioning and interface and it is not equal to the required set points then it is adjusted based on generated error and again signal is given to actuators and sensors.

Q 2		**Attempt any two :**	**16 Marks**
	a)	**Explain the working principle of Gear. State its classification. List applications of Gear.**	**8 Marks**
	Ans:	**Working Principle:** • Gears are mechanical elements which transmit motion by means of successively engaging teeth. • Gears are used to transmit motion from one shaft to another or between a shaft and a slide. • Rotary motion can be transferred from one shaft to another by a pair of plain cylinders or disk 1 and 2	**Diagram- 2M, working principle- 2 M, Types/classification- 2 M, any 4**

		 **Classification** • Spur gear • Helical gear • Spiral gear • Bevel gear • Worm gear • Rack and pinion **Applications** • Precision measuring instruments, machine tools, automobile gearboxes. • Automobile power transmission. • Suitable for transmission of small powers. • In automobiles • In machine tool like lathe, milling and drilling machines. • In machine tools like lathe, drilling and planar machines.	**applications- 2 M**
	b)	**Explain photoelectric sensors and proximity sensors w.r.t. their construction and applications.**	**8 Marks**
	Ans:	**Photoelectric sensor** 	**Photoelectric esnsor- diagram- 2M, explanation - 1M, 2 applications- 1M proximity sensors-**

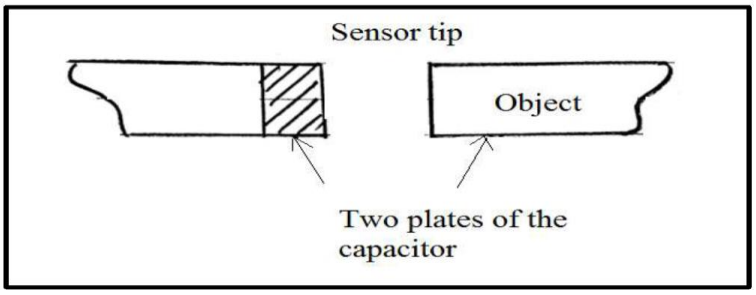
		• A reflective type sensor detects the object based on the reflection of light onto a detector from the target . • A transmissive type sensor is used to measure the change in light quantity caused by the targets crossing the optical axis. **Applications** 1. Detecting transparent /translucent objects at short ranges. 2. Detecting objects or substance levels through non- metallic container walls. 3. Detecting liquid or granular material level in an open container. 4. Sensing target shape details. **Proximity sensor(Capacitve proximity sensor OR Inductive proximity sensor)**  **Capacitive proximity sensor** • Capacitive proximity sensor is a device actuated by both conductive and non-conductive materials. The pair of plates of a capacitor is separated by some distance. • Depending upon the separation, the capacitance measured will be changed. Therefore, proximity of the object can be detected if one of the plates of the • Capacitor acts as a switch and the other as the metal object whose proximity is to be detected. $C = \varepsilon A/d$ • Where Ɛ is permittivity of dielectric material .A is area of plate d is distance between plates **OR** **Inductive proximity sensor** **Applications-** 1. Position Measurement 2. Detecting Dynamic Motion 3. Touchpads	**diagram- 2 M, explanation - 1M, 2 applications- 1M**
	c)	**With neat block diagram explain microcontroller based antilock brake system.**	**8 Marks**
	Ans:		**Block diagram- 4M, explanation- 4M**



Explanation:-

- Failure of the break system will almost invariably result in property damage, Personal injury or death.
- An ABS allows the driver to maintain steering control under heavy braking by preventing a skid and allowing the wheel to continue wheel to continue to roll forward and create lateral control, as directed by driver steering inputs.
- A typical ABS is composed of a central electronic unit, four speed sensors (one for each wheel) and two or more hydraulic valves on the brake circuit.
- The electronic unit constantly monitors the rotation speed of each wheel .The pulsed output from the wheel speed sensors goes to an electronic controller, which monitors each wheel's speed relative to the speed of the other wheels.
- As long as the brakes are not being applied and all of the monitored wheels are rotating at roughly the same speed, the system takes no action.
- If, however the brakes are being applied and one or more of the monitored wheels suddenly begins to reduce speed at a higher rate than the others indicating a loss of traction with the road and an imminent wheel lockup and skid the controller the activates the antilock system.
- When it senses that any one of wheels is rotating considerably slower than the others, it moves the valves to decrease the pressure on the braking circuit, effectively reducing the braking force on that wheel.

Q. 3	**A)**	**Attempt any four :**	**16 Marks**
	a)	**Draw the construction and explain working principle of capacitive sensor.**	**4 Marks**
	Ans:	**CONSTRUCTION:**	**2M diagram, 2 M explanation**



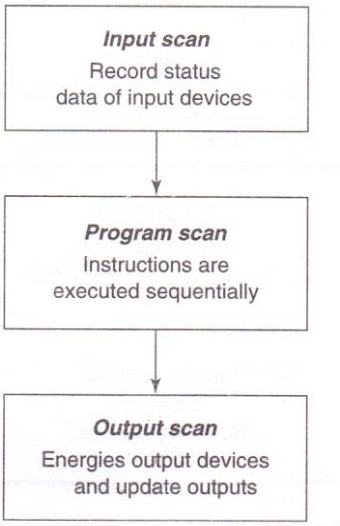
PRINCIPLE-

Capacitive proximity sensor is a device actuated by both conductive and non-conductive materials. The pair of plates of a capacitor is separated by some Distance. Depending upon the separation, the capacitance measured will be changed. Therefore, proximity of the object can be detected if one of the plates of the capacitor acts as a switch and the other as the metal object whose proximity is to be Detected.

$C = \varepsilon A/d$

Where Ɛ is permittivity of dielectric material .A is area of plate d is distance Between plates.

b)	**Describe PLC program scan sequence.**	**4 Marks**
Ans:	PLCs operate by continually scanning programs and repeat this process many times per second. When a PLC starts, it runs checks on the hardware and software for faults, also called a self-test. If there are no problems, then the PLC will start the scan cycle. The scan cycle consists of three steps: input scan, executing program(s), and output scan. • **Input Scan**: A simple way of looking at this is the PLC takes a snapshot of the inputs and solves the logic. The PLC looks at each input card to determine if it is ON or OFF and saves this information in a data table for use in the next step. This makes the process faster and avoids cases where an input changes from the start to the end of the program. • **Execute Program (or Logic Execution)**: The PLC executes a program one instruction at a time using only the memory copy of the inputs the ladder logic program. For example, the program has the first input as ON. Since the PLC knows which inputs are ON/OFF from the previous step, it will be able to decide whether the first output should be turned ON. • **Output Scan**: When the ladder scan completes, the outputs are updated using the temporary values in memory. The PLC updates the status of the outputs based on which inputs were ON during the first step and the results of executing a program during the second step. The PLC now restarts the process by starting a self-check for faults	**4M for description Diagram optional**

			
	c)	**List types of belt and state one application of each.**	**4 Marks**
	Ans:	1. **Flat belt:** It is mostly used in factories and workshops, where a moderate amount of power is to be transmitted from one pulley to another.egFlour Machine 2. **V belt:** These are more suitable for short distances. **Application: (any one)** • V belts are used in factories and workshops where large amount of power is to transmitted from one pully to another • Machine tools • Industrial washing machines • Textile machines • Continous paper machines • High power mills • Stone crushers 3. **Circular belt or rope:** Rope drives are, usually preferred when distances between the centers of shafts are long.eg.Sewing Machine 4. **Timing or Synchronous belt:** It is extensively used in low power applications.eg.Bicycle	**Any four each 1M**
	d)	**Draw the block diagram of robot and explain it.**	**4 Marks**
	Ans:		**2M for diagram and 2M for Explaination**

