



MODEL ANSWER

SUMMER- 19 EXAMINATION

Subject Title: Mechatronics

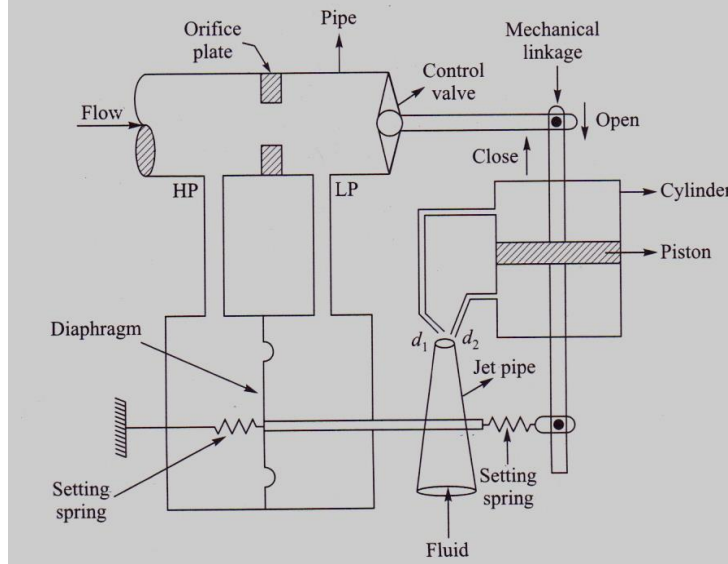
Subject Code: 17660

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		Attempt any Five :	20- Total Marks
	a)	List any four advantages of Mechatronic System.	4M
	Ans:	<ul style="list-style-type: none">➤ High level of integration.➤ Increased functionality and better design.➤ More use of electronics and software.➤ Use of artificial intelligence and intelligent process control➤ Assume responsibility for a process and operation with little interference of operators.➤ Multisensory and programs environments.➤ High reliability and safety.➤ Improved and less expensive control.	1M each
	b)	Distinguish between a transducer and a sensor.	4M

Ans:	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Serial No</th> <th style="width: 40%;">Transducer</th> <th style="width: 50%;">Sensor</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">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 style="text-align: center;">2</td> <td>This is basic ,elementary Device</td> <td>It is Sophisticated Device</td> </tr> <tr> <td style="text-align: center;">3</td> <td>All transducer are not sensor</td> <td>All sensor are transducer</td> </tr> <tr> <td style="text-align: center;">4</td> <td>May not accurate</td> <td>More accurate</td> </tr> <tr> <td style="text-align: center;">5</td> <td>Transducer may be primary or secondary, more classified</td> <td>Sensor are physical to electrical</td> </tr> <tr> <td style="text-align: center;">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.	1M each
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.																					
c)	Draw the block diagram of CNC based drilling machine.	4M																					
Ans:	<p>Diagram:</p> <p style="text-align: center;">OR</p> <div style="text-align: center;"> </div>	4M																					
d)	Describe the implimentation of proportional type of controller using hydraulic controller.	4M																					
Ans:	<p>Diagram:</p>	2M																					



2M

Explanation:

- 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.

OR

Implementation of proportional type hydraulic controller

- The jet pipe hydraulic proportional controller is explained.
- For getting the P action the amplifier should get feedback signal. In hydraulic P controllers, proportional feedback is accomplished by a feedback linkage that transmits piston movement to the spring about a movable pivot as shown in Fig. 3.25.

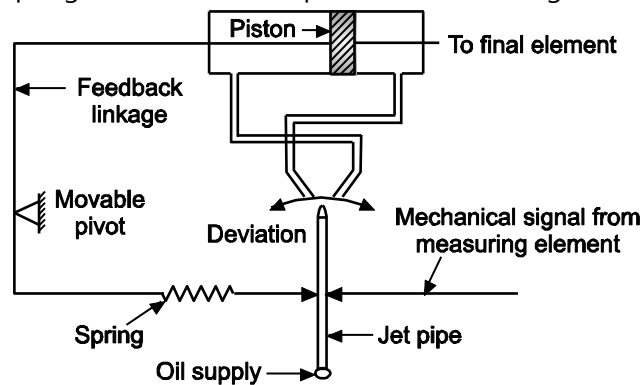


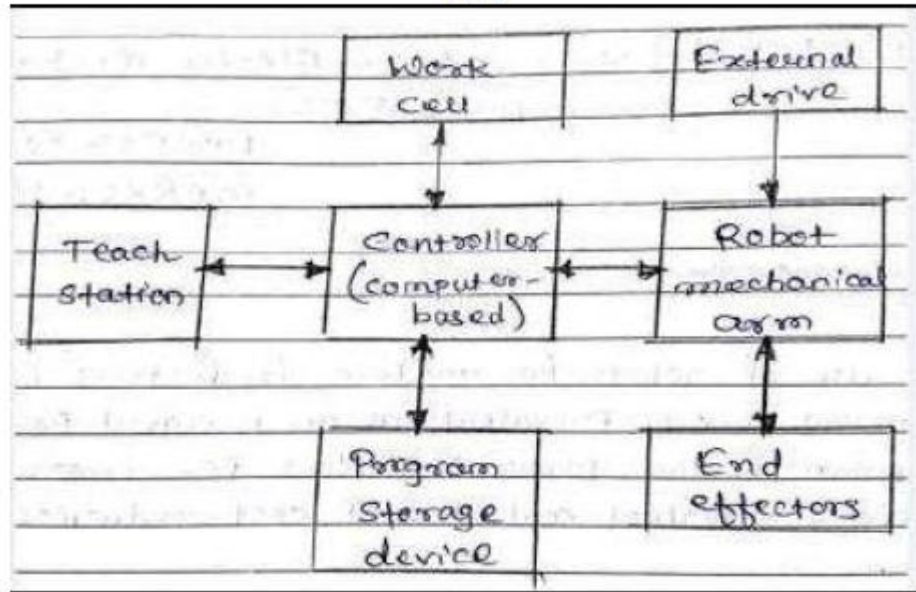
Fig. 3.25

Working:

- When the jet pipe is moved towards right by the deviation signal, the piston 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 of 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. PB adjustment can be done by

		changing the position of movable pivot that regulates the amount of piston motion required to restore the jet pipe to neutral position.	
e)	Draw block diagram of Robot system. List function of end effector.	4M	
Ans:	Diagram: <div style="text-align: center; margin: 10px 0;"> <p>Fig.: Functional Diagram of Robotics</p> </div> <p style="text-align: center; margin: 10px 0;">OR</p> <div style="text-align: center; margin: 10px 0;"> </div>	3M	

OR



Functions Of An End Effector : Any 2 functions

1. End effector is the device at the end of a robotic arm designed to interact with the environment.
2. End effectors originates from robotic manipulators (robotic arm) It is the last link of the robot.
3. It is a last link of the robot. It is similar to human hand with or without finger. It incorporates various sensors.

