



MODEL ANSWER
SUMMER– 17 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 anyequivalent 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 three:	12-Total Marks
	a)	State the importance of mechatronics in various field of engineering.	4M
	Ans:	<p><u>Mechanical System:</u> These system deal with behavior of matter under the action of forces. Mechanical system like hydraulic, pneumatic, rotational or translational, thermal, Fluid etc. are used in mechatronic applications. These systems are interfaced with computer through sensors, actuators and electronic systems.</p> <p><u>Electrical systems:</u> Electrical components mostly used are electrical motors (ac and dc) generators, relays, circuit breakers, switches and so forth.</p> <p><u>Electronic systems:</u> Analog electronics involves action and passive components such as resister, capacitor, inductor, diodes and transistors digital circuits contain logic, gates, counters, Flip-flops, memories, microcontroller and process. Instrumentation & control system: It includes transducer, signal conditioning, output device such as analog meters, display devices recorders and printers.</p> <p><u>Information system:</u> 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.</p> <p><u>Computer system:</u> It is combinational of hardware and software. In mechatronic applications hardware is computer-specific circuit like flip-flops, counters registers, memories software is nothing</p>	4M (Any Four Points)

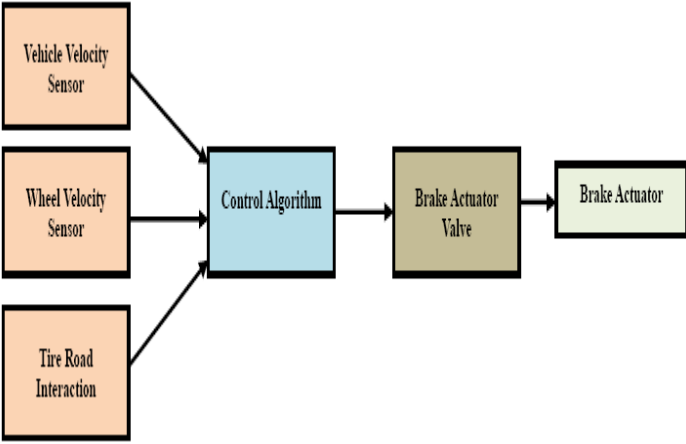


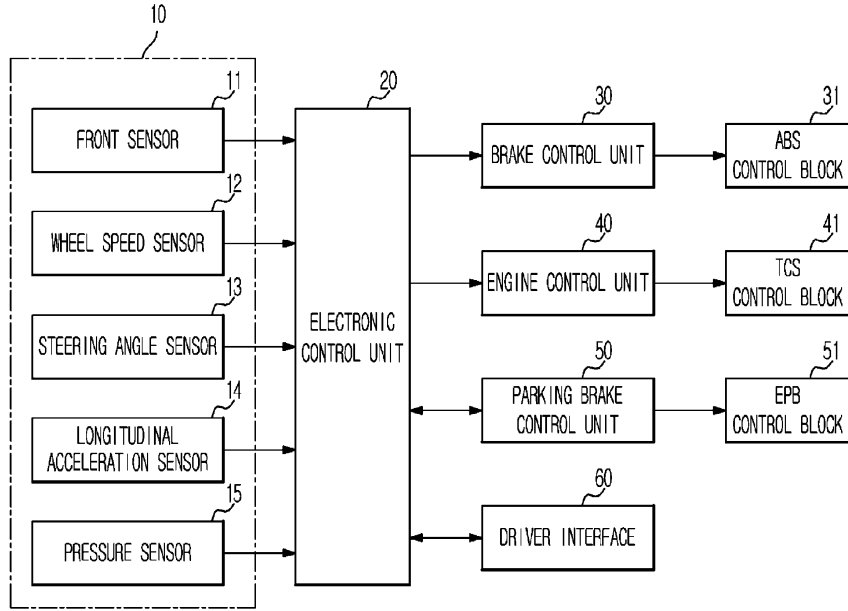
	but system & application	
b)	Explain in brief mechatronics. List its applications.	4M
Ans:	<p><u>Mechatronics:</u> Mechatronics is the synergistic integration of mechanical engineering with electronics and intelligent computer control in designing, manufacturing processes and production. It helps to develop atomized, reliable and efficient manufacturing/production systems to produce high quality products. A typical mechatronics system consist of mechanical system, electrical system and computer /information technology</p> <p><u>Basic element of Mechatronics system are:</u> Actuator, solenoids ,motors, switch, sensor, transducer, gear, drive and so on Electrical system/Electronics : Capacitor, semiconductor device, Amplifier, Filter, Digital and analog devices, accerometer Information Technology: Certain Software, System Engineering, Part programming, Artificial Intelligent , CAD,CAM</p> <p><u>APPLICATION:</u></p> <p>In automatic washing machine and dishwashers.</p> <ul style="list-style-type: none">● In CD players, VCRs, camcorders.● In document scanners.● In IC manufacturing system.● In robotics used in welding, nuclear inspection and robot manipulators.● In fax and photocopier machines.● In laser printers.● In flexible manufacturing system.● In air conditioners, elevator controls.● In automotive mechatronics (in automobiles for outdoor locking, collision avoidance and ignition● and antiroll system	2M 2M
c)	What is optical encoder? List its types.	4M
Ans:	<p><u>Optical Encoder :</u> An optical encoder is an electromechanical device which has an electrical output in digital form proportional to the angular position of the input shaft. Optical encoders enable an angular displacement to be converted directly into a digital form. It has a shaft mechanically coupled to an input driver which rotates a disc rigidly fixed to it. A succession of opaque and clear segments are marked on the surface of the disc. Light from infrared emitting diodes reaches the infrared receivers through the transparent slits of the rotating disc. An analogue signal is created. Then electronically, the signal is amplified and converted into digital form. This signal is then transmitted to the data processor.</p> <p><u>Types :</u></p> <ol style="list-style-type: none">1) Incremental optical encoder2) Absolute optical encoder:<ol style="list-style-type: none">a)Single turn absolute optical encoder	3M 1M