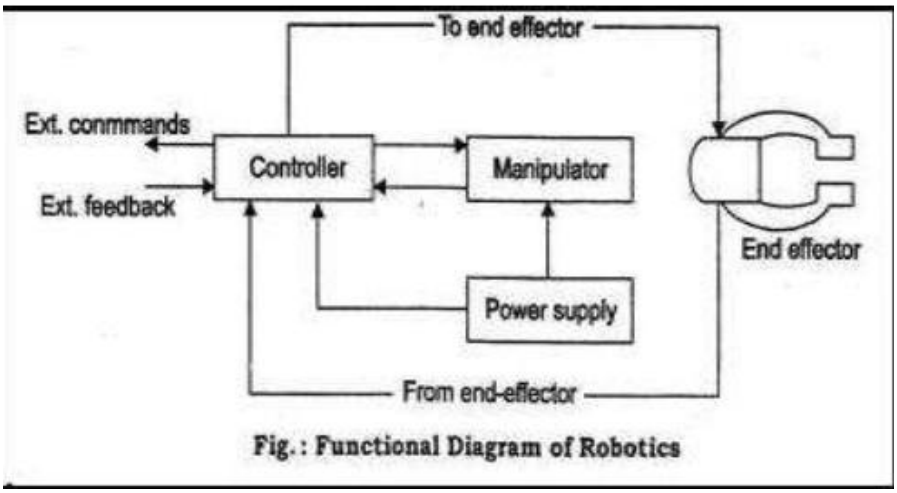
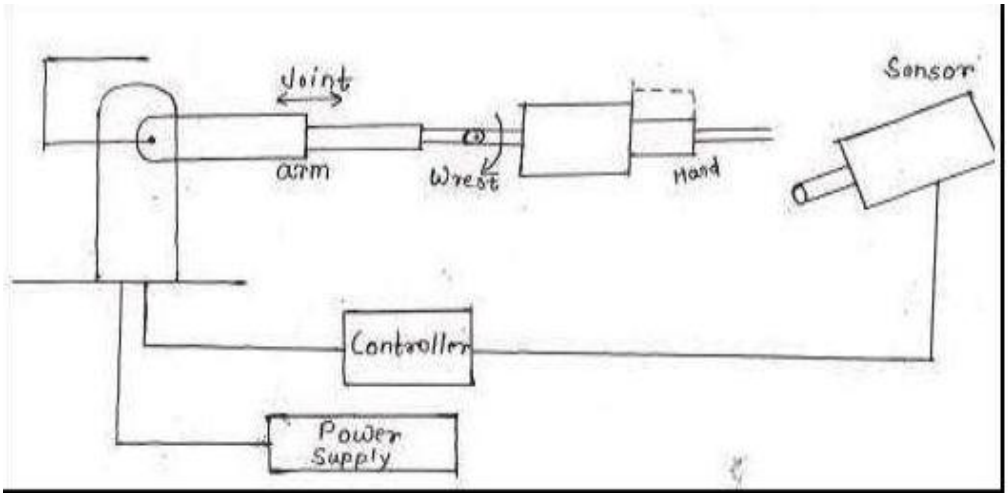


Fig. : Functional Diagram of Robotics

OR



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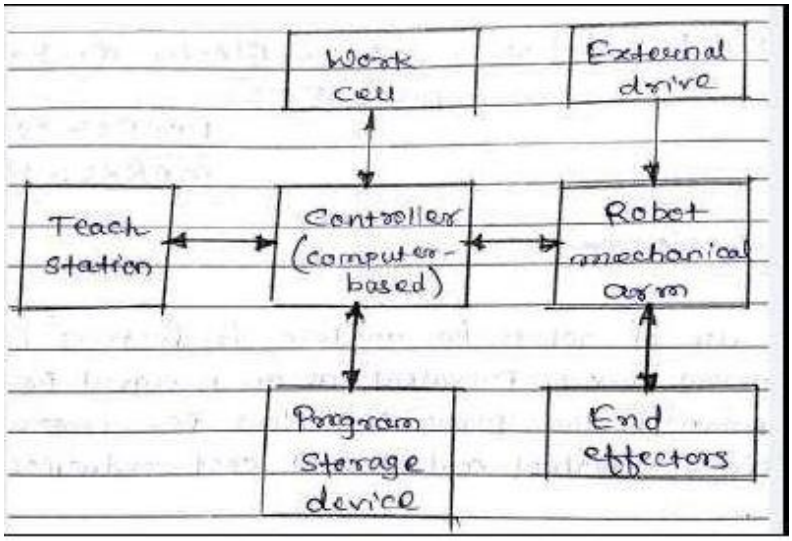
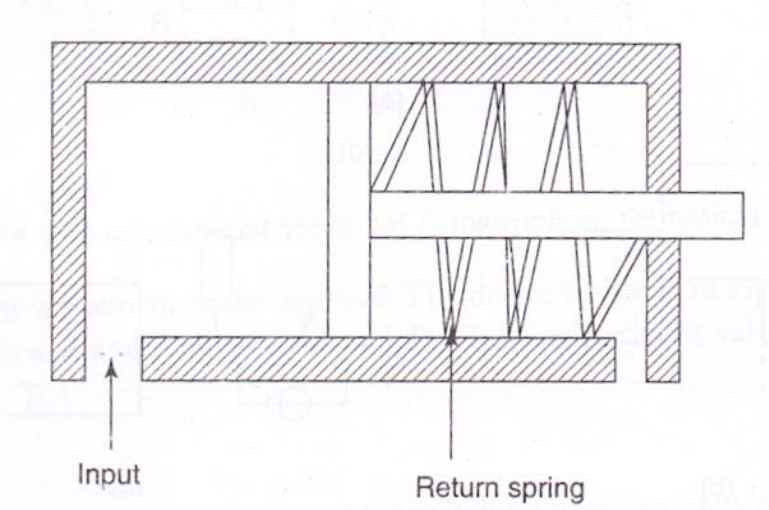