1M

f) **State and elaborate the importance of mechatronics in various field of engineering.**

4M

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.

1M

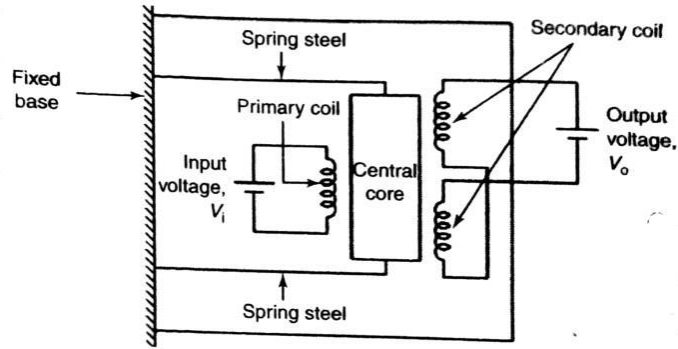
Importance of Mechatronics in various engineering fields:

- **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 System:**
Electrical components mostly used are electrical motors (ac and dc) generators, relays, circuit breakers, switches and so forth.
- **Electronic System:**
Analog electronics involves as action and passive components such as

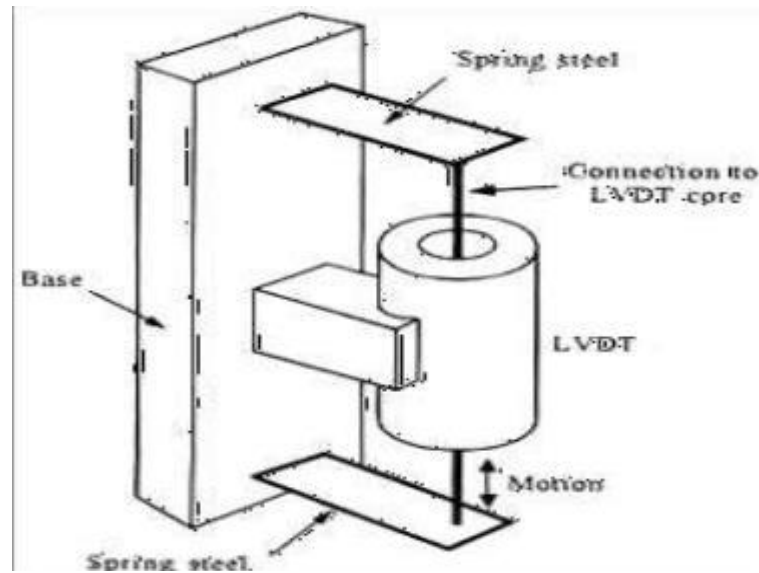
3M



	<p>resistor, 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, devices recorders and printers.</p> <ul style="list-style-type: none">• Information System: It related with all the aspects regarding information transmission from processing to control system and analysis techniques. It is a combinati communication systems, signal processing, control systems and numerical met• Computer System: It is combinational of hardware and software. In mechatronic applications ha is computer specific circuit like flip-flops, computer registers, memories soft nothing but system and application.	
	<p>g) State the application of rack and pinion.</p>	4M
<p>Ans:</p>	<p>Rack and Pinion : 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. Example : 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>	4M
<p>Q.2</p>	<p>Attempt Any Four:</p>	16 Total Marks
<p>a)</p>	<p>Draw and explain LVDT accelerometer.</p>	4M
<p>Ans:</p>	<p>Diagram:</p>	2M



OR



2M

Explanation:

- The LVDT accelerometer consists of one primary and two secondary windings which are placed on either side of central core. 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.

b)

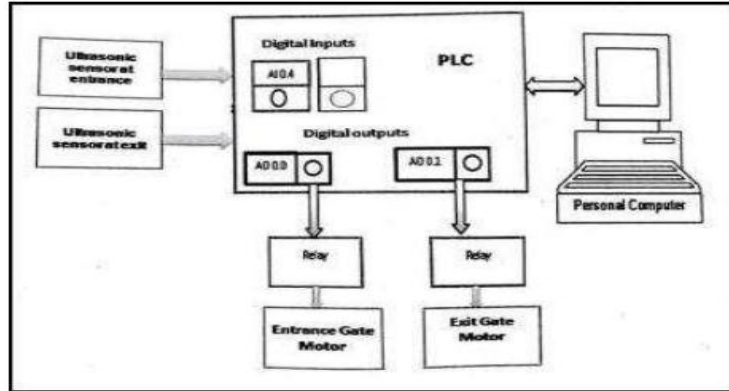
Describe the working of PLC based automatic car park barrier system with block diagram.

4M

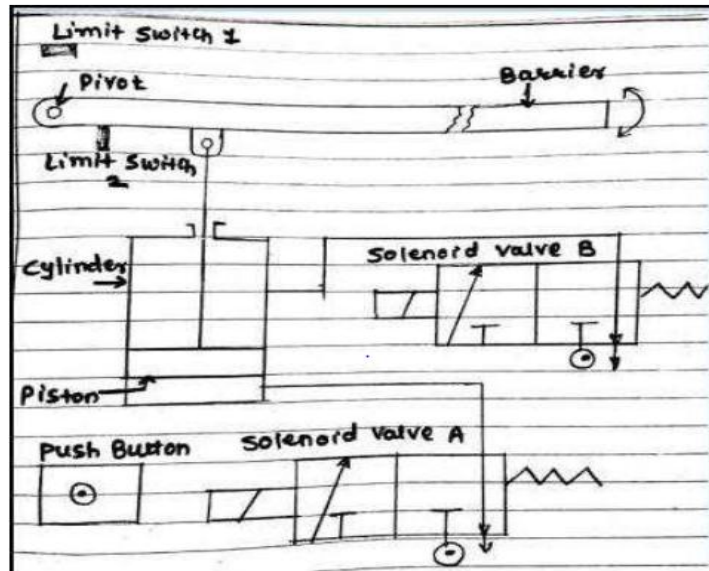
Ans:

Diagram:

2M



OR



Explanation:

- 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.

2M

c) Explain MEMs microactuator with neat diagram.