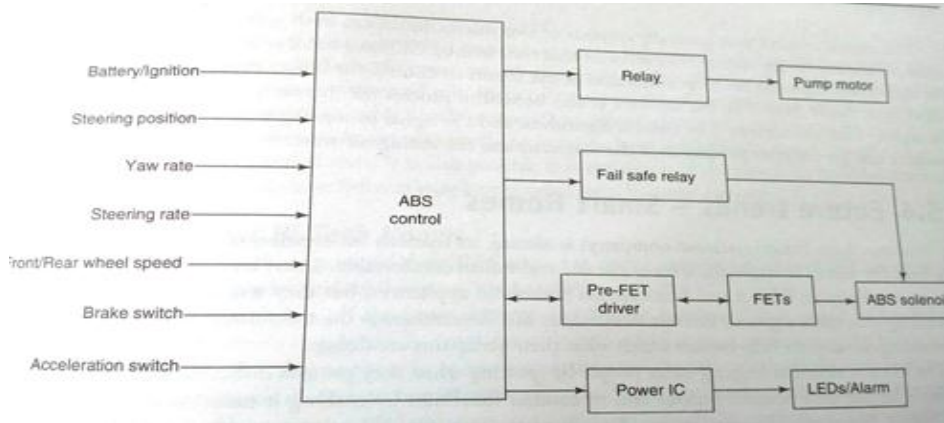
	b)Multiturn absolute encoder																						
d)	Distinguish between transducer and sensor.	4M																					
Ans:	<table border="1"><thead><tr><th>Serial No</th><th>Transducer</th><th>Sensor</th></tr></thead><tbody><tr><td>1</td><td>It is device which convert any physical quantity other physical quantity which is useful for electrical purpose</td><td>It is device which sense any physical quantity and convert it into electrical variable with may signal conditioner</td></tr><tr><td>2</td><td>This is basic ,elementary Device</td><td>It is Sophisticated Device</td></tr><tr><td>3</td><td>All transducer are not sensor</td><td>All sensor are transducer</td></tr><tr><td>4</td><td>May not accurate</td><td>More accurate</td></tr><tr><td>5</td><td>Transducer may be primary or secondary, more classified</td><td>Sensor are physical to electrical</td></tr><tr><td>6</td><td>Example : proximity sensor, (photonic, magnetic metallic), photo diode, LDR, thermistor , etc.</td><td>All sensor, LVDT, bellow, Bourdon tube, Speaker, etc.</td></tr></tbody></table>	Serial No	Transducer	Sensor	1	It is device which convert any physical quantity other physical quantity which is useful for electrical purpose	It is device which sense any physical quantity and convert it into electrical variable with may signal conditioner	2	This is basic ,elementary Device	It is Sophisticated Device	3	All transducer are not sensor	All sensor are transducer	4	May not accurate	More accurate	5	Transducer may be primary or secondary, more classified	Sensor are physical to electrical	6	Example : proximity sensor, (photonic, magnetic metallic), photo diode, LDR, thermistor , etc.	All sensor, LVDT, bellow, Bourdon tube, Speaker, etc.	4M Any Four Points
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B)	Attempt any One :	6M																					
a)	List advantages and disadvantages of CNC based drilling machine.	6M																					
Ans:	Advantages : <ul style="list-style-type: none">• Reduce the making/production cost• Increases the productivity• CNC improves the production• Low skill operator is required• High accuracy and repeatability• Complex machining operations are also performed easily• Indirect operating cost is reduced	3M (Any 3 point for each)																					
	Disadvantage : <ul style="list-style-type: none">• The initial cost is very high.• The repair and maintenance is complex.• Require part programming• Movement of machine is restricted• Its replacement is difficult, that it is difficult to change old system to new system.	3M (Any 3 point for each)																					



b)	Draw block diagram of practical ABS system. State its advantages.	6M
Ans:	<p><u>Advantages:</u> Anti-lock braking system (ABS) guarantees stable braking characteristics on all road surfaces, hence avoids overturning of the vehicle.</p> <ul style="list-style-type: none">• ABS reduces friction on wheels and road, thus increases the efficiency of tires (up to 30%).• The Vehicle with ABS can be stopped at a lesser distance than a non ABS vehicle.• Steering control is effective, i.e., the vehicle can be steered smoothly while braking. Thus minimizes the accidents.• A driver without experience can drive ABS vehicle effectively, then an experienced driver on the non ABS vehicle. <p><u>Diagram :</u></p>  <pre>graph LR; VVS[Vehicle Velocity Sensor] --> CA[Control Algorithm]; WVS[Wheel Velocity Sensor] --> CA; TRI[Tire Road Interaction] --> CA; CA --> BAV[Brake Actuator Valve]; BAV --> BA[Brake Actuator];</pre> <p style="text-align: center;"><u>OR</u></p>	<p>(Any 4, 2M)</p> <p style="text-align: center;">4M</p>



OR

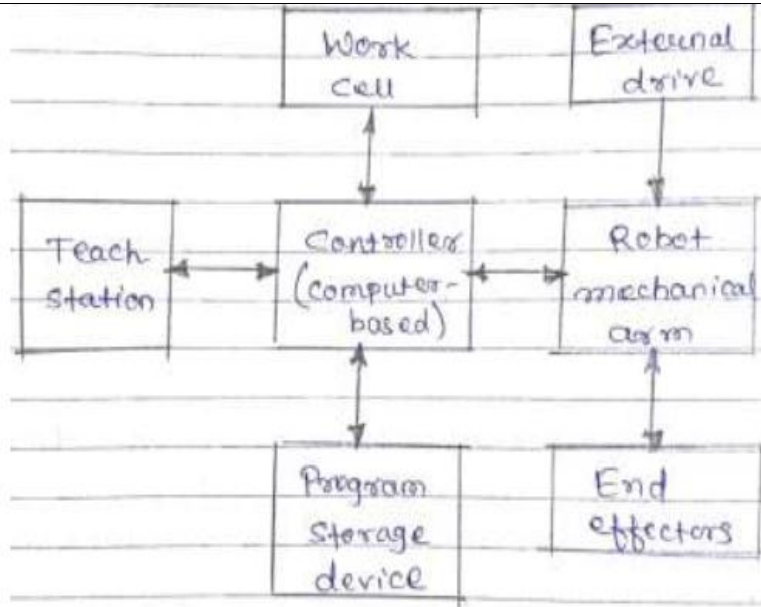


[Note- Any other conceptual diagram mark can be given]

Q 2 **Attempt any four :** **16M**

a) **Draw and explain general block diagram of Robotic system.** **4M**

Ans: **Diagram :** **2M**



[Note: Any other logical robotics diagram can given mark with any type of microcontroller]

2M

Explanation :

An Industrial robot has basic parts like arm, sensor, actuators, controllers etc. These 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

b) Explain in brief cam. State the types of cam. List two applications.

4M

Ans: Working principle of cam:

A cam is mechanical rotating machine element which is used for converting one motion in to 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.