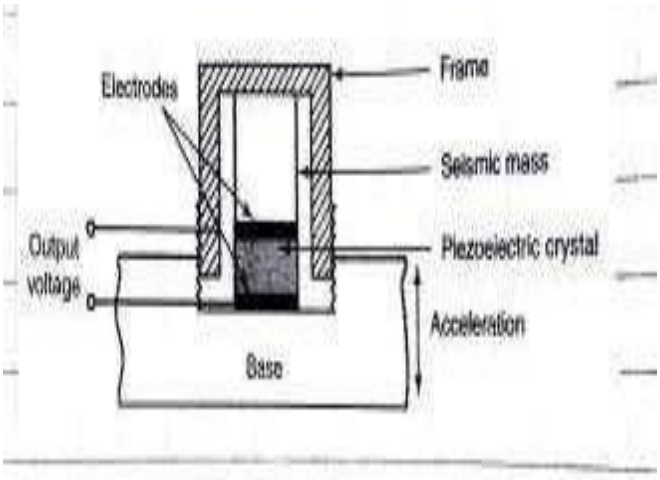
		An Industrial robot has basic parts like arm, sensor, actuators, controllers etc. There subsystem communicates among them via, interface, whose function consists basically of decoding the transmitted information from one medium to another. Fig. above shows block diagram of typical robotics mechanical system. The input is a prescribed task, which defined earlier The output of robotic mechanical system is the actual task, which is monitored by sensors. These sensors sense and transmit the information in the form of feedback signals. This is compared with the predefined task given to the controller. **[Any relevant explanation marks can be given.]**	
	e)	**Compare pneumatic and hydraulic system (any four points).**	**4 Marks**
	Ans:		**Any 4 each 1M**

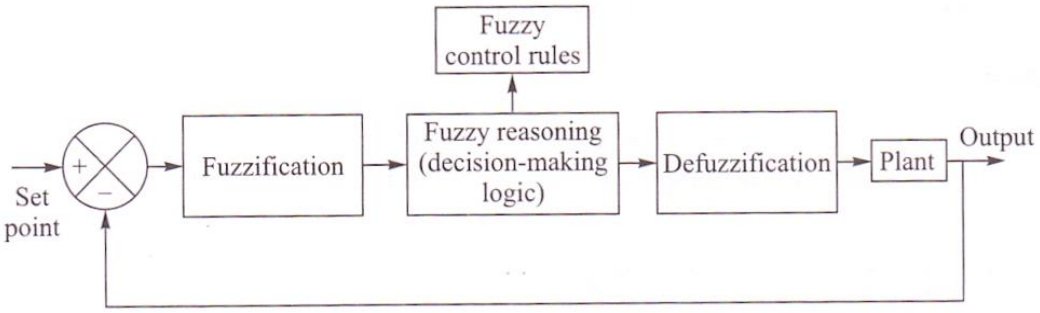
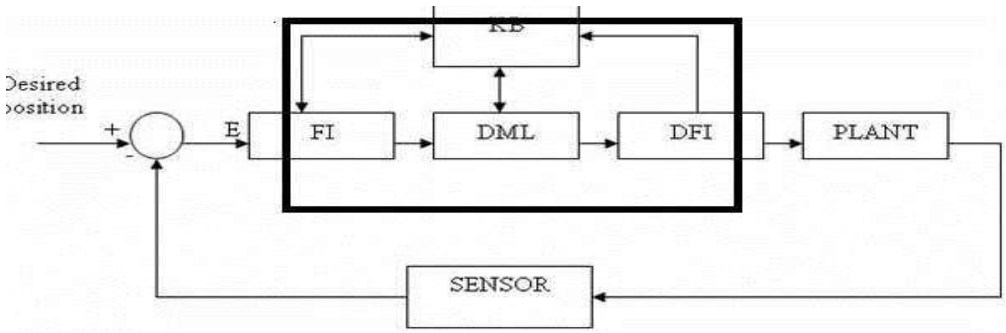
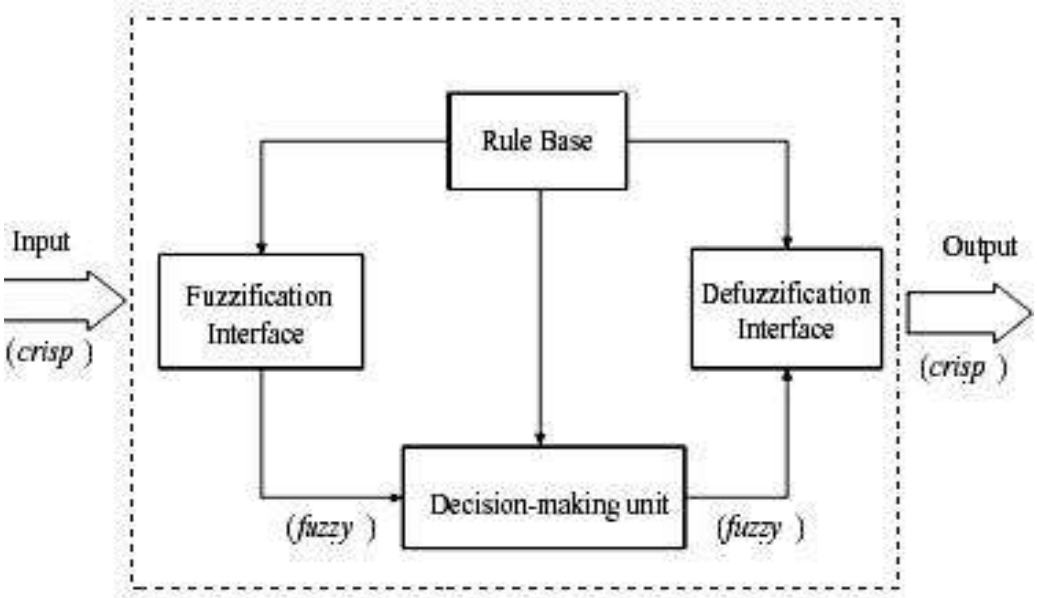
Sr. No.	Pneumatic System	Hydraulic System
1.	Pneumatic system uses gas for power transmission, after compression and it is used as medium for carrying out mechanical work.	In hydraulic systems, a liquid-based solution such as oil is used under pressure to carry out work.
2.	The components of these systems are compressor, air receiver, directional control valve, and pneumatic cylinder.	The components of these systems are pump, pressure regulation/relief valve, control valve, filter and hydraulic cylinder.
3.	The excess air is vent out to atmosphere.	The excess fluid is return back to the tank.
4.	Motor driven compressor is used to pull air from atmosphere.	Pump and motor combination is used to pull liquid from tank or reservoir.
5.	External lubricator is required during mechanical motion of cylinder.	External lubricator is not require as oil acts as a lubricator.
6.	The system is more costly	The system is less costly.
7.	Applications: In industrial applications, air conditioners	Applications: In petrochemical industries, oil refineries.