4M

Ans:

2M

Diagram:

		<pre> graph TD PS[Power supply] --> TS[Transduction stage] TS --> MAE[Microactuating element] MAE --> OA((Output action)) </pre> <p>Explanation:</p> <ul style="list-style-type: none"> • 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. • Micro pumps, micro switches, micro valves and micro grippers are different types of Micro actuators. 	2M
	d)	Draw the PLC ladder diagram of ON-OFF control of lamp. Write the input and output devices.	4M
	Ans:	<p>Diagram:</p> <p style="text-align: center;"><u>Ladder diagram for ON-OFF control of Lamp.</u></p> <pre> graph TD subgraph Rung1 [Rung 1] Start((Start I:0/0)) Stop((Stop I:0/1)) B3_0_0_1((B3:0/0)) Start --- OR(()) Stop --- OR OR --- B3_0_0_1 end subgraph Rung2 [Rung 2] B3_0_0_2((B3:0/0)) Lamp((Lamp O:0/0)) B3_0_0_2 --- Lamp end subgraph Rung3 [Rung 3] END((END)) end </pre>	3M
	e)	Compare pneumatic and hydraulic system.	4M

Ans:	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.	4M(Any 4 relevant comparison)
	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) Draw and describe Hall effect sensor. 4M

Ans: Diagram: 2M

Working:

- Working principle of a Hall effect sensor is that if strip of conducting material carries a current in presence of transverse magnetic field as shown fig .
- The difference of potential is produced between the opposite edges of the conductor. The magnitude of the voltage depends upon the current and magnetic field. The current is passed through leads 1 and 2 of the strip and output leads 3 and 4 are connected with Hall strip.
- When a transverse magnetic field passes through the strip, the voltage difference

2M

		occurs in output leads.	
Q.3		Attempt any FOUR:	16- Total Marks
a)		Draw and explain fuzzy logic controller.	4M
Ans:		<div style="text-align: center;"> </div> <p style="text-align: center;">Or</p> <div style="text-align: center;"> </div>	2 M
		<p>Explanation:--</p> <p>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 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</p> <p>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</p> <p>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</p>	2 M

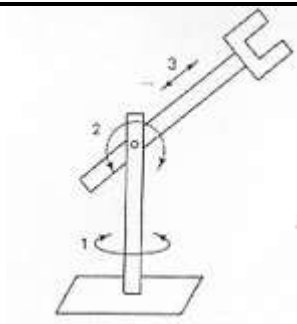
b)	List velocity sensors and explain any one type with neat diagram.	4M
Ans:	<p>Different type of velocity sensors are:-- 1)Encoders 2)Tacho-generators 3)Pyroelectric sensors 4)Moving coil type Explain any one-</p> <div data-bbox="495 443 1185 856" data-label="Diagram"> </div> <p>Explanation:-- A digital optical encoder is a device that converts motion into a sequence of digital pulses. By counting a single bit or by decoding a set of bits, the pulses can be converted to relative or absolute position measurements. Encoders have both linear and rotary configurations, but the most common type is rotary. Rotary encoders are manufactured in two basic forms: the absolute encoder where a unique digital word corresponds to each rotational position of the shaft, and the incremental encoder, which produces digital pulses as the shaft rotates, allowing measurement of relative position of shaft. Most rotary encoders are composed of a glass or plastic code disk with a photographically deposited radial pattern organized in tracks. As radial lines in each track interrupt the beam between a photo emitter-detector pair, digital pulses are produced.</p> <p>Tacho-generator: Is used to measure angular velocity Can be of two types: variable reluctance or ac generator The variable reluctance one consist of toothed wheel of ferromagnetic material which is attached to the rotating shaft. As the wheel rotates, the air- gap between the coil and the Ferro-magnet changes. Thus the flux linked by the a pick up coil changes. This result in alternating e.m.f in the coil. If the coil has n teeth and rotates with angular velocity w, then the flux and the induced voltage</p> <p>Piezoelectric sensors: A piezoelectric sensor is device that uses the piezoelectric effect to measure the changes in velocity converting to electric quantity</p> <div data-bbox="678 1661 1031 1948" data-label="Diagram"> </div>	<p>1 mark for listing (4types)</p> <p>3M -1 1/2 for diagram</p> <p>1 1/2 for explanation</p>

		<p>Moving COIL Type: velocity transducer/sensor consists of a moving coil suspended in the magnetic field of a Permanent magnet. The velocity is given as the input, which causes the movement of the coil in the magnetic field. This causes an e.m.f to be generated in the coil. This induced e.m.f will be proportional to the input velocity and thus, is a measure of the velocity</p>	
	c)	State four advantages of CNC system. What are G codes and M codes.	4M
	Ans:	<p>Advantages: (any Four)</p> <ul style="list-style-type: none"> • An increase in flexibility. • An improvement in the possibilities for correcting errors in part programming. • The possibility of using the computers peripheral equipment. • Tape and tape reads are used only once for resulting improved reliability. • CNC is more compatible. • CNC can accommodate the conversion of tapes prepared in units of inches to the International unit system. <p>G code and M code G code: Address for preparatory commands: G commands often tell the control what kind of motion is wanted (e.g., rapid Positioning, linear feed, circular feed, fixed cycle) or what offset value to use. M code: Miscellaneous function: Action code, auxiliary command; descriptions vary. Many M-codes call for machine functions, which is why people often say that the "M" stands for "machine", although it was not intended to.</p>	1/2 M (each) 2M
	d)	State the working principle of solenoid valve with neat sketch	
	Ans:	<div style="text-align: center;"> </div> <p>Principle of Operation:</p> <ul style="list-style-type: none"> • 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 	2M 2M

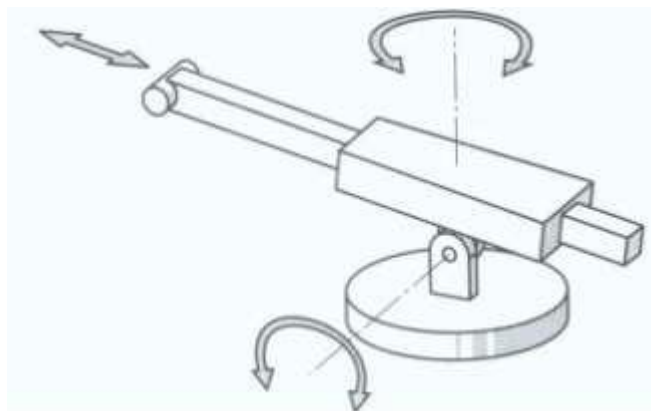
- The coil, and the amount of force by which the core is pulled mainly depends upon the number of coils and the amount of current flowing in the circuits.
- The cut way section is shown in fig (c) above, the operation of the solenoid actuator.
- The spring return plunger is held in the upper position when the coil is electrically de-energized.
- When the voltage is applied to the solenoid frame magnetic field is produced in the solenoid frame.

e) **Expalin the construction of spherical robot in brief. State its degree of freedom.**

Ans:



OR



Explanation:--

It has one linear and two rotary motions. It consist sliding arm actuated relative to the body, which can rotate about both vertical axis and horizontal axis.

Spherical robot is a stationary robot with two rotary joints and one prismatic /linear joint which forms a spherical coordinate system and hence it called spherical robot.