1M

Types of CAM:

- Wedge/flat cam
- Plane or disc cam
- Cylindrical cam
- Conical cam
- Helical cam
- Radial
- 3-dimentional

1M

		<p><u>Applications of cam:</u></p> <ul style="list-style-type: none"> • Automatic machines. • IC engines. • Machine tools. • Printing control mechanisms. • Spinning and weaving machineries. • Textile machineries. • Paper cutting machines. 	<p>2M Any Four</p>
	c)	<p>Explain working of Belt. List types of Belt.</p>	4M
	Ans:	<p><u>Working :</u></p> <ul style="list-style-type: none"> • A belt is a loop of flexible material used to mechanically link two or more rotating shafts, most often parallel. • Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to continuously carry a load between two point. <p><u>Types of belt :</u></p> <ol style="list-style-type: none"> 1)Vee belt 2)Flat belt timing belt 3)Ribbed belt 4)Film belt 5)Multigrooved belt 	<p>2M (Any 4, ½ M Each)</p>
	d)	<p>Draw and explain electronic PID controller.</p>	4M
	Ans:	<p><u>Diagram :</u></p>	2M



	<p><u>Explanation</u></p> <p>The PID control scheme is named after its three correcting terms, whose sum constitutes the manipulated variable (MV). The proportional, integral, and derivative terms are summed to calculate the output of the PID controller. Defining $u(t)$ as the controller output, the final form of the PID algorithm is:</p> $u(t) = MV(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{d}{dt} e(t)$ <p>Where ,</p> <p>K_p: Proportional gain, a tuning parameter K_i: Integral gain, a tuning parameter K_d: Derivative gain, a tuning parameter e: Error = $SP - PV$ t: Time or instantaneous time (the present) τ: Variable of integration; takes on values from time 0 to the present t.</p> <p>The proportional term produces an output value that is proportional to the current error value. The proportional response can be adjusted by multiplying the error by a constant K_p, called the proportional gain constant</p>	2M
e)	Define sensor, signal conditioner, controller and actuator in mechatronic system.	4M
Ans:	<p><u>Sensor</u>: - A sensor is an element in a measurements system that acquires a physical parameter and changes it into electrical signal. E.g. Bellows, Thermocouple <u>Signal Conditioners</u>:- The signal conditioner performs isolation, impedance matching, noise reduction, amplification, conversion of sensor output signal. <u>Actuators</u>:- Actuators are the process of conversion of energy to mechanical form. <u>Controllers</u>:- Controllers are the brains of control system operation and decide the kind of action taken in response to an error</p>	1M Each
f)	List out various position sensors. Explain any one in detail.	4M
Ans:	<p><u>List :</u></p> <ol style="list-style-type: none">1)Potentiometer2) Eddy current sensorproximity sensor3)Capacitive sensor4)Hall effect sensor5)Optical sensor/photo electric sensor6)Inductive sensor <p><u>Explanation :</u></p> <p><u>(Note : Any one can be explain with principle of position control ,basic schematic diagram and application as postion measurement and position control)</u></p> <p><u>Example :</u></p> <p><u>Capacitive sensor:</u></p> <p>Capacitance is an electrical property which is created by applying an electrical charge to two conductive objects with a gap between them. A simple demonstration is two parallel conductive plates of the same profile with a gap between them and a charge applied to</p>	2M

them. In this situation, the Capacitance can be expressed by the equation:

$$C = \epsilon_0 K A / d$$

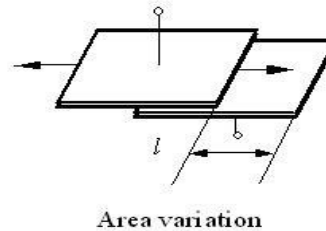
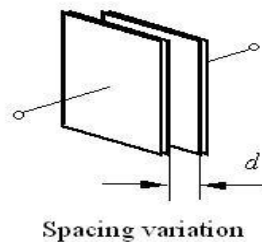
Where C is the capacitance, ϵ_0 is the permittivity of free space constant, K is the dielectric constant of the material in the gap, A is the area of the plates, and d is the distance between the plates.

There are two general types of capacitive displacement sensing systems. One type is used to measure thicknesses of conductive materials. The other type measures thicknesses of non-conductive materials or the level of a fluid.

Application:

Precision positioning

One of the more common applications of capacitive sensors is for precision positioning. Capacitive displacement sensors can be used to measure the position of objects down to the nanometer level. This type of precise positioning is used in the semiconductor industry where silicon wafers need to be positioned for exposure. Capacitive sensors are also used to pre-focus the electron microscopes used in testing and examining the wafers.



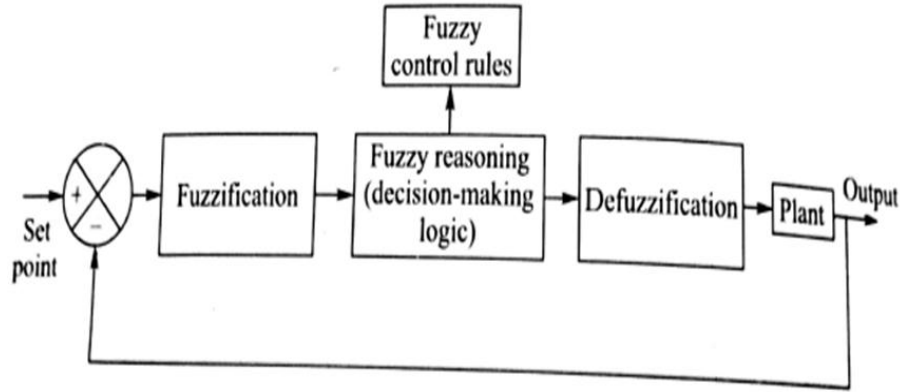
[Note: For Any logical Diagram Mark can be given]

e.g potentiometer is direct contact type position control sensor as rotation will change motor will rotate that change will measure shaft rotation which will give us change in resistance that will give us voltage which can be consider as error and actuator will move according to correct position.

Q. 3	Attempt any four:	16M
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	a) Draw and explain Fuzzy logic controller.	4M
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	Ans: <u>Diagram :</u>	2M
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Explanation:

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 inference mechanism.
- Membership function forms a crucial part in fuzzy rule base model because actually they only define Fuzzification of control variable in other word.
- 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

2M

b) Compare Electronic controllers with pneumatic controllers.