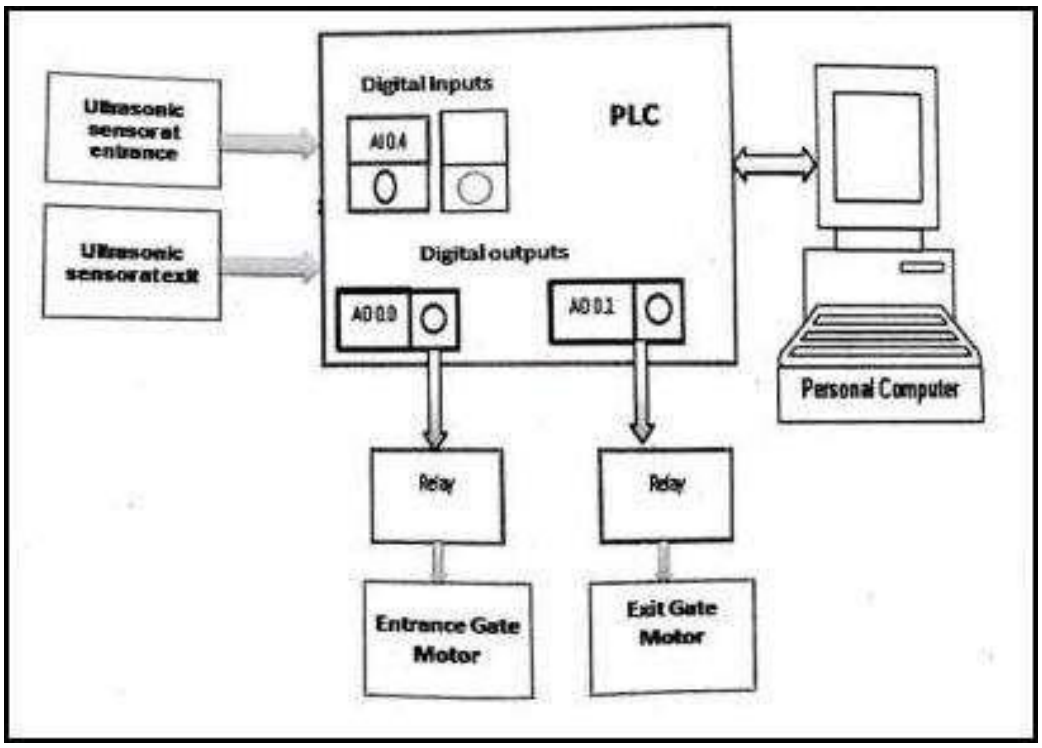
	f)	**State the types of actuators. Draw and explain single acting cylinder.**	**4 Marks**
	Ans:	Types of actuator 1) Electromechanical actuators 2) fluid power actuators (a) hydraulic (b) pneumatic 3) Electrical actuators 4) Mechanical actuators 5) Active material based actuators	**any 4 types-2M, diagram-1M, explanation-1M**