Its degree of freedom is ‘3’

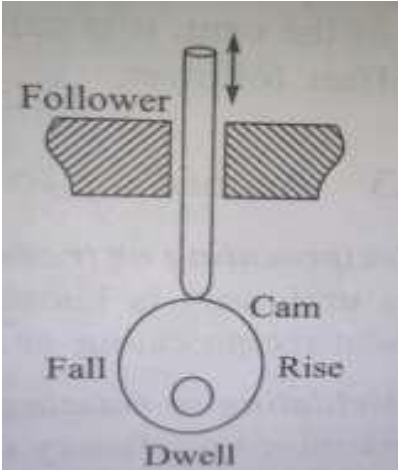
It is as follows

This robot positions the wrist through two rotations and one linear actuation.

As shown in the orientation the tool plate is achieved through three rotations in the wrist with roll of A, Pitch of B and Yaw of C.

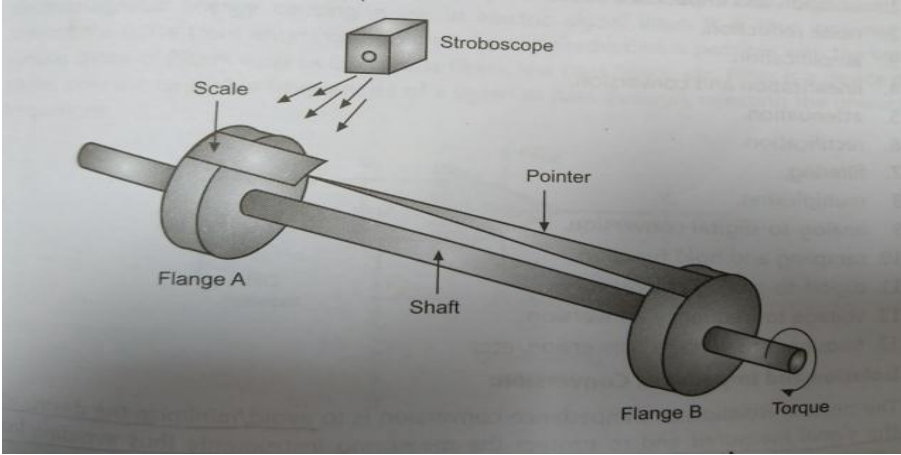
Diagram and explanation 3 marks.

Degree of freedom- 1 mark

		OR	
		<p>Degrees of freedom (DOF) can be defined as a term that describes a robot's freedom of motion in three dimensional space.</p> <p>It refers to the ability of the robot arm to move forward and backward, up and down, and to the left and to the right.</p>	
	f)	Give advantages and disadvantages of CNC based drilling machine.	4 marks
	Ans:	<p>Advantages : (any 4)</p> <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 <p>Disadvantage : (any 4)</p> <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. 	2M
Q.4	A)	Attempt any Two(8 marks each) :	16- Total Marks
	a)	State the working principle of Cam. List its types. Give any four applications of Cam.	8
	Ans:		
		<p>Working principle of CAM: A cam is mechanical rotating machine element which is used for converting one motion in to another. It is rotating machine element that gives reciprocating or oscillating motion to another element known as follower. Usually cams are rotated at uniform</p>	2M



	<p>speed by shaft. The follower motion is predetermined according to the shape of cam . Cam rotates and doing so , imports reciprocating motion to follower, with which it is in contact. As the cam rotates, the follower is made to rise dwell and fall ,the lengths of times spent at each of these positions depending upon shape of the cam.</p> <p>Types of CAM: (any 4)</p> <ul style="list-style-type: none"> • Wedge/flat cam • Plane or disc cam • Cylindrical cam • Conical cam • Helical cam • Radial • 3-dimentional <p>Applications of CAM: (any 4)</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 align="center">2M</p> <p align="center">4M</p>
<p>b)</p>	<p>Explain microcontroller based antilock brake system with neat block diagram.</p>	<p align="center">8M</p>
<p>Ans:</p>	<p>An ABS is a system on motor vehicles which prevents the wheels from locking while braking stopping safely is one of the most important functions a motor vehicle can perform</p> <p>Diagram:--</p> <p>Explanation:--</p> <p>Failure of the brake system will almost invariably results in property damage, personal injury or even death. An ABS allow the driver to maintain steering control under heavy braking by preventing a skid and allowing the wheel to continue to roll forward and create lateral control, as directed by driver steering inputs.</p>	<p align="center">4M</p> <p align="center">4M</p>

	<p>A typical ABS is composed of a central electronic unit, four speed sensors (one for each wheel)</p> <p>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 wheels speed relative to the speed of the other wheels.</p> <p>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.</p> <p>If however the brakes are being applied and one or more monitored wheels suddenly beings to reduce speed indicating a loss of traction with load the controller then activates the antilock system.</p> <p>When it senses that any one of the wheels is rotating slower than the others, it moves the valves to decrease the pressure on the braking circuit, effectively reducing the braking force on that wheel.</p>	
<p>c)</p>	<p>Explain with sketch torque measurement using (i) Stroboscope method, (ii) Capacitive method.</p>	<p>8M</p>
<p>Ans:</p>	<p>(i) Stroboscope method:--</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> <p>When a torque is applied on the shaft it causes angular displacement of pointer relative to the scale due to the angular twist.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>(ii) Capacitive Method : The principles of capacitive measurement and ratio metric calculation provide the advantage of robustness towards environmental influences</p> <p>In order to measure the torsion angle resulting from the torque transmitted by a rotating shaft, we have modified the capacitive angle/angular speed sensor by mounting two asymmetric rotors on two concentric shafts between the sensor stators. Both grounded</p>	<p>2 M diagram, 2 Explanation</p>

rotors realise a single effective rotor with a variable geometry, depending on the relative angle between the rotating shafts. These modifications extend the abilities of the sensor to measure the absolute angle (360° -range) and the angular velocity of the effective rotor with the ability to measure the difference-angle between the two rotors.