4M

Ans:

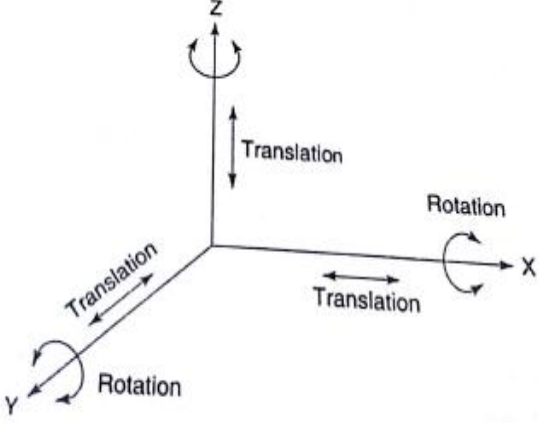
(Any 4,1M each)

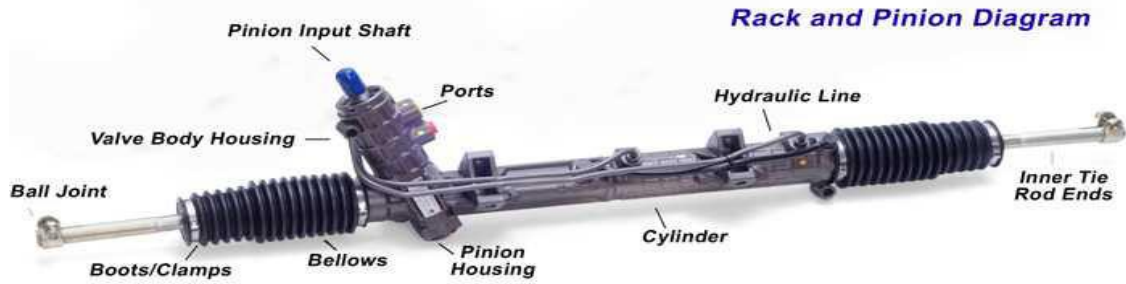
Electronic contrllers	Pneumatic controller
Low power requirements	High power requirements
Speed of response is substantially instantaneous	Speed of response is not substantially instantaneous
Complex networks	Simple networks
Difficult maintenance and test kit requirements	Essay maintenance and test kit requirements



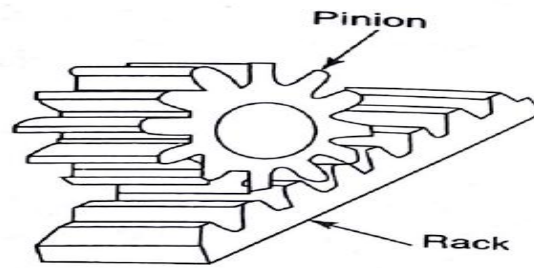
<p>c)</p> <p>Ans:</p>	<p>List different components of Industrial Robot. State functions of any two.</p> <p>Components of Robots: A robot is a complex machine which may contain mechanical, electrical, pneumatic, hydraulic and microelectronic components. Essentially a robot consists of four elements.</p> <p>Drive system: The drive system controls and velocity of end effectors. There are three major type of drive used in robots, namely,</p> <ul style="list-style-type: none"> • Electrical drives; • Hydraulic drives; • Pneumatic drives. <p>Control system: The control system controls and velocity of the end effectors of the robot based on the logical sequence and operating programs.</p> <p>Measuring system: A measurement of output is important; the control system continuously measures the actual position during a motion cycle and compares it with the theoretical values required, in order to provide a correction action.</p> <p>Sensors: The main function of to permit the robot to interact with the environment in an intelligent manner. Various types of sensors are available nowadays including tactile proximity, ultrasonic ranging and vision sensors.</p>	<p>4M</p> <p>List-2M, Function of any Two-1M each.</p>
<p>d)</p> <p>Ans:</p>	<p>Define DOF. Draw and explain six degrees of freedom.</p> <p>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. Six degrees of freedom (6DoF) refers to the freedom of movement of a rigid body in three-dimensional space. Specifically, the body is free to change position as forward/backward (surge), up/down (heave), left/right (sway) translation in three perpendicular axes, combined with changes in orientation through rotation about three perpendicular axes, often termed yaw (normal axis), pitch (lateral axis), and roll (longitudinal axis).</p> <div data-bbox="565 1591 1112 1942" data-label="Diagram"> </div>	<p>4M</p> <p>Definition -1M, Explanation -1½M,</p> <p>Diagram-</p>



	<p style="text-align: center;"><u>OR</u></p> 	1½M
<p>e)</p> <p>Ans:</p>	<p>Draw and explain Rack and Pinion assembly.</p> <p><u>Rack and Pinion :</u> A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.</p> <p><u>Example :</u> in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and forces a train up a steep slope. For every pair of conjugate involute profile, there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius (i.e. a toothed straight edge). A generating rack is a rack outline used to indicate tooth details and dimensions for the design of a generating tool, such as a hob or a gear shaper cutter.</p> <p><u>Diagram:</u></p>	<p>4M</p> <p>Expalination-2M</p> <p>2M</p>



OR



f) **Classify bearing and explain any one in brief.**

4M

Ans:

Bearing :

- Hydrodynamic Bearings
- Hydrostatic Bearings
- Rolling Element Bearings

Types of bearings-

- **Radial bearing**
- **Thrust bearing**
- **Sliding contact bearings**
- **Rolling contact bearings**

Hydrodynamic and Hydrostatic Bearing :

Hydrodynamic and Hydrostatic Bearings are those which we design and manufacture all by ourselves for the majority cases.

These are more specific to the application, costlier in budget but work really effectively.

Rolling Element Bearing :

Rolling Element Bearings are those which are readily available catalogued products in the market.

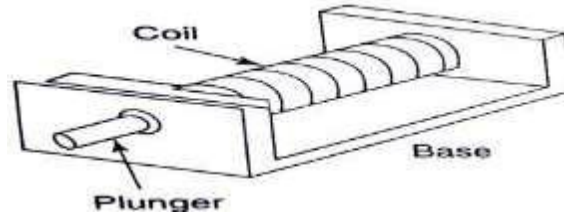
They are surely cost effective; just select them from the catalogue based on the requirement.

Very rarely are rolling element bearings designed and manufactured.

Although the bearings are classified into these three types the varieties each type of bearing holds is enormous. The forthcoming articles will deal more with these details.