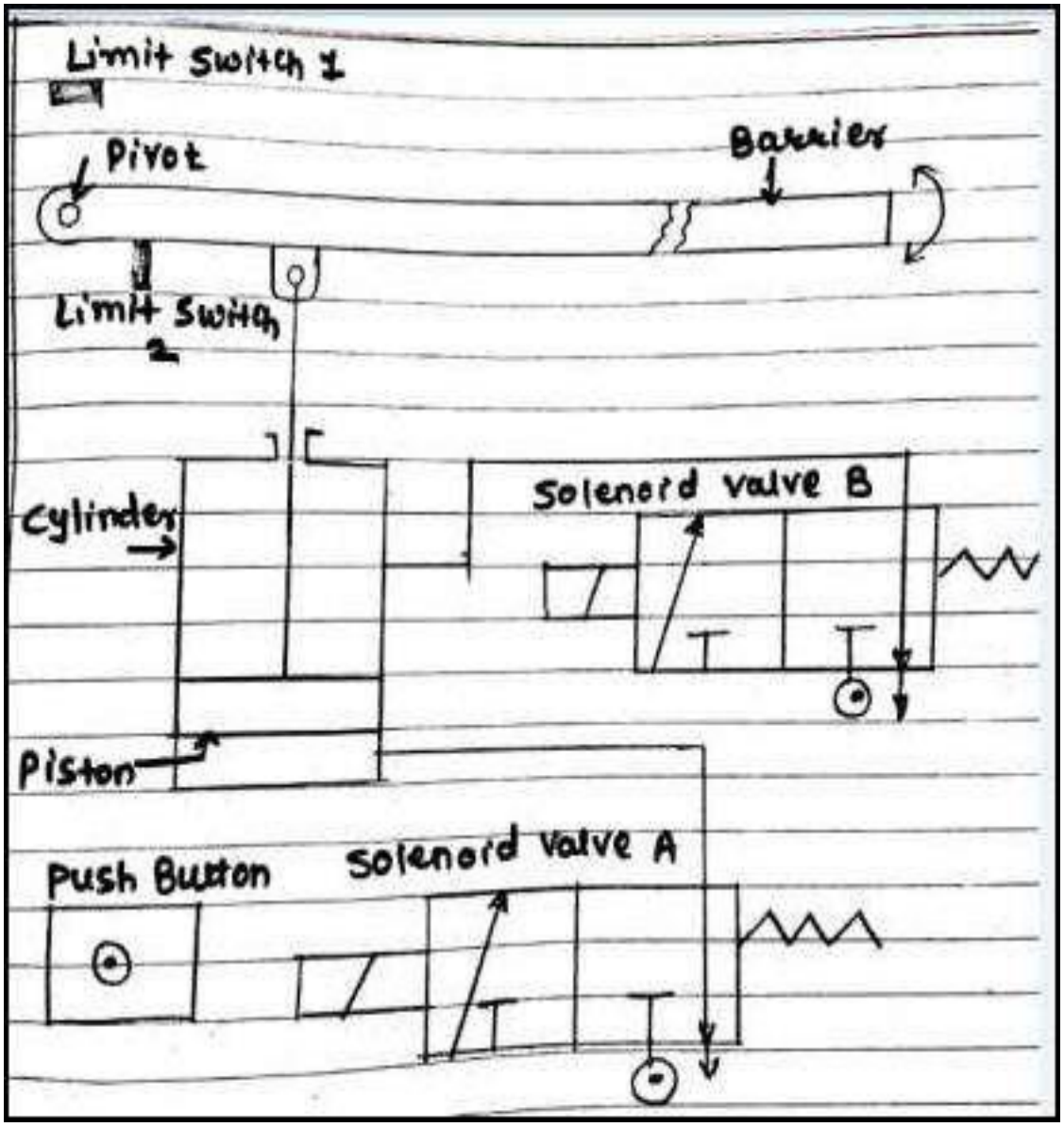


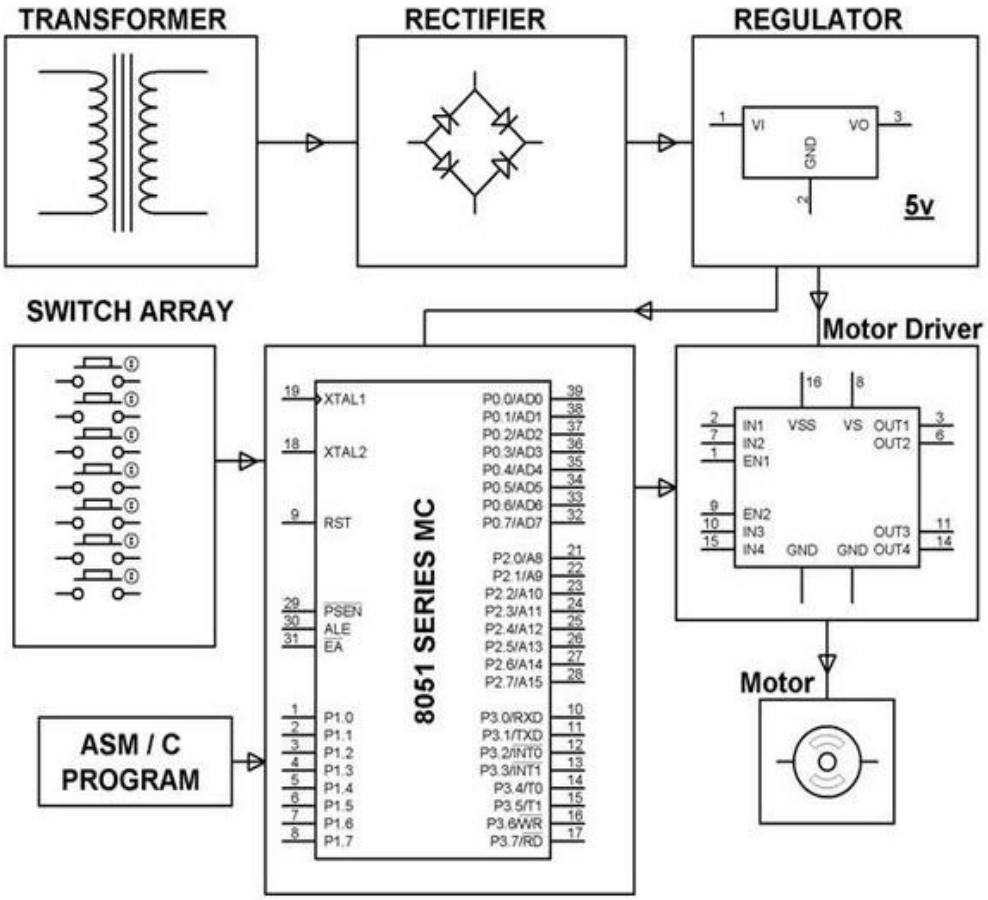
These cylinders produce work in one direction of motion hence they are named as single acting cylinders. The compressed fluid pushes the piston located in the cylindrical barrel causing the desired motion. The return stroke takes place by the action of a spring .generally the spring is provided on the rod side of the cylinder.

Q. 4		**Attempt any four:**	**16 Marks**
	a)	**Describe construction and working of piezoelectric accelerometer.**	**4 Marks**
	Ans:	 The sensor consists of a piezoelectric crystal sandwiched between two electrodes and has a mass placed on it. The unit is fastened to the base whose acceleration Characteristics are to be determined.. The mass exerts a force on the crystal and a Certain output voltage is generated. When the base is now accelerated downward, The internal reaction force on the base acts upward against the top of the frame. This relieves stress on the crystal and from newton's second law, since the mass is a fixed quantity, the decreased in force is proportional to the acceleration. The resulting change in the output voltage is recorded and correlated to the acceleration imposed on the base	**2 M for diagram , 2 M for explanation**

	b)	**Draw the block diagram of fuzzy logic controller and explain the function of each block.**	**4 Marks**
	Ans:	 **OR**  **OR**  **1. Fuzzification:** It is the action of transforming a given state as crisp input into fuzzy values by evaluating membership function for purpose to be used by a fuzzy interference mechanism. Membership function forms a crucial part in fuzzy rule base model because actually they only define Fuzzification of control variable in other word	**2M for Diagram 2M for Explaination**

		Fuzzification is the process of making a crisp quantity fuzzy. In the real world, hardware such as a digital voltmeter generates crisp data, but these data are subject to experimental error. Fuzzification based on rule base or by decision making with knowledge base Membership function is bell shaped or triangular or trapezoidal shape. **2. Fuzzy Interference:** Once membership function is found for each of variable an intelligent decision Can be made to what output should be. This decision process is called interference this can be done knowledge base decision as well as rule base. This output then connected to Defuzzification block **3. Defuzzification**: Converts the fuzzy output of the inference engine to crisp using membership Functions analogous to the ones used by the fuzzifier. A Defuzzification strategy is aimed at producing a non- fuzzy control action that best represent the possibility of an inferred fuzzy control action	
	c)	**Draw schematic of PLC based automatic car park barrier system.**	**4 Marks**
	Ans:	Automatic car parking system allow to park maximum numbers of car in parking zone According to size of parking zone. In parking zone number of vehicle parked in parking zone is less than available parking space then automated parking system allow entering next car in parking zone. In parking zone number of vehicle parked in parking zone is equal to available parking space then automated parking system does not allow enter next car in parking zone.  **OR**	**2M for diagram 2M for explanation**

			
	d)	**Draw and explain DC motor speed control using microcontroller.**	**4 Marks**
	Ans:		**2M for diagram 2M for explanation**



[note :For any other logical diagram marks can be given]

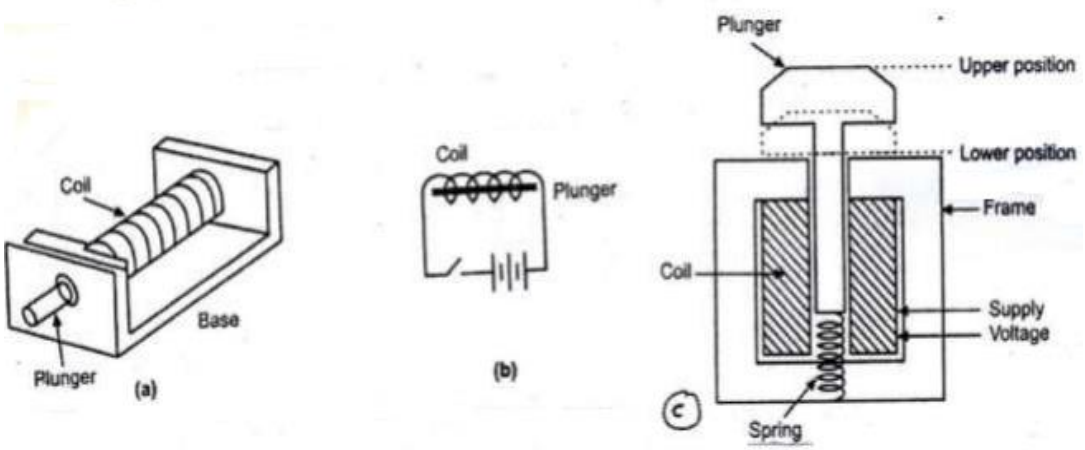
Explanation:

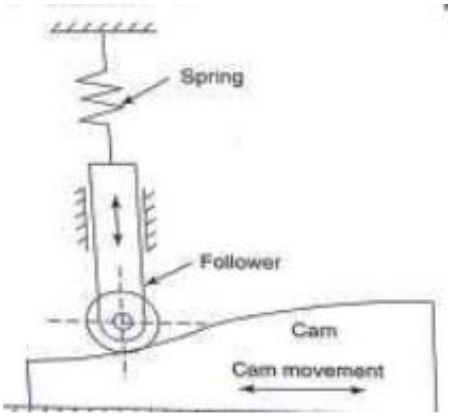
The main purpose of DC interfacing with 8051 microcontroller is for controlling the speed of the motor. The DC motor is an electrical machine with a rotating part termed as a rotor which has to be controlled. For example, consider the DC motor whose speed or direction of rotation of DC motor can be controlled using programming techniques which can be achieved by interfacing with 8051 microcontroller. Here, interfacing 8051 with DC motor requires a motor driver. There are various types of driver ICs among which L293D is typically used for interfacing DC motor with 8051.