Figure 1 shows a typical mechanical construction for converting the torsion on a shaft into an angle between the two rotors. The torsion shaft carrying one rotor is mounted concentrically in a hollow and stiff shaft carrying the second rotor. From the measured torsion angle and the length and the G-modulus of the shaft the transmitted torque is calculated using Hooke's Law

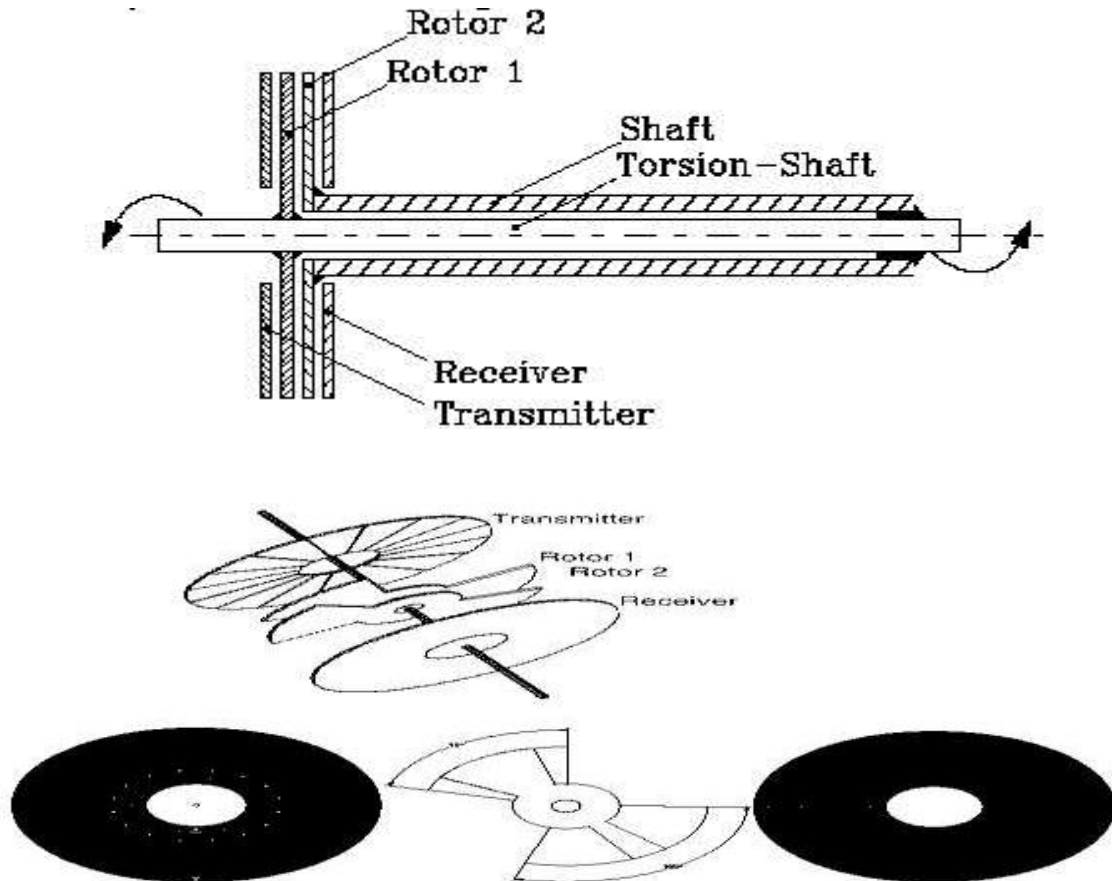
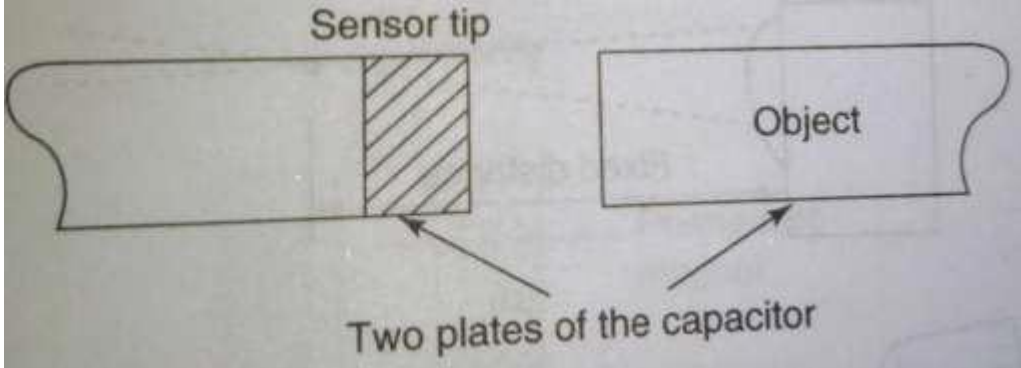


Figure 2 shows the electrode structure of the capacitive sensor. One stator plate is used as transmitter with 16 transmitting segments with centre angles of 22.5° , the other stator contains the receiving ring electrode. Two rotors with a symmetrically arranged blades with a centre angle of 60° (Figure 2) are mounted mirror-symmetrically on two concentric shafts as shown in Figure 1.

The shafts electrically connect the conductive rotors to ground potential. The zero position of the relative angle is defined for overlapping rotors building two blades with centre angles of 75° and 105° . From this asymmetrical geometry results the ability to determine the direction of the torsion or the sign of the torque, respectively, and the maximum range of the difference angle of $\pm 15^\circ$. As the applied torque changes the angle between the rotors, the electrical effective size of the rotor blades is changed. These changes influence the capacitive coupling between the transmitting segments and the receiving electrode.

	<p>In one measurement cycle a pulse sequence is applied to each segment. Depending on the rotor position and the effective size of the rotor the received signals change for each segment. By applying a radiometric algorithm to the received signals, the signed relative angle between the rotors is calculated.</p> <p>Note:-- (any other suitable capacitive method could also be considered)</p>	
Q.5	Attempt any FOUR:	16- Total Marks
a)	State the working principle of capacitive sensor with neat diagram.	4M
Ans:	 <p>Explanation:-- 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 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.</p>	2 M
b)	State the function of 'Signal Conditioner' in measurement system.	4M
Ans:	<p>Function of 'Signal Conditioner' :-- In Mechatronics systems, processing and controlling of physical parameters like temperature, pressure, flow, etc. is carried out by converting them into electrical signals by means of suitable transducers. Depending upon the excitation system or requirement of power supply, transducers are classified as passive and active. The excitation source (ac or dc) is necessary for passive transducers like potentiometers, strain gauges, etc. because these transducers do not produce their own output voltage or current. Similarly, amplification stage is also necessary to increase the level of output</p>	(Any 4 point)4M