**(Classification-2M
Explanation
any 1-2M)**

Q.4	A)	Attempt any three :	12M
	a)	Draw block diagram of microcontroller based pick and place Robot. List the four movements required by this Robot.	4M
	Ans:	<p>Diagram :</p> <p style="text-align: center;">OR</p> <p>Explanation:</p> <ul style="list-style-type: none"> • The robot has three axes about which motion can occur. • Rotation in a clockwise or anti-clock wise direction of the unit on its base Arm extension or contraction and arm up or down. • Gripper can open or close. • These movements can be actuated by the use of pneumatic cylinders operated by solenoid controlled 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 the downward motion from it retracting. • 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 	2M



Note: Diagram is optional

Principle:

A solenoid is a simple electromagnetic device that converts electrical energy directly into linear mechanical motion, but it has a very short stroke (length of movement), which limits its applications. A solenoid valve is the combination of a basic solenoid and mechanical valve. So a solenoid valve has two parts namely- Electrical solenoid, mechanical valve. Solenoid converts electrical energy to mechanical energy and this energy is used to operate a mechanical valve that is to open, close or to adjust in a position.

Parameters on which selection of solenoid is based-

1. Size
2. Flow capacity
3. Applied Voltage

**Principle-
2M**

2M

B) Attempt any one :

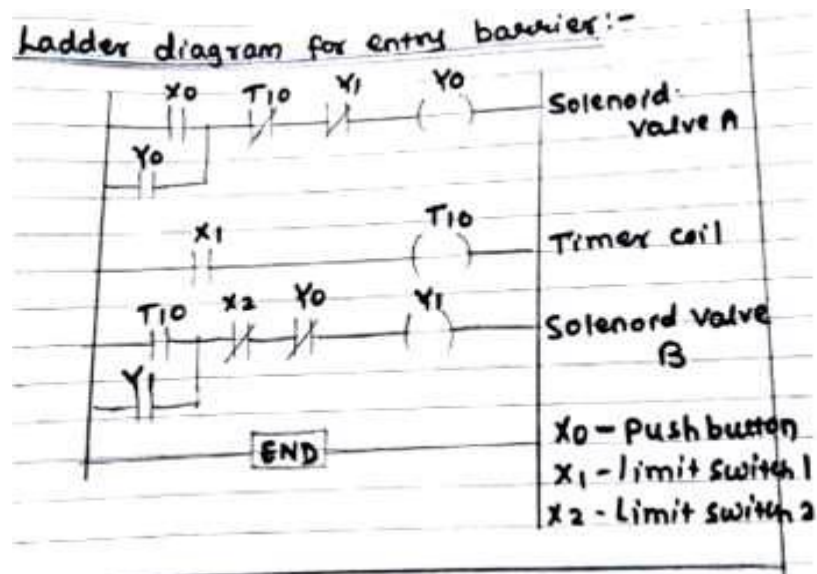
6M

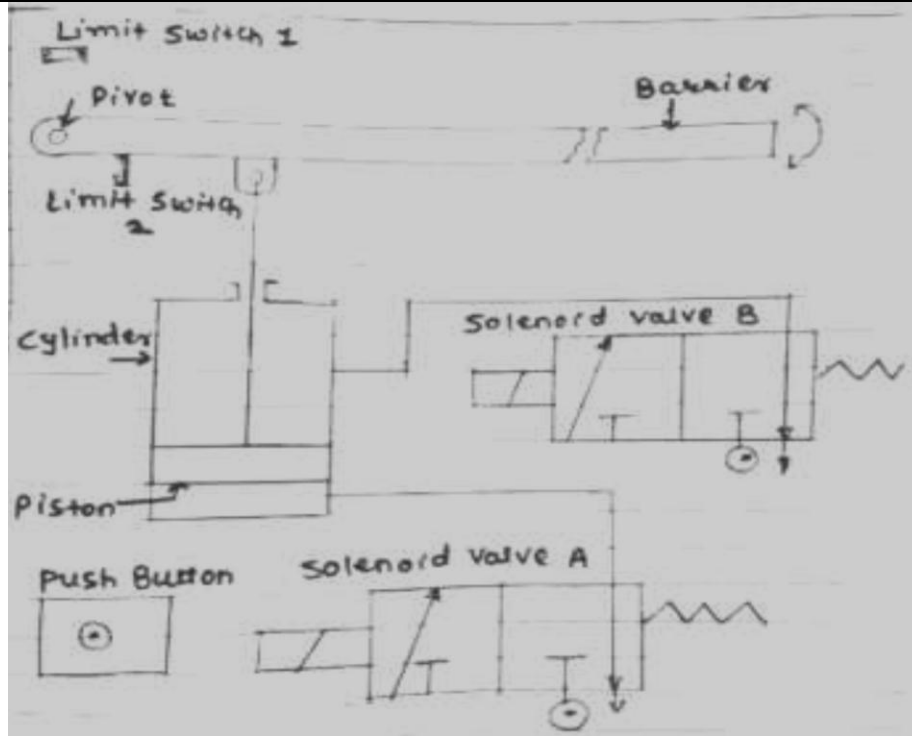
a) Draw and explain schematic of PLC based automatic car parking barrier system.

6M

Ans: Diagram :

**Ladder
Diagram-
4M**





Explanation:

Automatic car parking system allow to park maximum numbers of car in parking zone according to size of parking zone. 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.

Explanation :2M

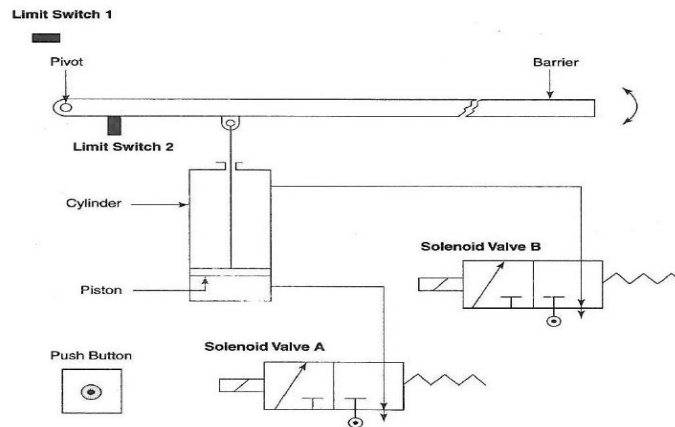
- b) **Draw a ladder diagram for following conditions of conveyor motor.**
- I) **Start push button to start the conveyor motor.**
 - II) **Bottle moves past the photo sensor and the conveyor motor stops automatically after count of 25 bottles.**
 - III) **The counter is to be rest to zero after 25 bottles.**
 - IV) **The conveyor motor can be stopped manually at any time.**
 - V) **The accumulated count of the counter is reset manually by means of count reset button.**