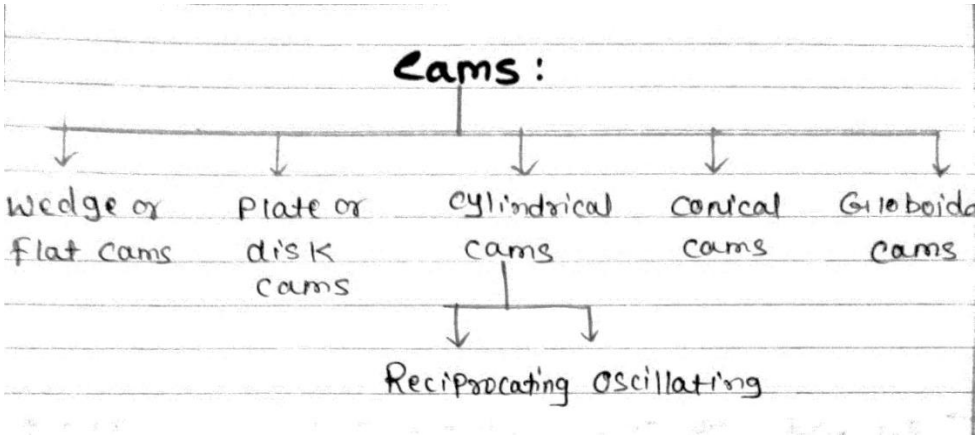
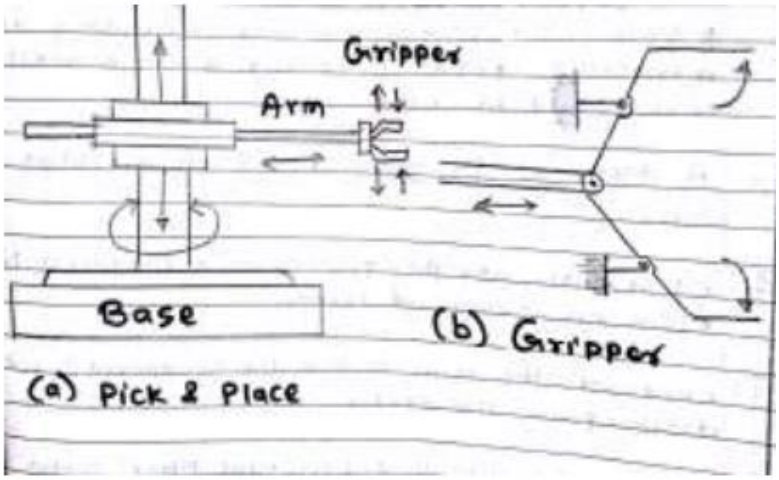
The four quadrant DC motor speed control operation can be achieved by interfacing DC motor with 8051 microcontroller. The speed of the motor as well as the operation of motor in four quadrants such as forward brake, reverse brake, clockwise, anti-clockwise rotation can be controlled using 8051 microcontroller.

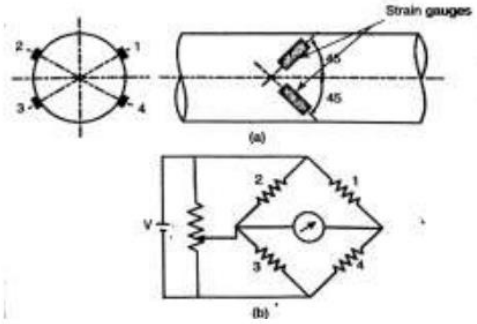
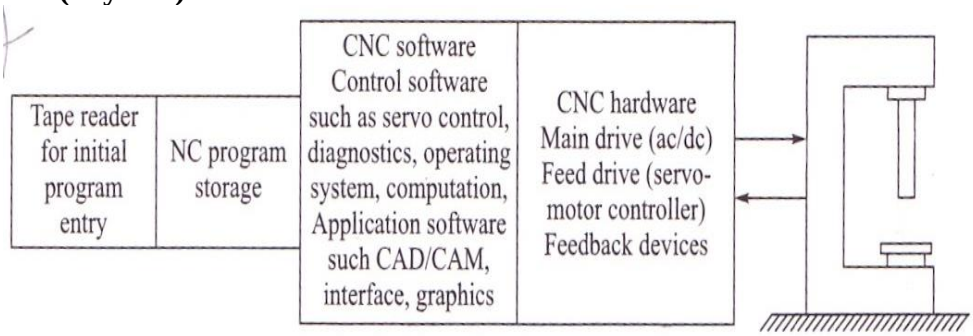
[Note: Explanation should be relevant to diagram]

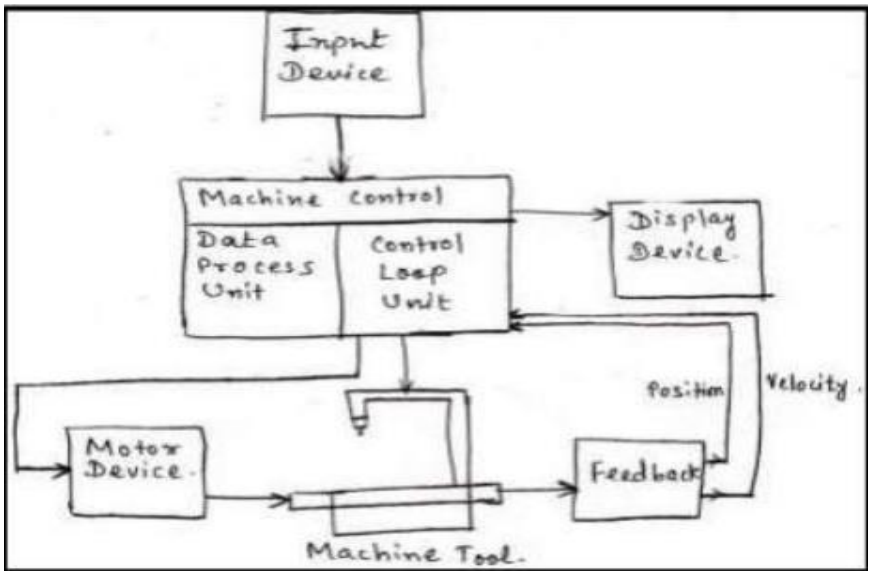
e)	**Define degree of freedom. State the significance of degree of freedom in robot.**	**4 Marks**
Ans:	**DOF: -**Degree of freedom is a term used to describe a robot's freedom of motion in 3 Dimensional spaces specifically the ability to move forward and backward, up and down, left and right. For each DOF a joint is required. **Significance Of Degree Of Freedom In Robot** :	**2M for definition 2M significance**