	<p>signal. Active transducers (piezoelectric, thermocouple, etc.) produce their own electrical output when physical quantities are applied to them, but amplifier stage is used to bring the output signal up to a suitable level. In both cases, amplifiers are used because the output is at low level. The output signal is amplified to bring it compatible with control elements, indicating and display devices, recorders, controllers and so on.</p> <p>OR</p> <p>The signal conditioner blocks in any instrumentation system because this blocks do the functions of</p> <ol style="list-style-type: none"> i) Passive input from transducer to active output which can be in terms of electrical voltage or current. ii) it amplify weak signal to strong signal. iii) it can filter and remove the unwanted signal from input of transducer. iv) it help in selectivity v) it can convert analog to digital signal as require. vi) it help for impedance from source to load, <div style="text-align: center; margin: 10px 0;"> <p style="font-size: small; margin-top: 5px;">{ diagram is optional }</p> </div> <p>[any 4 from above]</p>		
	c) How a PLC can be used to handle an analog input? Justify.	4M	
Ans:	<p>Diagram:--</p> <div style="text-align: center; margin: 10px 0;"> </div> <p>Explanation:</p> <ul style="list-style-type: none"> • For analog operation, the level of a PLC input signal is sensed by an analog input module, like in a data acquisition system when input parameters may be the analog values of temperature or pressure. Similarly, the output may be an electrical signal controlling the current through a system which can operates positions between ON and OFF. • Analog PLC systems are of two general types: the BCD and the straight numerical. The BCD is called multi-bit type. The inputs include data from devices like thumbwheels, encoders . BCD codes are fed into the PLC input module from the thumbwheel output. Other possible BCD-type inputs are barcode readers and encoders. Similarly, the output may be a digital display, various position actuators and sow" motors. • A straight numerical type of module is used for a large variety of input devices like a potentiometer inputs a linear varying electrical value. Other inputs are thermocouples, strain gauges and signal generators which generate electrical signals. • The method in which these analog inputs are handled is of course similar to a 	1M	3M

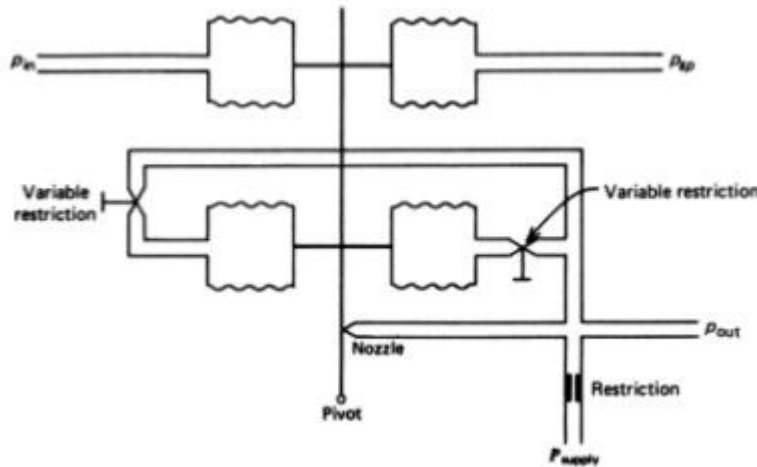
microprocessor. First the data is to be converted into digital signals and then processed by the PLC

- On the output side, the output data from the PLC are converted into analog data and given to the output device. Figure shows lac block diagram of this process. Initially the data handled is in BCD, and then as soon as it reaches the PLC, it is first converted into machine code and then the necessary control signals are generated to the output module.

d) Draw and explain pneumatic PID controller.

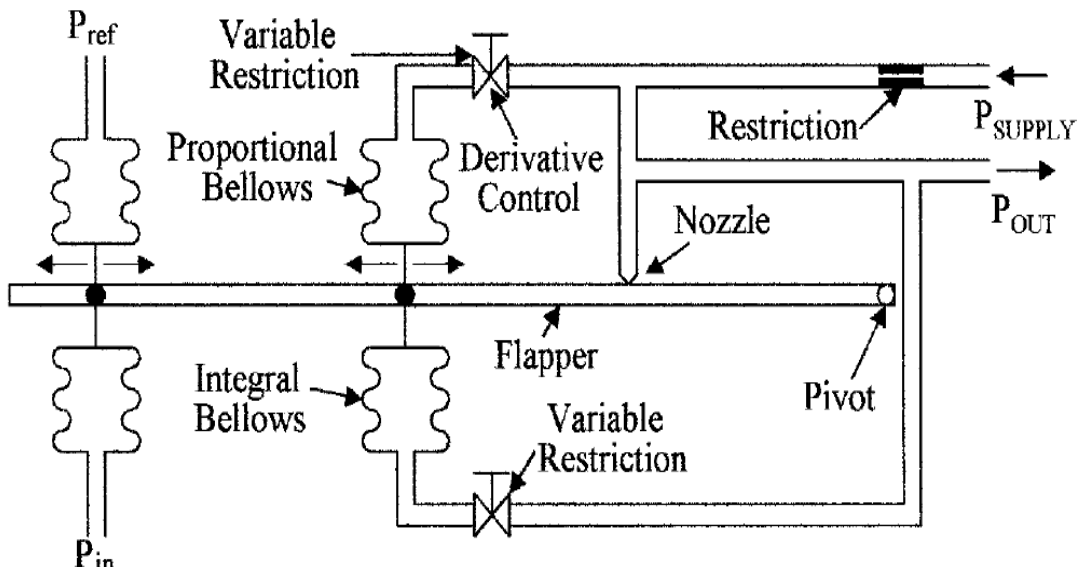
4M

Ans:



2M

OR

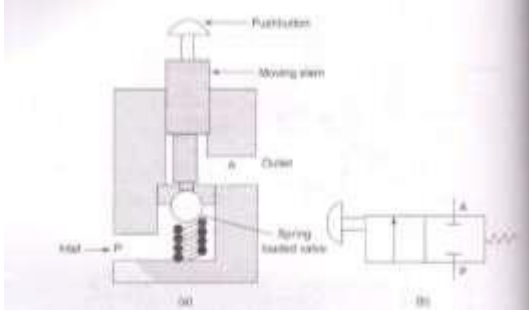
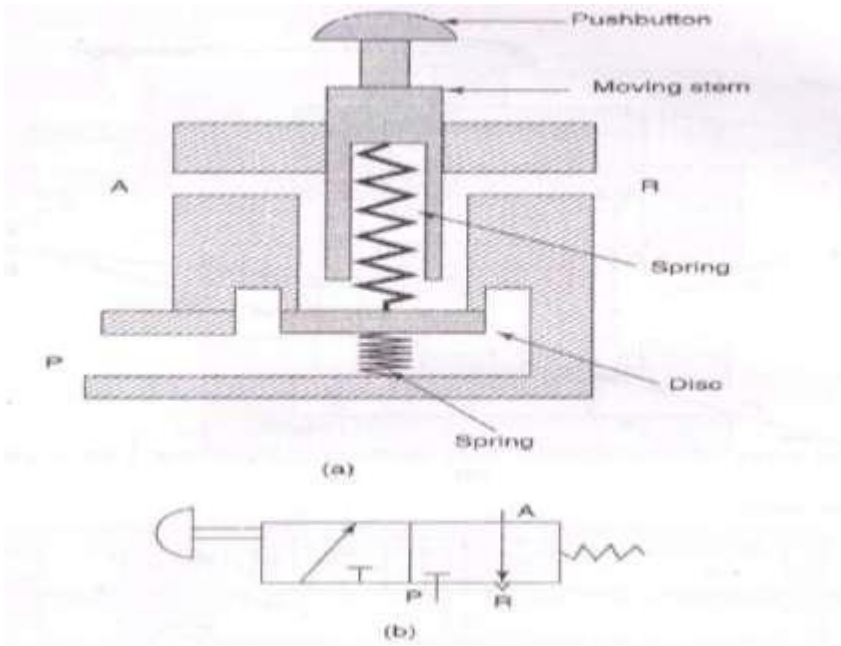