6M

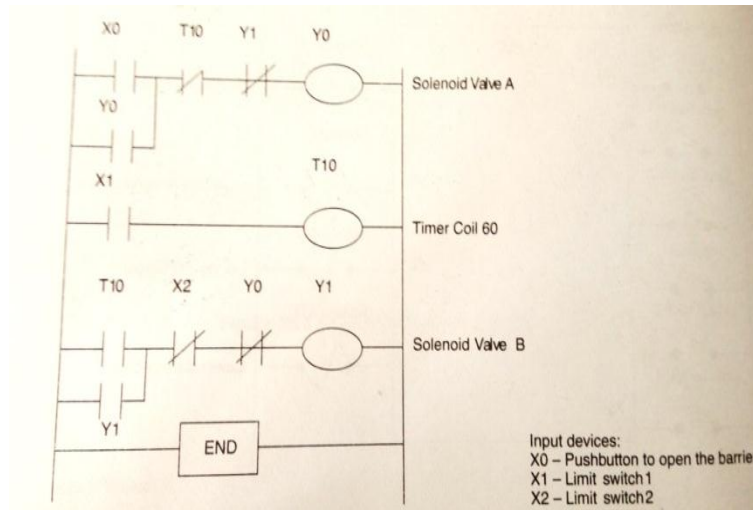
Ans: Diagram :

Note: Any other relevant logic for program can be considered.

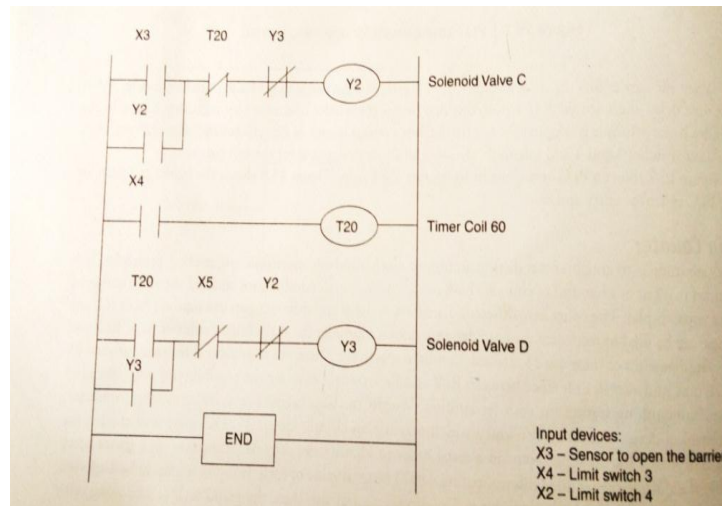
Ladder Diagram-6M

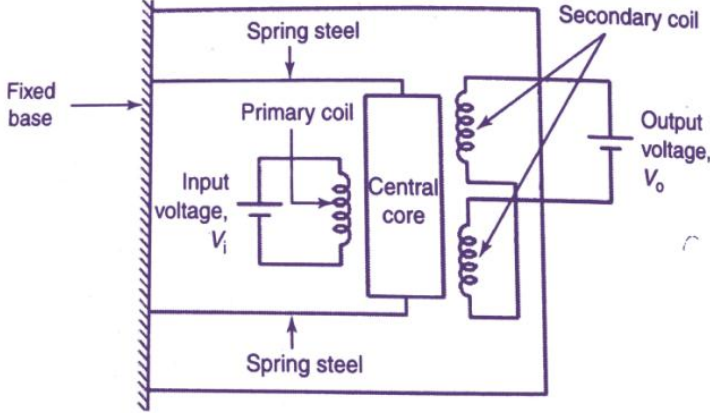
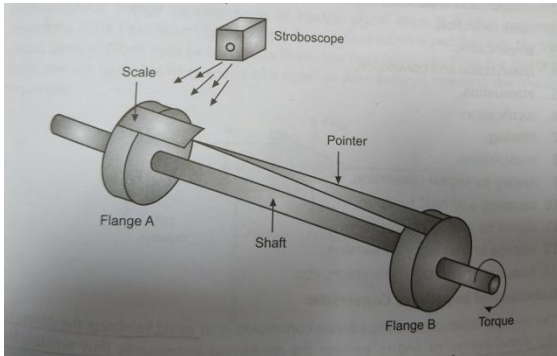


Ladder Diagram for entry-



Ladder Diagram for Exit-



Q.5	Attempt any four :	16M
a)	Draw and explain the working principle Linear Velocity Transducer (LVT).	4M
Ans:	<p>Diagram : –</p>  <p>Principle :</p> <ul style="list-style-type: none"> • The LVDT accelerometer consists of one primary and two secondary windings which are placed on either side of a central core. The two ends of the core are connected with a 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 call as static field voltage. • If any vibration occurs on the casing 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. 	2M
b)	Explain working principle of stroboscope with neat sketch.	4M
Ans:	<p>Diagram :</p>  <p>Explanation :</p> <p>The arrangement of two flanges A and B placed at a distance on the shaft is as shown. Flange A carries a scale while flange a pointer.</p>	2M

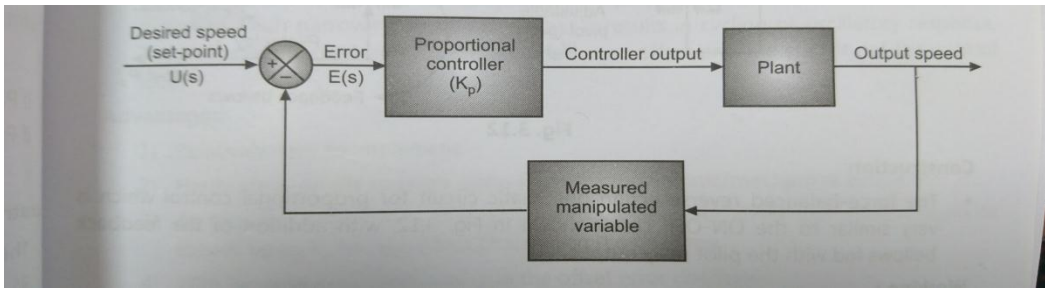
When a torque is applied on the shaft it causes angular displacement of pointer relative to the scale due to the angular twist.
 The deflection of the shaft may be read off directly when the shaft is stationery. However this is not possible if the shaft is rotating.
 In such cases, stroboscope is used. The flashing light of the stroboscope is applied onto the scale and the flashing frequency is adjusted till a stationery image is obtained.
 The scale reading can now be taken for measuring the angular twist. This method is simple and inexpensive. However, the accuracy of measurement is poor.