		Degrees of freedom defined modes in which a mechanical device or system can move. The number of degrees of freedom is equal to the total number of independent displacements or aspects of motion. A machine may operate in two or three dimensions but have more than three degrees of freedom. The term is widely used to define the motion capabilities of robots. Consider a robot arm built to work like a human arm. Shoulder motion can take place as pitch (up and down) or yaw (left and right). Elbow motion can occur only as pitch. Wrist motion can occur as pitch or yaw. Rotation (roll) may also be possible for wrist and shoulder. Such a robot arm has five to seven degrees of freedom. If a complex robot has two arms, the total number of degrees of freedom is doubled. In an android, additional degrees of freedom exist in the end effectors, the legs and the head. Fully functional androids and multi-legged mobile robots can have more than 20 degrees of freedom. An example is Project No, an intelligent android designed for the consumer market. No, which looks Superficially like a large space-age doll, has 25 degrees of freedom.	
	f)	**Define sensors, signal conditioners, controllers and actuators in mechatronics system.**	**4 Marks**
	Ans:	**Sensor**: - A sensor is an element in a measurements system that acquires a physical parameter and changes it into electrical signal. E.g. Bellows, Thermocouple **Signal Conditioners**:- The signal conditioner performs isolation, impedance matching, noise reduction, amplification, conversion of sensor output signal. **Actuators:**- Actuators are the process of conversion of energy to mechanical form. **Controllers**:- Controllers are the brains of control system operation and decide the kind of action taken in response to an error.	**1M Each**
Q.5		**Attempt any two:**	**16 Marks**
	a)	**Explain solenoid valve with neat diagram. State its principle of operation. Advantages , disadvantages and applications.**	**8 Marks**
	Ans:	**Diagram:**  **Principle of Operation:** • A solenoid is used for translating ON/OFF electrical signals to ON/OFF mechanical movements and normally used as a linear actuator. • As shown in fig (b) above, when the coil is energized, the core is pulled inside	**Diagram 3M, Operation 2M, Advantages 1M, Disadvantages 1M, Applications 1M**

		the coil, and the amount of force by which the core is pulled mainly depends upon the number of coils and the amount of current flowing in the circuits. • The cut way section is shown in fig (c) above, the operation of the solenoid actuator. • The spring return plunger is held in the upper position when the coil is electrically de-energized. • When the voltage is applied to the solenoid frame magnetic field is produced in the solenoid frame. **Advantages (any one):** • Fast operation and high reliability • Long service life, compact design • Solenoid may partially open with higher voltage short pulse **Disadvantages (any one):** • Control muse stay on during operation • Performance degrades when a solenoid gets hot (steam) • Fast solenoid valves draw larger hold current **Applications (any one):** • Control of room heating • Control of gas flow • Irrigation sprinkler system	
b)	**State the working principle of cam. List its types. Give any four applications.**		**8 Marks**
Ans:	**Working principle of cam:** • A cam is mechanical rotating machine element which is used for converting one motion into another. • A cam is a curved or grooved surface which mates with a follower and imparts motion to it. • In general the cam may be rotating or oscillating whereas the follower may be rotating, reciprocating or oscillating. • A wedge cam converts a translational motion of the wedge into the reciprocating motion of the follower. **Diagram (optional):**  		**Working 4M, Types 2M, Application ½ M each ,**

		Types of cam:  **Applications (any four):** • Automatic machines • IC engines • Machine tools • Printing control mechanisms • Spinning and weaving machineries • Textile machineries • Paper cutting machines	
c)		**Explain PLC based pick and place robot. List required movements for it.**	**8 Marks**
Ans:		**Diagram:**  **Explanation:** • Figure above shows the basic form of a pick and place robot unit. The robot has three axes about which motion can occur. • These movements can be actuated by the use of pneumatic cylinders operated by solenoid controller valves with limit switches to indicate when a motion is completed. • Thus clock wise rotation of the unit might result from the piston in a cylinder being extended and the anticlockwise direction by its retraction. • Likewise the upward movement of the arm might result from the piston in a linear cylinder being extended and downward motion from it retracting.	**Diagram 3M, Explanation 3M, Required movements 2 M**

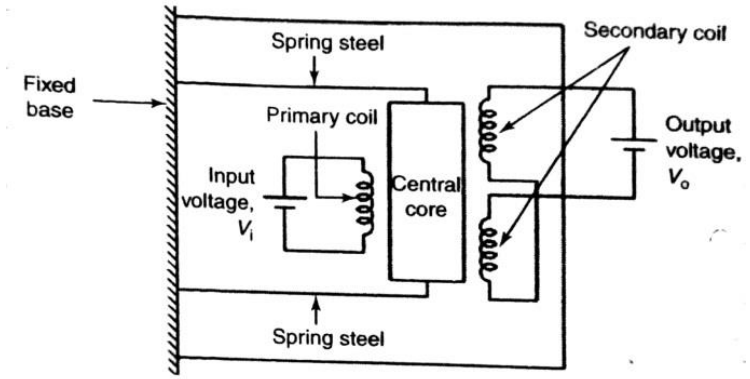
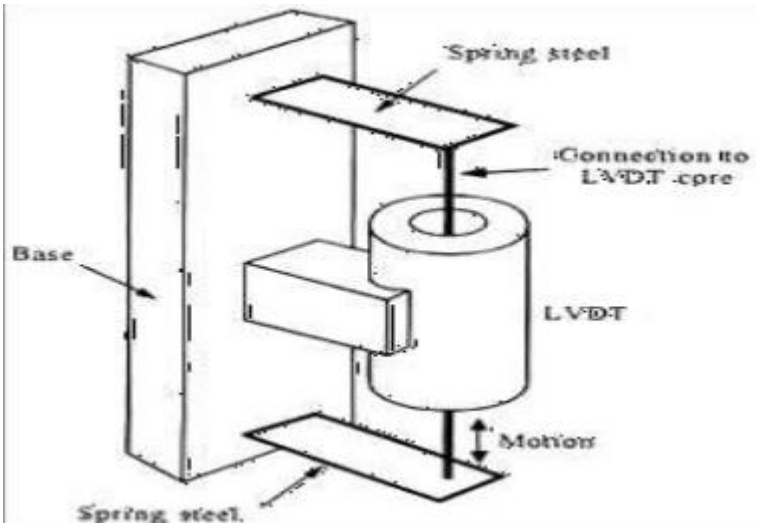
		• The extension of the arm by the piston in another cylinder extending and its return movement by the piston retracting. • The gripper can be opened or closed by the piston in a linear cylinder extending or retracting as shown in fig. (b) **Required movements:** • Rotation in clockwise or anti-clock wise direction of the unit on its base • Arm extension or contraction and arm up or down • Gripper can open of close	
Q.6		**Attempt any four:**	**16 Marks**
	a)	**Explain torque measurement using strain gauge.**	**4 Marks**
	Ans:	**Diagram:**  **Explanation:** • Torque transducers based on strain measurement are normally made by applying strain gauges to a shaft to measure the shear strain caused by torsion. • The shear strain causes strains to appear at 45^o to the longitudinal axis of the shaft. Therefore, the strain gauges must be placed precisely at 45^o to the shaft axis as shown in figure above. • The output is increased by using four gauges so that the adjacent arms have strain of opposite nature. Also this arrangement provides complete thermal compensation. • For taking signals in and out the rotating shaft, slip rings and brushes are used.	**Diagram 2 M, Explanation 2 M**
	b)	**State general configurations of CNC system. List advantages of CNC.**	**4 Marks**
	Ans:	**Diagram (any one):**  **OR**	**Diagram 3 M, Advantages ½ M each**

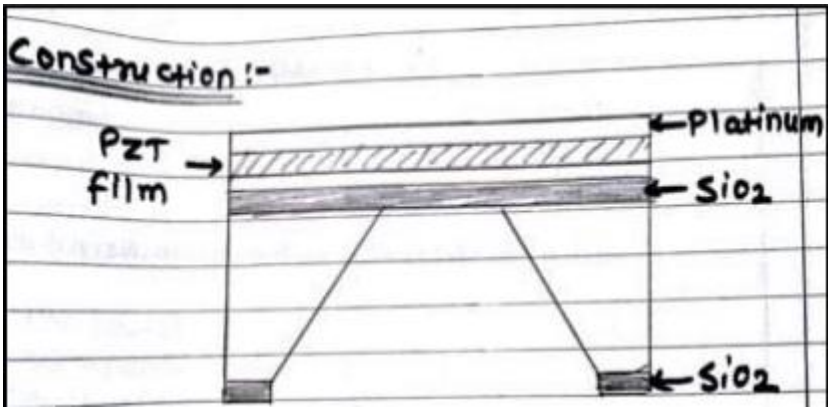


Advantages (any two)

- An increase in flexibility
- An improvement in the possibilities for correcting errors in part programming
- The possibility of using the computers peripheral equipment
- Tape reads are used only once for resulting improved reliability
- CNC is more compatible
- CNC system can accommodate the conversion of tapes prepared in units of

c)	**State and explain the advantages of microcontroller in digital logic control of mechatronic systems.**	**4 Marks**
Ans:	**Advantages of microcontroller in digital logic control (any four)** • **Inexpensive:** Since microcontrollers are fully integrated onto one chip, they are cheap to manufacture. Microcontrollers typically have much lower space than even a low-power consumer grade general CPU and generally standardized architecture, making them even more easy to mass produce • **Labor saving:** Many tasks performed by microcontrollers are far too minute and repetitive for human attention, such as the assembly of small electronics. • **Power saving options:** Microcontrollers have power saving options which will enable longer battery life of devices. • **Programming flexibility:** Microcontrollers can be programmed to perform various task • **Low supply voltage:** Microcontrollers required low supply voltage for operation typically up to 12 V. • **Compact:** Microcontrollers are available in the form of integrated circuits. **[Note: Any other suitable advantage and its explanation should be awarded marks]**	**1 Mark each**
d)	**Explain principle of operation of LVDT accelerometer and state its one application.**	**4 Marks**

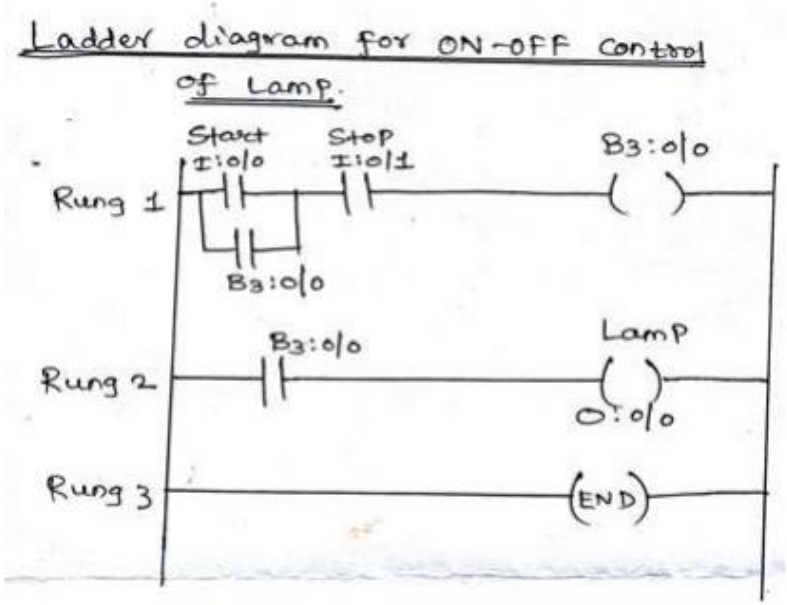
	Ans:	**Diagram:**  **OR**  **Explanation:** • The LVDT accelerometer consists of one primary and two secondary windings which are placed on either side of central code. The two ends of the core are connected with spring steel but these are already placed in a casing. • If a core is exactly placed at the center, the voltage produced between primary and secondary windings will be exactly equal; this voltage is called as static field voltage. • If any vibration occurs on the casings of the LVDT accelerometer, the core will either move upward or downward. • Owing to this, the voltage is induced in the secondary coil according to the movement of the core. Now the difference in voltage arises in the output terminal. This output voltage is directly proportional to the vibration or acceleration. **Applications (any one):** • It is used in steady state acceleration. • It is used in low frequency measurements.	**Diagram 1.5 M, Explanation 1.5 M, Applications 1M**
	e)	**How MEMS accelerometer is used as air bag sensors for car safety ?**	**4 Marks**
	Ans:	**Diagram:**	**Diagram 2 M,**



Explanation:

- Mechanical ignition airbags fit inside the steering wheel pad. When a collision occurs, the inertial sensor moves, setting off a mechanical igniter and inflator to deploy the airbag. As the sensor and igniter were in the same unit, the compact airbag unit easily fit most steering wheels, allowing broad application of the airbag unit.
- With electrical ignition airbags, a computer monitors signals from the impact sensor. When it detects a collision, the computer sets off the airbag's igniter electrically. Therefore, the sensor need not be close to the airbag, but can be placed anywhere on the vehicle and connected to the airbag with wiring. This is especially effective when fitting both driver- and passenger-side airbags.

Explanation 2 M

f)	**Draw ladder diagram of ON-OFF control of lamp.**	**4 Marks**
Ans:	**Diagram (any correct ladder logic)**  **Explanation:** Figure above shows simple ladder diagram for ON- OFF control of lamp. • I: 0/0 is start button, as soon as it is pressed the contact gets closed and output binary	**Diagram 3 M, Explanation 1 M**

		bits B3: 0/0 goes high (logic 1). • As soon as B3: 0/0 is high, lamp O: 0/0 turns ON as shown in rung 2. • When I:0/1 stop button is pressed, contact gets open and B3:0/0 goes low(Logic 0). • When B3:0/0 goes logic 0, lamp named O:0/0 turns off.	