- PID controller is a continuous control action which is a combined action Proportional, Integral and Derivative control actions.
- In pneumatic PID controller control action is achieved using diaphragm-bellow-flapper nozzle system.
- The pressure from the sensing device P_{in} is compared to a set or reference pressure

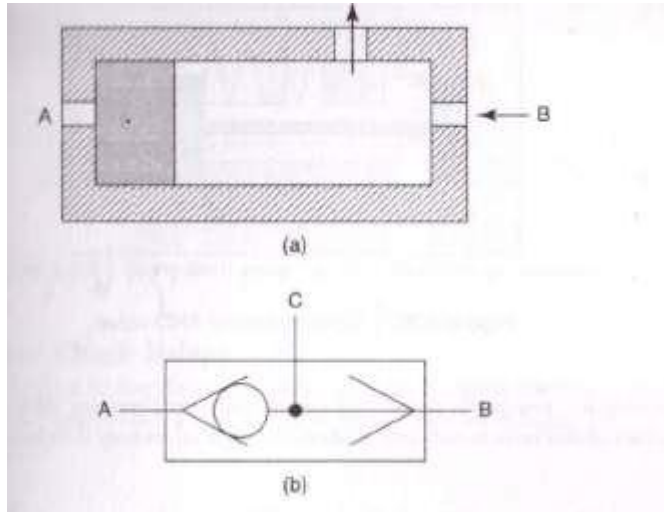
2M



		<p>P ref to generate a differential force (error signal) on the flapper to move the flapper in relation to the nozzle giving an output pressure proportional to the difference between P_{in} and P_{ref}.</p> <ul style="list-style-type: none">• If the derivative restriction is removed the output pressure is fed back to the flapper via the proportional bellows to oppose the error signal and to give proportional action. System gain is adjusted by moving the position of the bellows along the flapper's arm,• Integral action is achieved by the addition of the integral bellows and restriction. An increase in P_{in} moves the flapper towards the nozzle causing an increase in output pressure. The increase in output pressure is fed to the integral bellows via the restriction until the pressure in the integral bellows is sufficient to hold the flapper in the position set by the increase in P_{in}, creating integral action	
	e)	Classify the robots based on workspace.	4M
	Ans:	Classification of robot: 1)Material Processing robot 2)Material handling robot 3)Assembly robot 4)Inspection robot	Each 1 mark
	f)	Write a note on 'Evolution of Mechatronics'.	4M
	Ans:	Explanation:-- <ul style="list-style-type: none">• Mechanical engineering products and systems that employ some form of electrical engineering principles and devices have been developed and used since the early part of the 20th century.• These systems included the automobile, electric typewriter, aircraft, and elevator. Some of the power sources used in these systems were not necessarily electrical, but there were batteries and/or the conversion of thermal power into electricity through generators.• These electromechanical systems were not Mechatronics systems because they did not use an integrated approach characterizing Mechatronics for their analysis, design, development, and implementation• Rapid advances in electromechanical devices and systems were possible particularly due to developments in control engineering, which began for the most part in the early 1950s, and still more rapid advances in digital computer and communication as a result of integrated circuit (IC) and microprocessor technologies, starting from the late 1960s. With these advances, engineers and scientists felt the need for an integrated multidisciplinary approach to design and hence a mechatronic approach.• Yasakawa Electric in Japan was the first to coin the term mechatronics, for which the company obtained a trademark in 1972.• With today's sophisticated technologies of mechanics and materials, analog and digital electronics, sensors, actuators, controllers, electromechanical design, and micro-electromechanical systems (MEMS) with embedded sensors, actuators, and microcontrollers, the field of mechatronics has attained a good degree of maturity. Now, many universities around the world offer undergraduate and graduate programs in mechatronic engineering, which have become highly effective and popular among students, instructors, employees, and employers	4M

		alike.	
Q.6		Attempt any TWO:	16- Total Marks
a)		Describe with sketch (i) Poppet valve (ii) Spool valve.	8M
Ans:	 <p style="text-align: center;">OR</p> 	<p>4 mark for poppet valve and 4 mark for spool valve- 2m dia. 2m expla.</p>	
		<p>A poppet valve (also called mushroom valve) is a valve typically used to control the timing and quantity of gas or vapors flow into an engine. It consists of a hole, usually round or oval, and a tapered plug, usually a disk shape on the end of a shaft also called a valve stem. The portion of the hole where the plug meets with it is referred to as the 'seat' or 'valve seat'. The shaft guides the plug portion by sliding through a valve guide. In exhaust applications, a pressure differential helps to seal the valve and in intake valves a pressure differential helps open it. Poppet valves date from at least the 1770s, when James Watt used them on his steam engines.</p>	

A shuttle valve:



A shuttle valve is a type of valve which allows fluid to flow through it from one of two sources. Generally a shuttle valve is used in pneumatic systems, although sometimes it will be found in hydraulic systems.

The basic structure of a shuttle valve is like a tube with three openings; one on each end, and one in the middle. A ball or other blocking valve element moves freely within the tube. When pressure from a fluid is exerted through an opening on one end it pushes the ball towards the opposite end. This prevents the fluid from traveling through that opening, but allows it to flow through the middle opening. In this way two different sources can provide pressure without the threat of back flow from one source to the other. In pneumatic logic a shuttle-valve works as an OR gate.

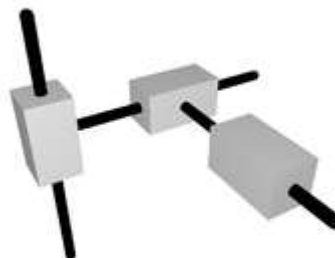
b)

Draw construction of Cartesian and cylindrical robots and explain their degree of freedoms.