c) Draw and explain pneumatic proportional controller. **4M**

Ans: **Explanation :** **2M**
Basic :
 Proportional control is one in which the process input is change in direct proportion to the error(t) controls the output so that the manipulated variable and the error has proportional relation. The controller set the manipulated variable in proportion to The difference between the set point SP and the measured variable MV.
 The variable to be controlled, e.g. speed of a motor. Higher the difference, more is the change in the manipulated variable.
 The coefficient of deviation is called proportional gain, K_p and is mathematically written as:

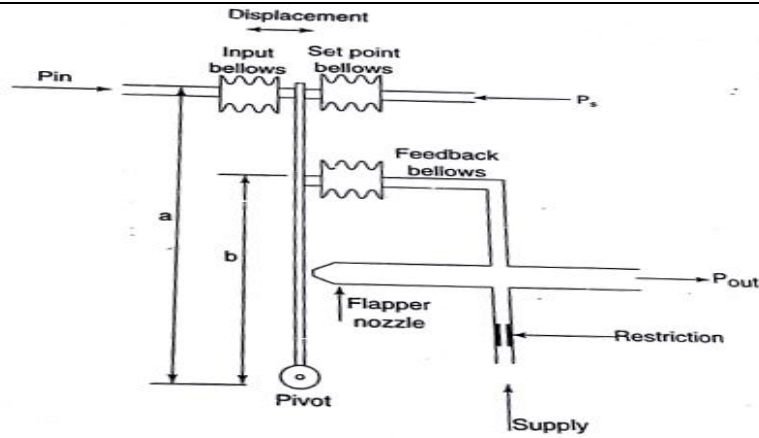
$$K_p = G_c(s) = \frac{C_v(s)}{E(s)}$$

Diagram :



2M

OR



The controller is effectively an amplifier with a constant gain having certain range called as appropriate band.

The proportional control action is used where the position of the final operator is determined by the relationship between the MV and SP reference value called as error

Given as :

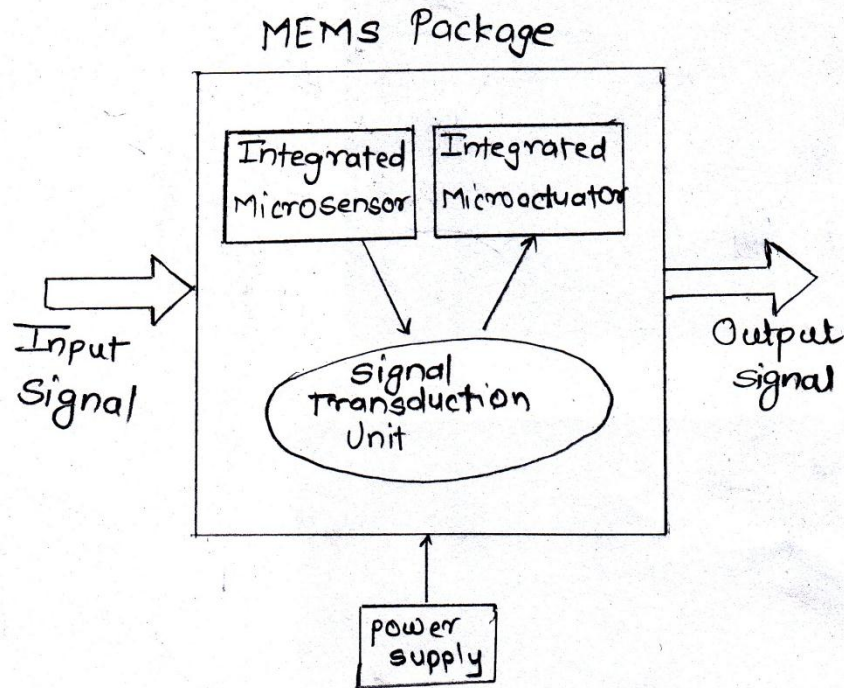
$$\text{Error} = \text{SP} - \text{MV}$$

d) Draw and explain block diagram of MEMS.

4M

Ans: Diagram :

2M



Explanation :

Definition of MEMS: MEMS are Mechatronics systems that consist of mechanical elements and electronic circuits. A micro electromechanical system is an integration of mechanical elements, sensors, actuators and electronics on a common silicon substrate through micro fabrication technology.

2M



		<ul style="list-style-type: none">• Input signals: These are the signals admitted to the MEMS package from various sources or systems such as electrical, mechanical, chemical optical and so on.• MEMS package: It is a semiconductor chip which can be fabricated by suitable micromachining technique. It consists of micro sensor, micro actuators and a signal transduction unit.• Signal transduction unit: This unit is provided for conditioning the generated signals. The transduction processes includes amplification, filtration and signal conversion.• Output signals: These are the signals interfaced with the system to be controlled or monitored.• Due to monolithic integration of sensors, actuators and signal transduction unit, closed loop control system can be easily developed.	
	e)	List advantages and disadvantages of MEMS.	4M
	Ans:	<p>Advantages :</p> <ol style="list-style-type: none">1. Batch fabrication and hence reduced cost.2. Reduced size and reduced power (due to pin size and reduced package volume)3. High precision and resolution.4. Reduced parasitic due to interconnecting devices. <p>Disadvantages :</p> <ol style="list-style-type: none">1. Very small to trace out2. Due to small size, it is physically impossible for MEMS to transfer any significant power.3. They are made from poly-si , a brittle material , they cannot be loaded with large forces because brittle materials can be fractured easily under high stress.	2M Any Two 2M Any Two
	f)	For a signal conditioner explain the terms linearization and signal conversion.	4M
	Ans:	<p>Definition :</p> <ol style="list-style-type: none">1. linearization : Many primary elements produce nonlinear outputs and the signal must be linearized to produce a nearly ideal calibration. Specialized analog circuits such as offsetting circuits, proportional output circuits, V to I convertor etc. are used to linearize a signal. Even computer algorithms are also used.2. Signal conversion : Data Converter: To convert data into particular form as required by the load. They may be of following type analog-to-digital converters, digital-to-analog converters, frequency converters or translators, voltage converters or inverters, frequency-to-voltage converters, voltage-to-frequency converters, current-to-voltage converters, current loop converters, and charge converters.	2M 2M
Q.6		Attempt any four :	16M
	a)	Give two applications of each : <ol style="list-style-type: none">1) Eddy current sensor2) Optical sensor.	4M
	Ans:	<p>Eddy current sensor :</p> <ol style="list-style-type: none">1. Detection of non-magnetic but conductive materials.2. Displacement sensing3. Position sensing	2M (Any Two)

Optical sensor.:

1. Position Detection
2. Velocity Detection
3. Acceleration Detection
4. Direction Detection

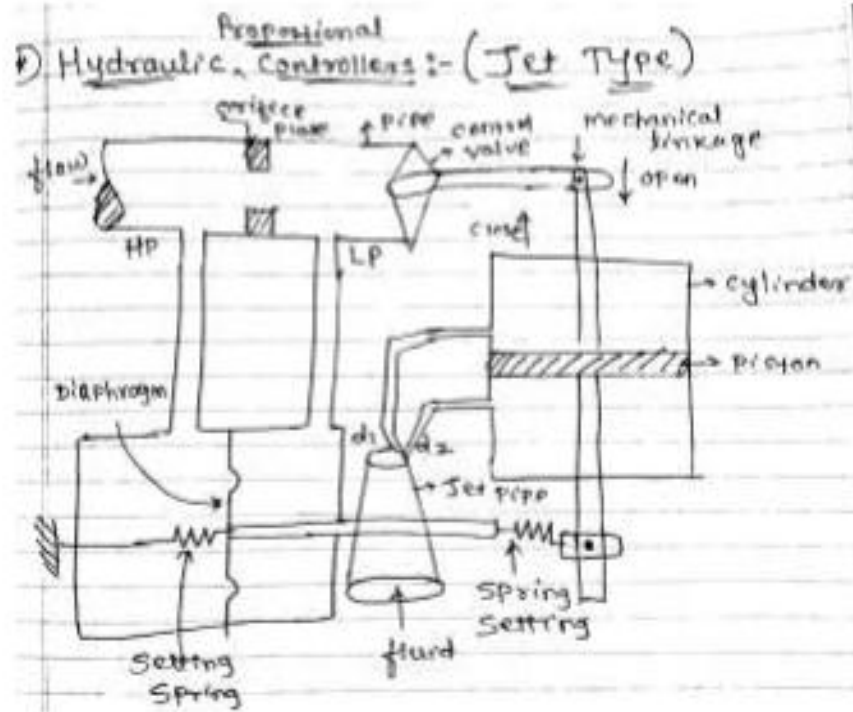
2M
(Any Two)

b) Draw and explain implementation of proportional type Hydraulic controller.

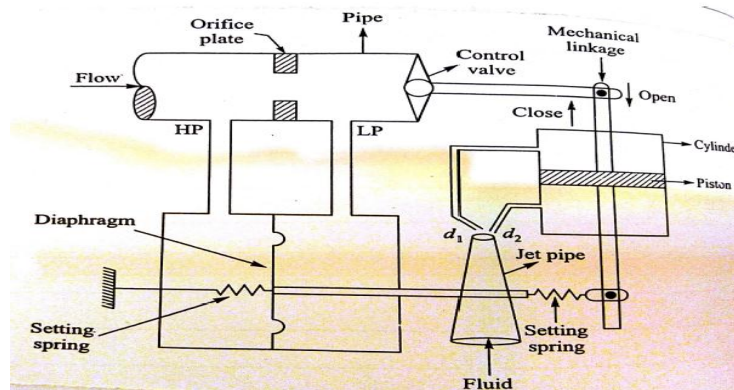
4M

Ans: Diagram :

2M



OR



Explanation :

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.

c) List different types of Gears and state two applications of each.

4M

Ans:

Sr. No.	Type of gear	Applications
1.	Spur gear	Precision measuring instruments, machine tools, automobile gearboxes.
2.	Helical gear	Automobile power transmission.
3.	Spiral gear	Suitable for transmission of small powers.
4.	Bevel gear	In automobiles.
5.	Worm gear	In machine tool like lathe, milling and drilling machines.
6.	Rack and pinion	In machine tools like lathe, drilling and planar machines.

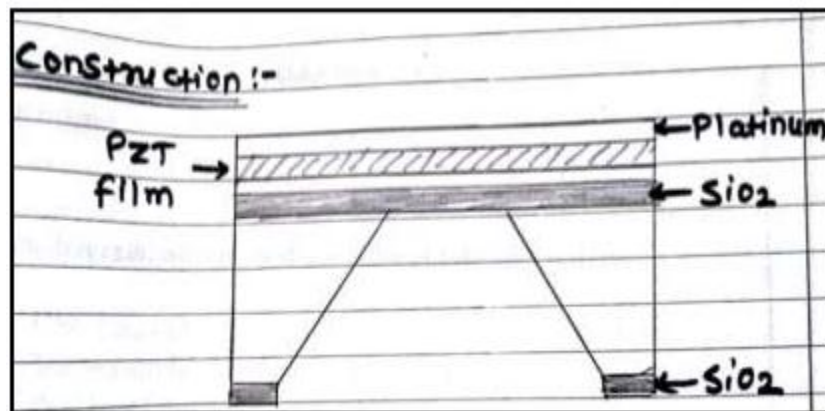
4M
(Any Four Points)

d) Draw and explain the working principle of MEMS accelerometer.

4M

Ans: Diagram :

2M



Explanation :

2M

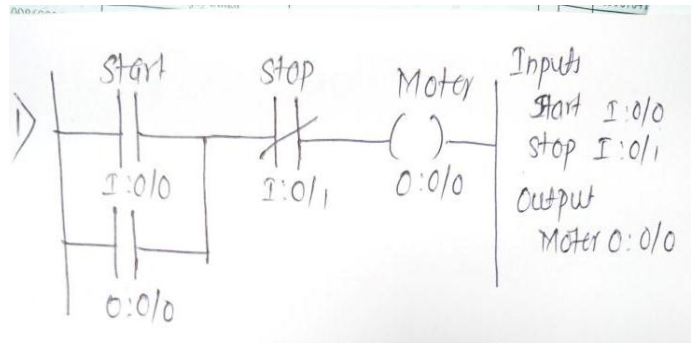
Mechanical ignition airbags fit inside the steering wheel pad. When a collision occurs, the inertial sensor moves, setting off a mechanical igniter and inflator to deploy the airbag. As the sensor and igniter were in the same unit, the compact airbag unit easily fit most steering wheels, allowing broad 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.

- e) **Draw a ladder diagram for**
I) To ON-off a motor with push button.
II) To off a motor after 5 sec.

4M

Ans: To ON-off a motor with push button :

2M



To off a motor after 5 sec :

2M