4M

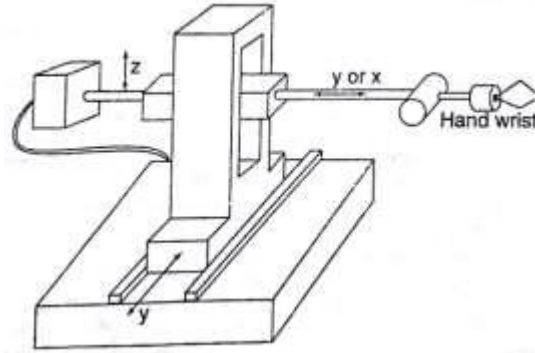
Ans:

Diagram:



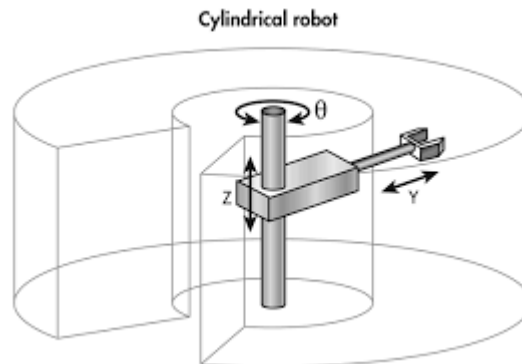
OR

1 mark for each sketch
1 mark of each DOF

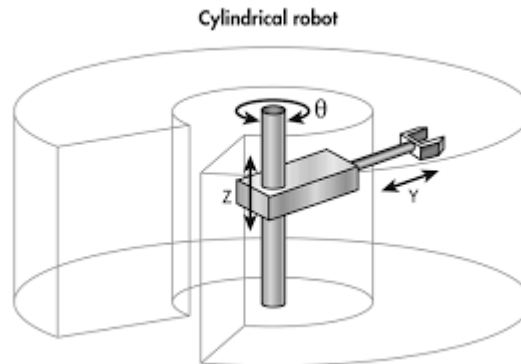


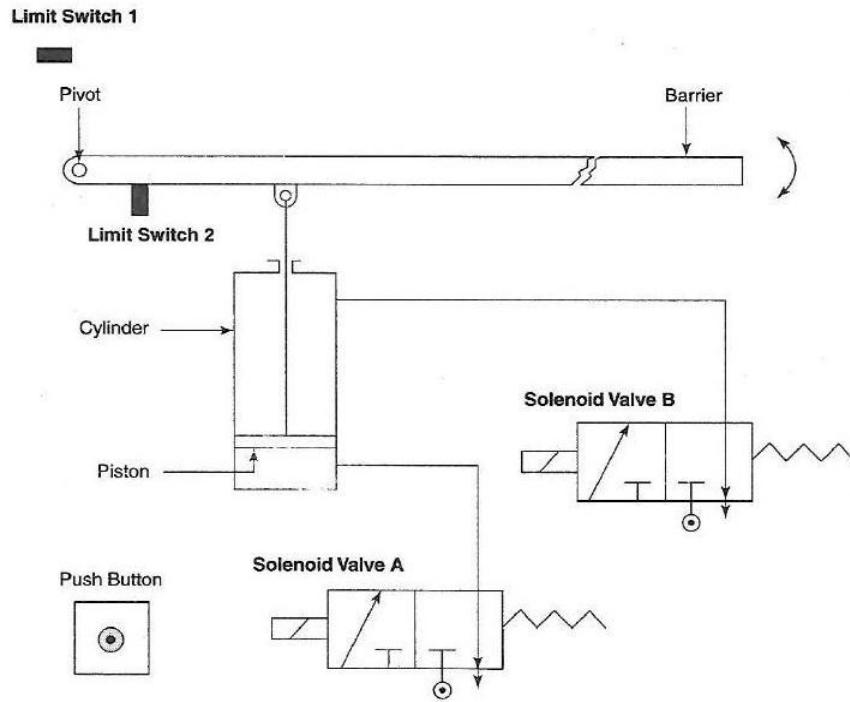
DOF: A **Cartesian coordinate robot** (also called **linear robot**) is an industrial robot whose three principal axes of control are linear (i.e. they move in a straight line rather than rotate) and are at right angles to each other. The three sliding joints correspond to moving the wrist up-down, in-out, back-forth.

Cylindrical coordinate:

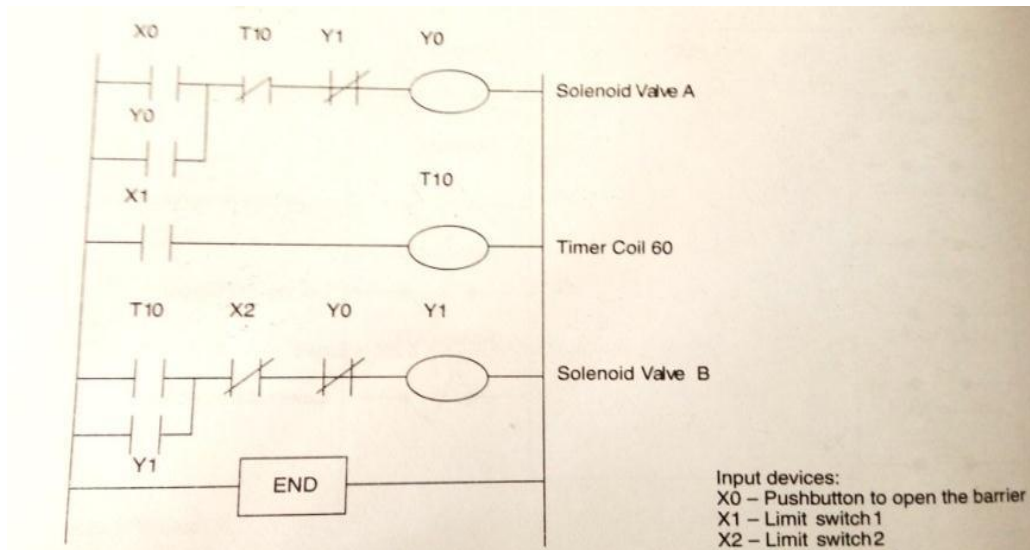


A cylindrical arm also has three degrees of freedom, but it moves linearly only along the Y and Z axes. Its third degree of freedom is the rotation at its base around the two axes. The work envelope is in the shape of a cylinder.

	<p>DOF: A Cartesian coordinate robot (also called linear robot) is an industrial robot whose three principal axes of control are linear (i.e. they move in a straight line rather than rotate) and are at right angles to each other. The three sliding joints correspond to moving the wrist up-down, in-out, back-forth.</p> <p>Cylindrical coordinate:</p>  <p>A cylindrical arm also has three degrees of freedom, but it moves linearly only along the Y and Z axes. Its third degree of freedom is the rotation at its base around the two axes. The work envelope is in the shape of a cylinder.</p>	
<p>c)</p>	<p>Develop a ladder diagram for to control conveyor belt motor equipped with the:</p> <ul style="list-style-type: none"> (i) Counter of item. (ii) Start & Stop functions. (iii) Change of direction function. 	<p>4M</p>
<p>Ans:</p>	<p>(Note: Mark can be given to correct logic diagram may not be same as below because question does not mention application and counter for reverse and forward)</p>	



Forward:





Reverse:

