



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 judgment 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.

Q1. Attempt any THREE of following:

12M

- a) Explain the scope of Mechatronics in Industry. Give any four examples.

Ans: [Scope 2marks, example 2 marks]

Scope:

- There is no limit for scope of Mechatronics in industry. Due to mechatronics speed, quality, flexibility, sophistication and quantity of product has improved drastically.
- Marketing of product has also become simple. It has increased accuracy in design for example production of machine tool through CNC machines more accurate and precise than conventional lathe.
- Similarly quality and hygiene of food product due automation and robotics in packing industry has improved.
- Due to embedded system domestic machinery has become simple and user friendly. Automobile industry has become more sophisticated as well as user friendly.
- Due to application prompt sensors accident of automotive vehicles are less. The use of automation in Hospital diagnosis of diseases has become simple not only that but doing the tele-health care is also possible for patient.

Examples :- (any four)

- MRI,
- CT-SCAN,
- Endoscopy
- Robotics
- Unmanned Air vehicle.

[Note: students can write any other four example mark should given to it]



b) Differentiate between ‘Sensor’ and ‘Transducer’.

Ans: [any four point 1 mark each]

SR No	Transducer	Sensor
1	It is device which convert any physical quantity into other physical quantity which is useful for electrical purpose	It is device which senses any physical quantity and convert it into electrical variable
2	This is basic ,elementary Device	It is Sophisticated Device
3	all transducers are not sensors	all sensors are transducer
4	May not be accurate	more accurate
5	transducer may be primary or secondary	sensors are physical to electrical
6	Example : proximity sensor, (photonic, magnetic, metallic),photo diode, LDR, thermistor,etc.	LVDT, bellow, Bourdon tube, Speaker, etc.

[Note: students can write any other valid points]

c) Explain electronic PID controller with the help of diagram.

Ans: [Diagram-2 marks, explanation-2 marks]

Diagram:

[Note: Diagram can be block diagram or electronic diagram shown Below]

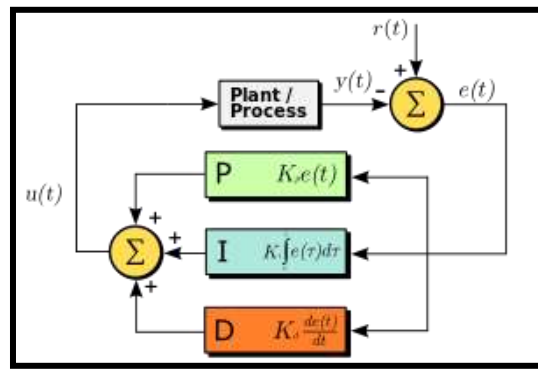
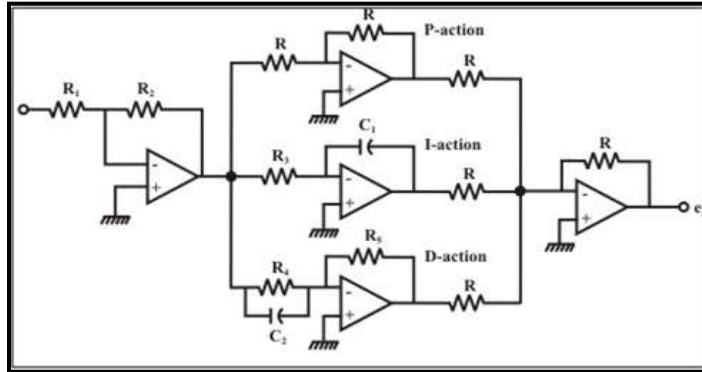


Fig. PID controller

OR



Explanation:

- 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:

$$u(t) = MV(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{d}{dt} e(t)$$

Where,

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 .

- 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.

The proportional term is given by:

$$P_{out} = K_p e(t)$$

- The contribution from the integral term is proportional to both the magnitude of the error and the duration of the error. The integral in a PID controller is the sum of the instantaneous error over time and gives the accumulated offset that should have been corrected previously. The accumulated error is then multiplied by the integral gain and added to the controller output.

The integral term is given by:

$$I_{out} = K_i \int_0^t e(\tau) d\tau$$

- The derivative of the process error is calculated by determining the slope of the error over time and multiplying this rate of change by the derivative gain K_d . The magnitude of the contribution of the derivative term to the overall control action is termed the derivative gain, K_d .

The derivative term is given by:

$$D_{out} = K_d \frac{d}{dt} e(t)$$

Derivative action predicts system behavior and thus improves settling time and stability of the system.

d) State the working principle of 'solenoid valve' with neat sketch.

Ans: [working principle: 2mark sketch (any 1): 2mark]

Working 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.

Diagram:

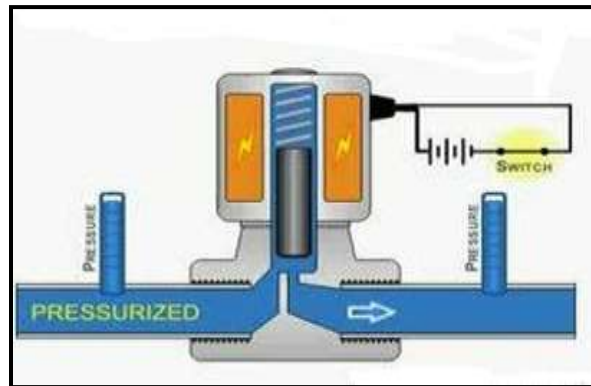
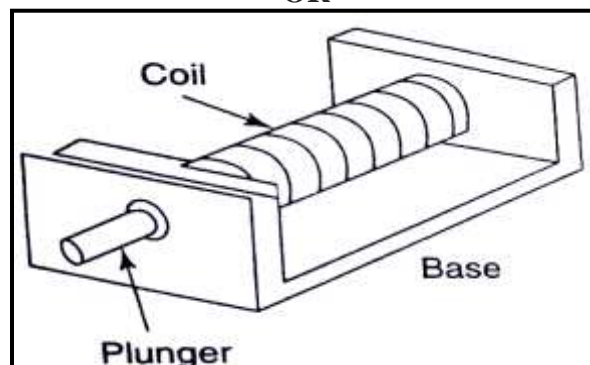
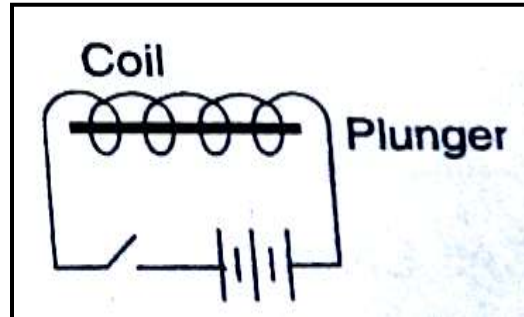


Fig. solenoid valve

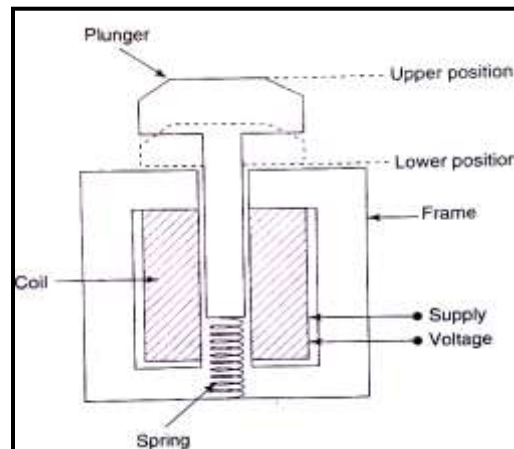
OR



OR



OR



[Note: students can any other correct Diagram]

Q.1.B) Attempt any ONE:

6 M

a) Explain the construction and working of LVDT accelerometer with the help of diagram.

Ans: [3marks for diagram, 3marks for working]

Working:

A type of accelerometer takes advantage of the natural linear displacement measurement of the LVDT to measure mass displacement. LVDT is Linear Variable differential transducer which works on magnetic principle. In these instruments, the LVDT core itself is the seismic mass. Displacements of the core are converted directly into a linearly proportional ac voltage. These accelerometers generally have a natural frequency less than 80 Hz and are commonly used for steady-state and low-frequency vibration. Fig. shows the basic structure of such an accelerometer.

Diagram:

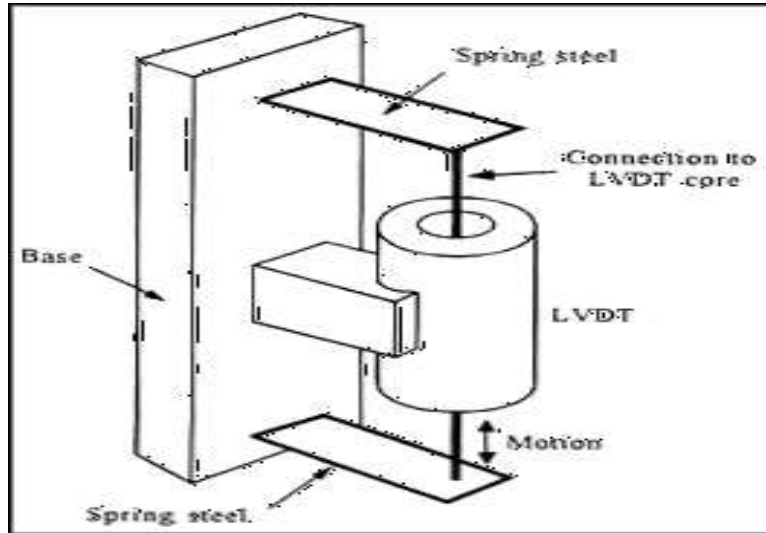
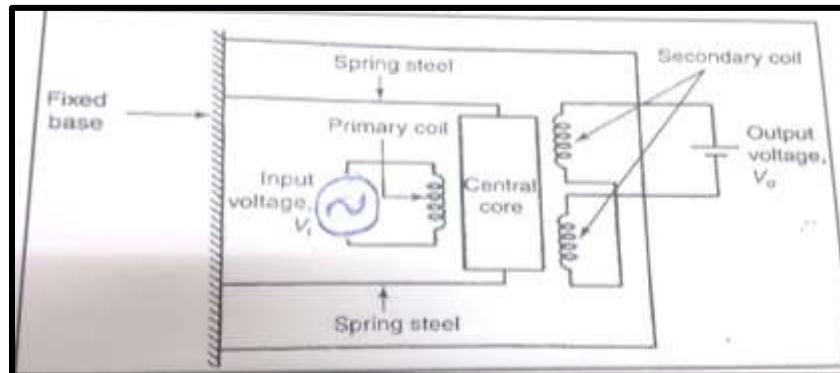


Fig.LVDT accelerometer

OR



b) What is Part Programming? Enlist Basic Requirement for part programming with suitable example.

Ans: [Definition: 2mark, Requirement and explanation: 4 mark]

Definition:

The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of a numerical control computer program. It is the task of preparing a program sheet from a drawing sheet. All data is fed into the numerical control system using a standardized format. Programming is where all the machining data are compiled and where the data are translated into a language which can be understood by the control system of the machine tool.

- The part programming contains the list of coordinate values along the X, Y and Z directions of the entire tool path to finish the component. The program should also contain information, such as feed and speed. Each of the necessary instructions for a particular operation given in the part program is known as an NC word. A group of



such NC words constitutes a complete NC instruction, known as block. The commonly used words are N, G, F, S, T, and M.

- Hence the methods of part programming can be of two types depending upon the two techniques as below:
- Manual part programming
- Computer aided part programming

Requirement:

- Knowledge about various manufacturing processes and machines.
- Sequence of operations to be performed for a given component.
- Knowledge of the selection of cutting parameters.
- Editing the part program according to the design changes.
- Knowledge about the codes and functions used in part programs.
- Requirement Computer aided part programming
- The programme has to do only following things:
 - (a) Defining the work part geometry.
 - (b) Defining the repetition work.
 - (c) Specifying the operation sequence



Q2. Attempt any TWO

[16 mark =2*8]

a) What is the significance of signal conditioner? Explain the need of following in mechatronics system.

i) Isolator ii) Filter iii) Amplifier iv) Data converter

Ans: [Significance: 4 marks ,need: 1 mark each]

Significance: Signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Signal inputs accepted by signal conditioners include DC voltage and current, AC voltage and current, frequency and electric charge.

Sensor inputs can be accelerometer, thermocouple ,thermistor, resistance thermometer, strain gauge or bridge and LVDT or RVDT. Specialized inputs include encoder, counter or tachometer, timer or clock, relay or switch, and other specialized inputs. Outputs for signal conditioning equipment can be voltage, current, frequency, timer or counter, relay, resistance or potentiometer, and other specialized outputs.

It is primarily utilized for data acquisition, in which sensor signals must be normalized and filtered to levels suitable for analog-to-digital conversion so they can be read by computerized devices. Other uses include pre-processing signals in order to reduce computing time, converting ranged data to Boolean values, for example when knowing when a sensor has reached certain value.

Isolator: Signal isolation must be used in order to pass the signal from the source to the measurement device without a physical connection so that input will not load next stage .optical isolator may be used.

Filter: To filter out noise due to environment or any other reason like EmI, or 50 Hz noise

Amplifier: Signal amplification performs two important functions: increases the resolution of the input signal, and increases its signal-to-noise ratio. For example, the output of an electronic temperature sensor, which is probably in the milli volts range, is probably too low for an analog-to-digital converter (ADC) to process directly

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.

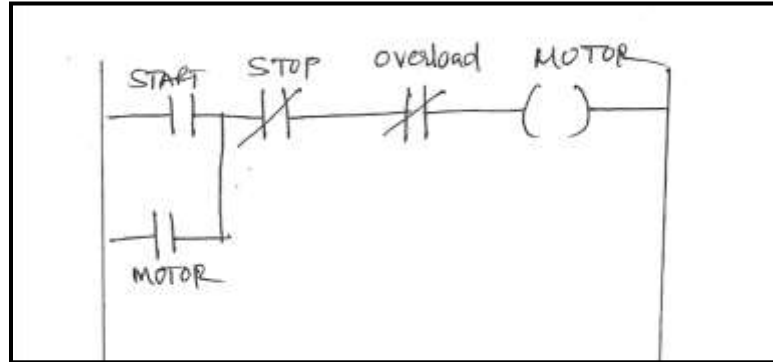
b) Develop ladder diagram/ program using PLC for following:

i) To ON-OFF a motor

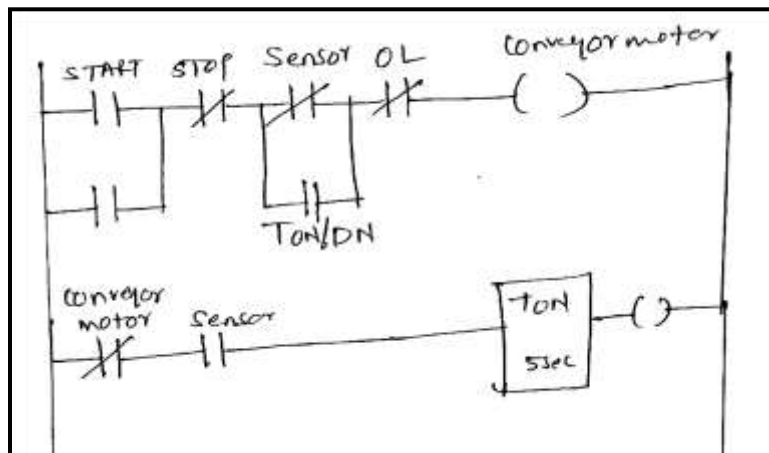
ii) To control conveyor belt motor

Ans: [4 mark each ladder program] (Any Other Correct Logic Can Be Used)

i) To ON-OFF a motor



ii) To control conveyor belt motor



c) What is belt? Explain operation of belt. List different types of belt and give one example of each.

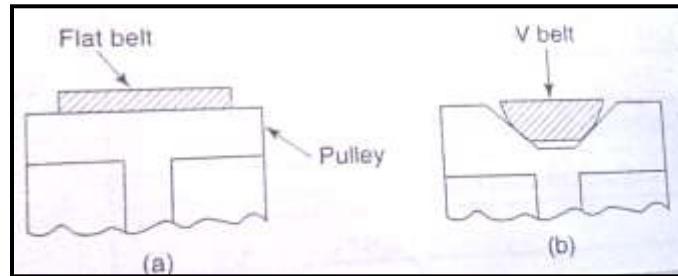
Ans: [Definition: 2 marks, operation: 2mark, different types (any four):2 marks, example: 2 mark]

Definition:- 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.

Operation- 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 points.

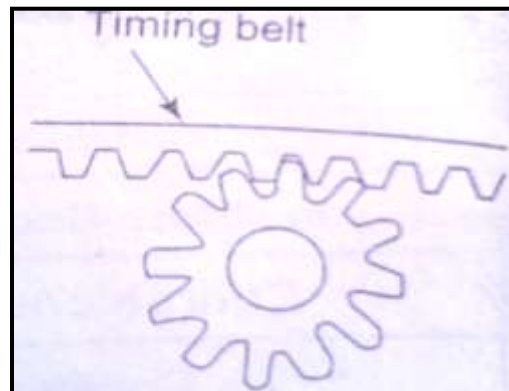
Types of belts & example (Diagrams are optional)

V belt: industrial and agricultural machinery



Flat belt: bucksaws, sawmills, threshers, siloblowers, conveyors for filling corn water pumps (for wells, mines, or swampy farm fields), and electrical generators.

Timing belt: Camshafts of automobiles, miniature timing systems, and stepper motors.

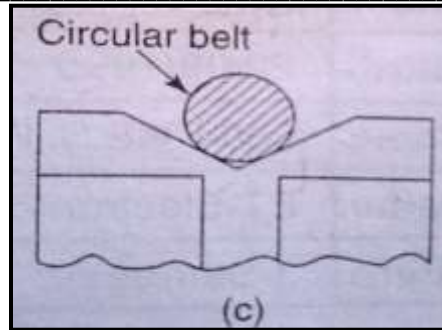


Ribbed belt: compressors, fitness bikes, agricultural machinery, food mixers, washing machines, lawn mowers

Film belt: business machines, tape recorders, and other light-duty operations.

Multi-grooved belt: bicycle chain

Round belt: sewing machines



Q.3 Attempt any FOUR of the following:

16M

(a) When to select P-I controller? Give any two application of P-I controller.

Ans: [Selection- 2 Mark, applications (any two) – 1 Mark each]

Selection of P-I controller:

2M

- The PI mode of controller is commonly selected for slow-to- moderate speed processes.
- Fast response of the system is not required.
- Large disturbances and noise are present during operation of the process.
- There is only one energy storage in process (capacitive or inductive).
- There are large transport delays in the system.

Applications of P-I controller: (any two) – 1 Mark each]

2M

- PI controller is used in the control system with frequent or large load changes.
- Because of the integration time, the process must have relatively slow changes in the load to prevent conditions indicated by the integral overshoot.
- Used in industry where speed of response is not an issue.
- As a adaptive controller for flow process.
- Real time pressure control process.

(b) Explain the Mechatronics system with the help of block diagram and labeled the various elements.

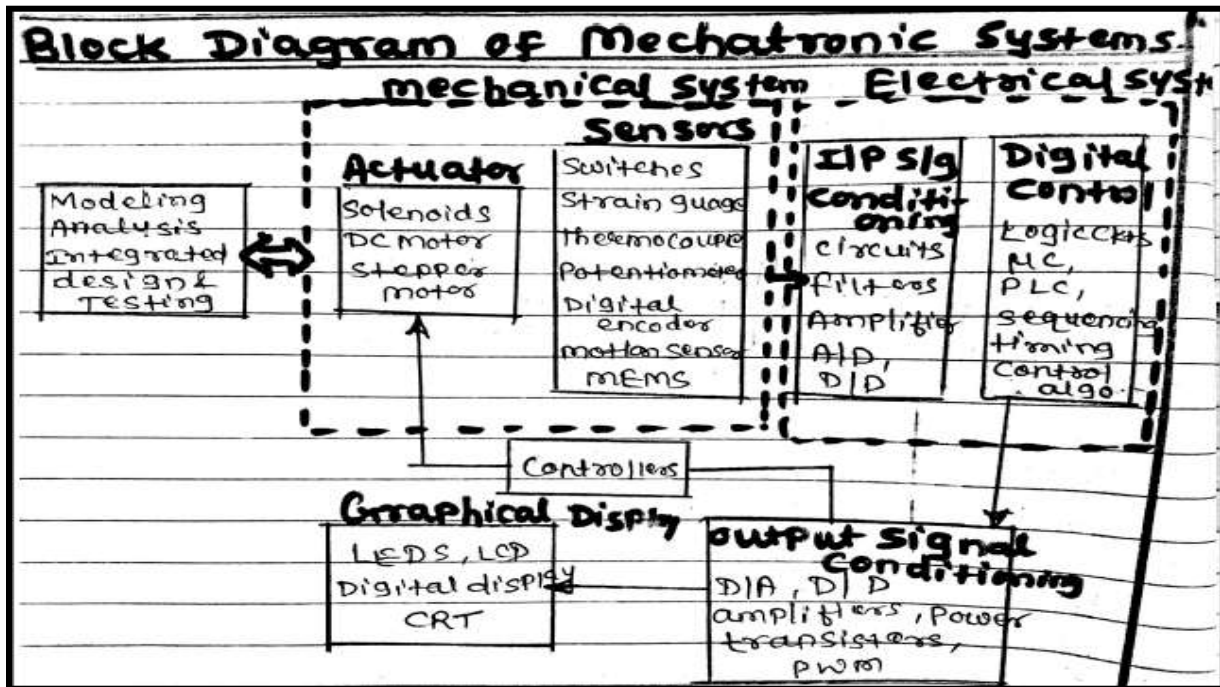
Ans: [Block diagram-2 Marks, Explanation-2 Marks]

The key elements of Mechatronics systems can be classified under following categories:

- Information systems
- Mechanical systems
- Electrical systems
- Computer systems
- Sensor and actuators
- Real-time interfacing

Block Diagram:

2M



Explanation:

2M

Mechanical systems:

- **Actuators:** Actuations is the result of direct physical action on process directly. In any physical process, there is motion or some sort of action. This motion or action can be applied to mechanical processes or structure through actuators. E.g. Stepper motor, Solenoids, DC motor, synchros etc.
- **Sensors:** It accepts the physical quantities (process variables) from mechanical processes (dynamic system) and converts them into a signal that can be processed by the system.

Electrical Systems:

- **Input signal conditioning and interfacing:** The output of a transducer may be too small, too noisy, contain DC offset, not be compatible with next stages, and contain wrong information. Signal conditioning process if amplification using amplifier in which the signal magnitude is increased.
- **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.

(c) State the working principle of capacitive sensor with neat diagram.

Ans: [Diagram-2 Mark, Working principle-2 Mark]

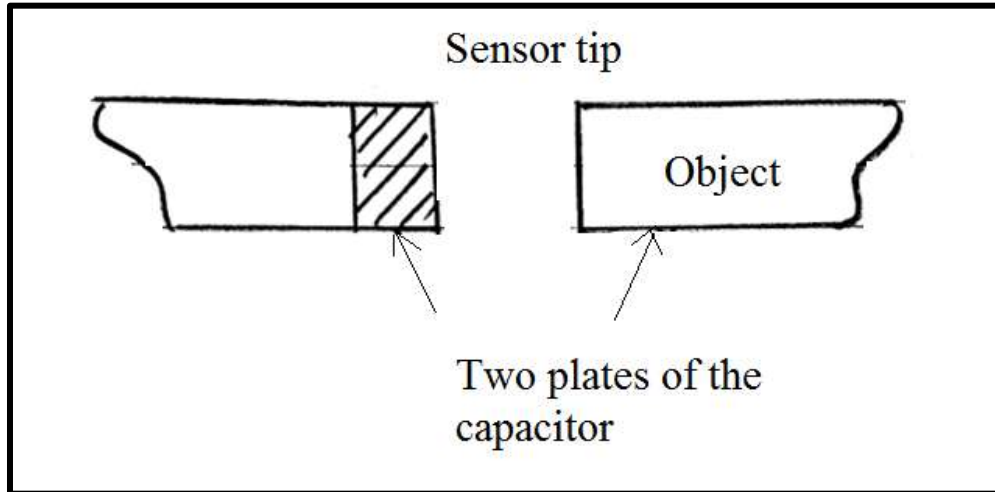


Fig. capacitive sensor

Working 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.

$$C = \frac{\epsilon A}{d}$$

Where, ϵ is permittivity of dielectric material.

A is area of plate

d is distance between plate.



(d) Differentiate between pneumatic and hydraulic system.

Ans: [any four correct point (any other relevant point)- 1 Mark each]

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.

(e) Enlist any eight applications of 'ROBOT'

Ans: [Any eight correct applications- ½ Mark each]

- **Automobile Industry:** Assembly of care engines, Car wheel mounting system
- **Electronic Industry:** Microcircuit assembly and surface mounting.
- **Nuclear industry and hazardous environments:** Fuel handling in nuclear reactors, inspection in nuclear power plants.
- **Material handling:** Packaging system, to load and unload industrial work piece.
- **Welding:** Spot welding, Arc welding
- **Assembly**
- **Machining**
- **Spray coating**

- Die-casting
- Coal mining

(f) Explain in brief how anti-lock braking system works.

Ans: [Diagram- 2 Marks, Explanation-2 Marks]

- 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.

Diagram:

2M

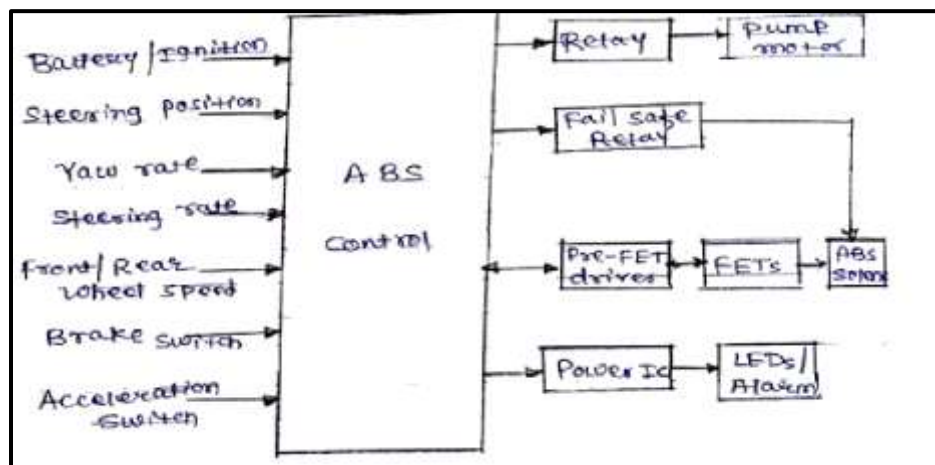


Fig. Anti-lock braking system

Explanation:

2M

- 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.
- 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 wheels 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 monitored wheels suddenly beings to reduce speed indicating a loss of traction with load the controller then activates the antilock system.
- 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.

Q.4 (A) Attempt any THREE:**(3X4 = 12M)**

a) Explain in brief 'Hall effect sensor'.

Ans: [Diagram- 2 Marks, Explanation-2 Marks]

Hall Effect sensor:

- When a beam of charged particles passes through a magnetic field, the beam is deflected from its straight line path due to the forces acting on the particles.
- A current flowing in a conductor, such as a beam, is deflected by a magnetic field. This effect is called Hall Effect.

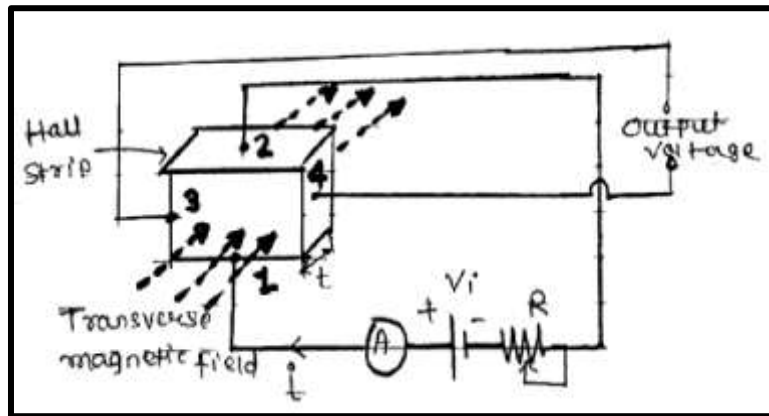


Fig. Hall effect sensor'

- The working principle of Hall Effect sensor is that if a strip of conducting material carries a current in the presence of a transverse magnetic field as shown in figure above, 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 lead 1 and 2 of the strip and the output leads 3 and 4 are connected with a Hall strip.
- When transverse magnetic field passes through the strip, the voltage difference occurs in the output leads.

b) What are advantages and disadvantages of Mechatronics system?

Ans: [Any two advantages- 1 Mark each; any two disadvantages- 1 Mark each]

Advantages of Mechatronics system:**2M**

- High level of integration.
- Increased functionality and better design.
- More use of electronics and software instead of mechanical function.
- Assumes responsibility for process and operation with little interference of operators.
- Uses artificial intelligence and intelligent process control.
- Multisensory and program environment.

- High reliability and safety.
- Improved and less expensive controls.

Disadvantages of Mechatronics system:

2M

- The initial cost is very high.
- The complicated design and system.
- The repair and maintenance is complex.
- Its replacement is difficult, that it is difficult to change old system to new system.

c) Define PLC and draw its labeled diagram.

Ans: [Definition (any relevant definition)- 1 Mark, Labeled Diagram- 3 Mark]

Definition of PLC:

A PLC is microprocessor-based controller that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting and arithmetic in order to control machines and process.

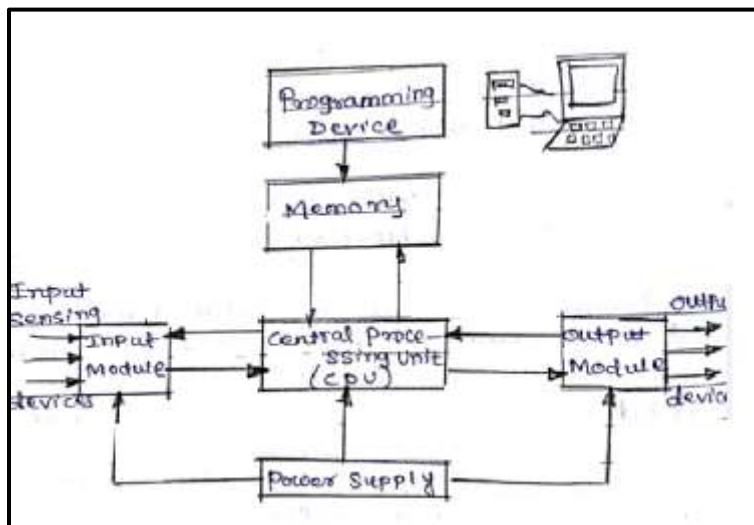


Fig. Architecture of PLC

d) How robots are classified on the basis of work place? Give one example of each robot.

Ans: [Classification- ½ Mark each, Application (any one) for each robot- ½ Mark each]

Classification of robot:

- Material Processing robot
- Material handling robot
- Assembly robot
- Inspection robot



Type of Robot	Example
Material processing robot	1. Spot welding 2. Continuous arc welding 3. Spray painting 4. Machining operations
Material handling robot	1. Movement of parts, tools, materials and equipment.
Assembly robot	1. Select and assemble components. 2. Part linking and part joining. 3. Pick and Place robot.
Inspection robot	1. Detect the presence or absence of a component in an assembly line using touch or an optical sensor.

(B) Attempt any ONE of the following:

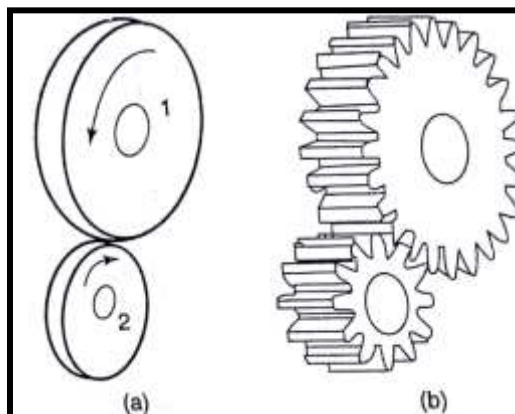
6M

a) State the working principle of gears and give its applications.

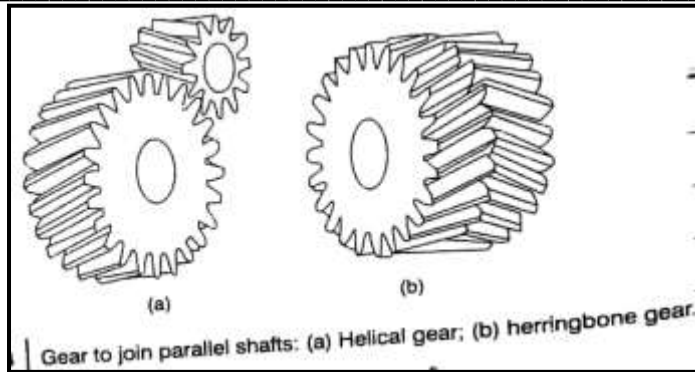
Ans: [Working Principle- 2 Mark, Diagram of any one gear- 2 Mark, Application (any two) - 1 Mark each]

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 as shown in figure (a) below.



- Power transmitted between two shafts is small because there is a possibility of slip. In order to avoid slipping, a number of projections (called teeth) as shown in figure (b) above.
- According to the relative positions of their axes they are classified as spur gear, helical gear, and herringbone gear as shown in figure below.



Applications of Gears:

- Differential analyzers.
- Agricultural equipment.
- Industrial construction.
- Mining equipment.
- Automotive equipment.

b) What is ‘MEMS’? Explain with neat block diagram.

Ans: [Definition- 1Mark, Block diagram- 3 Marks, Explanation- 2 Marks]

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.

Block Diagram:

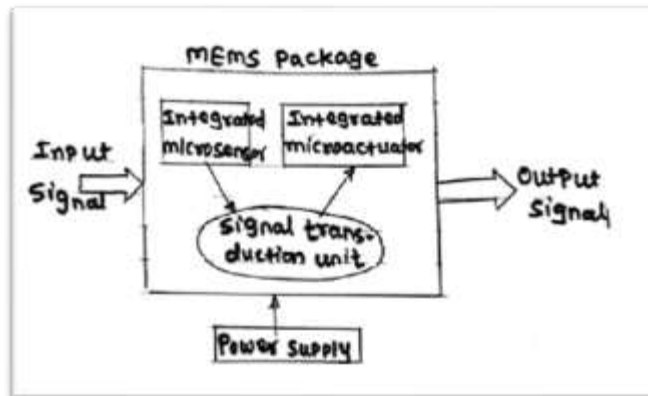


Fig. Block diagram of MFMS



Explanation:

- **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.

Q5) Attempt any FOUR:

16M

a) State the principle of 'Tachogenerator' with the help of diagram.

Ans: (2- Marks for diagram (any one), 2 Marks for explanation related diagram)

Diagram:

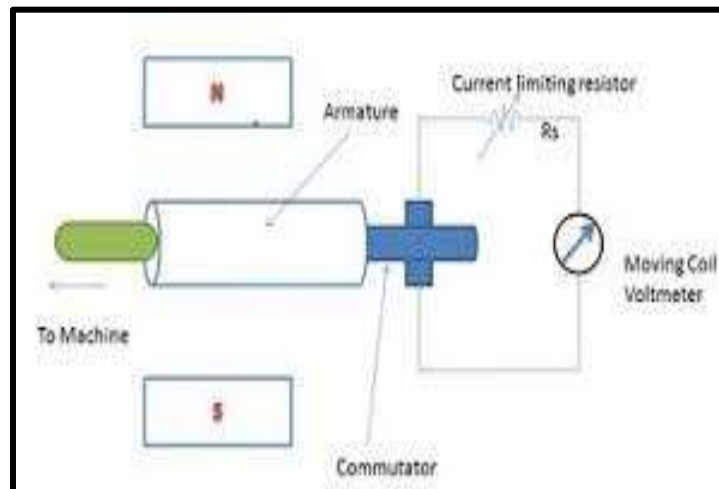


Fig. Tachogenerator

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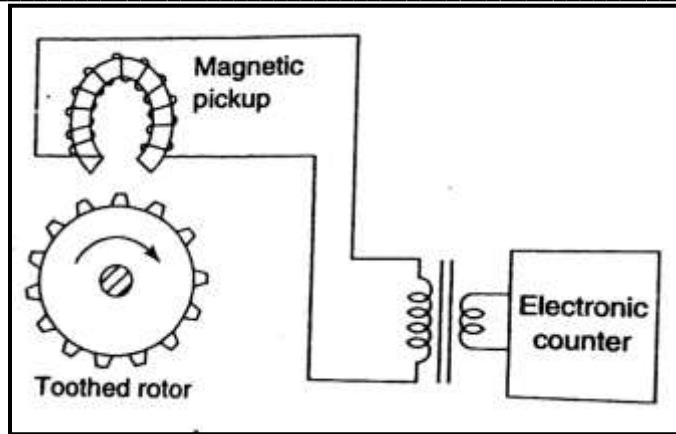


Fig. Toothed rotor tachogenerator

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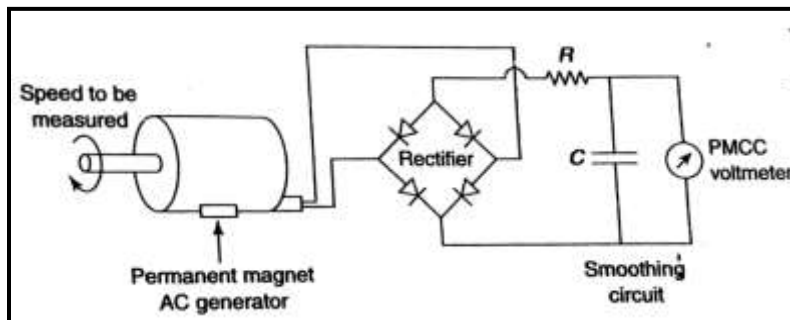


Fig. AC tachogenerator

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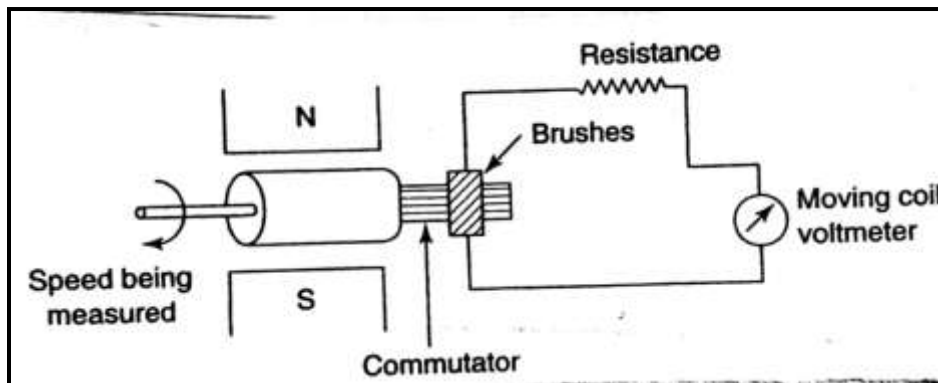


Fig. DC tachogenerator



Principle of 'Tachogenerator':

- Tachogenerators are AC or DC generators that output a voltage in proportion to the rotational speed of a shaft on a rotating electrical machine (electric motor), and thus are used to measure the speed and direction of rotation.
- Most commonly found in fractional horsepower (FHP) applications they are often referred to as 'sensors', most electric motor manufacturers offer a tachogenerator on DC commutated (brushed/permanent magnet) motor types.

b) Enlist the advantages of Microcontroller (any Four).

Ans: [1 mark for each advantage]

Advantages of microcontrollers:

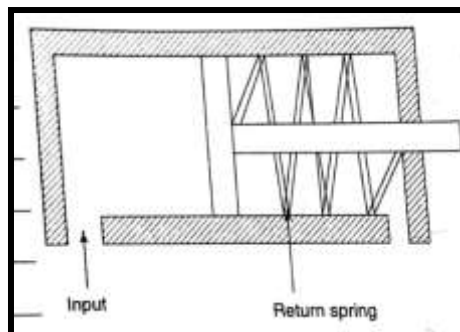
- It is an integrated chip with all valuable components including RAM, ROM, I/O Ports.
- Cost reducing programs with simple circuitry.
- Inbuilt timers / counters.
- More no.of instructions available.
- Microcontrollers are cheap and very small in size.
- Programming of Microcontrollers is simple to learn

c) What are 'Linear actuators'? State any four applications.

Ans: [Definition- 2 Mark, Any four application -1/2 Mark each] (Diagram is optional)

Linear actuators:

A **linear actuator** is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor.



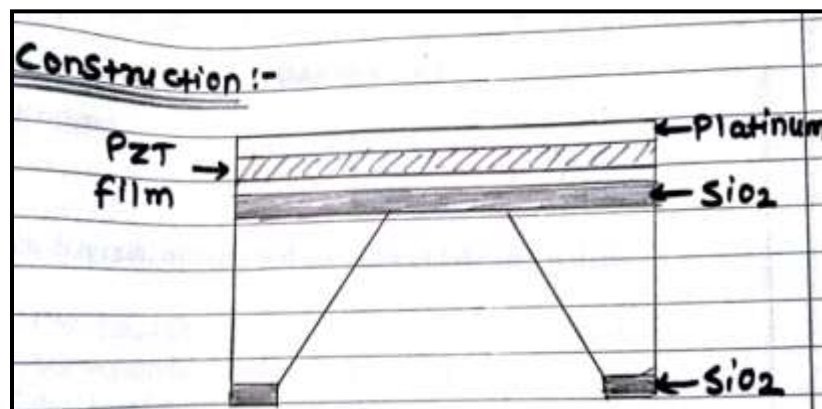
Applications:

- machine tools
- disk drives
- printers
- valves
- Dampers.

d) Explain how MEMS accelerometer is used as airbag sensor for car system.

Ans: [Diagram- 2 Mark, Explanation-2 Mark] [Related explanation should be given marks]

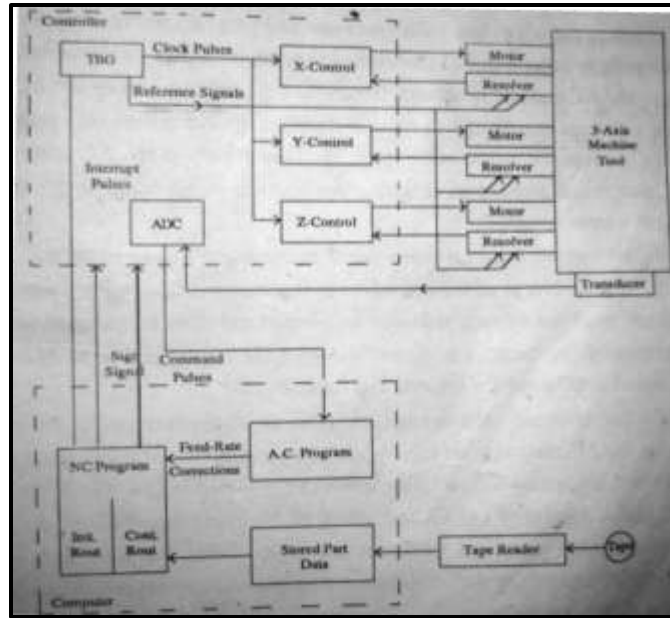
MEMS Accelerometer is used as airbag sensor:



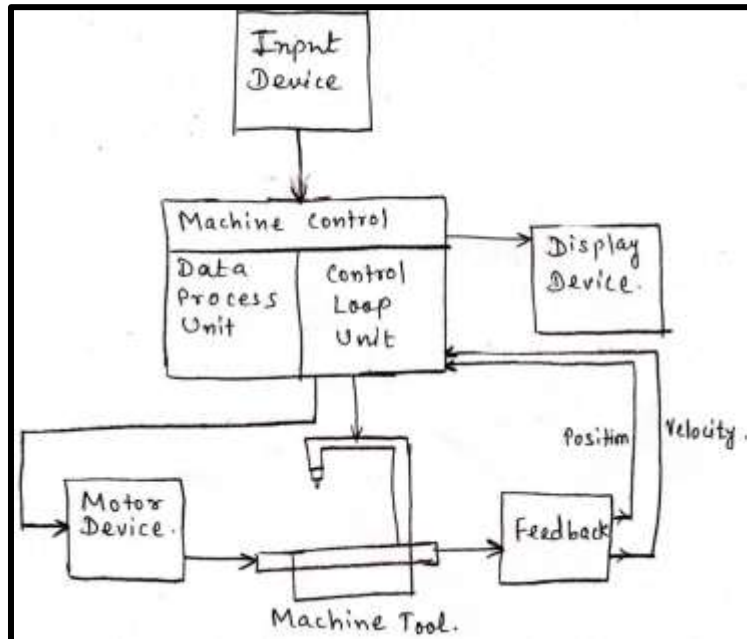
- Mechanical ignition airbags fit inside the steering wheel pad. When a collision occurs, the inertial sensor moves, setting off a mechanical igniter and inflator to deploy the airbag. As the sensor and igniter were in the same unit, the compact airbag unit easily fit most steering wheels, allowing broad 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 block diagram for CNC drilling machine and explain its working.

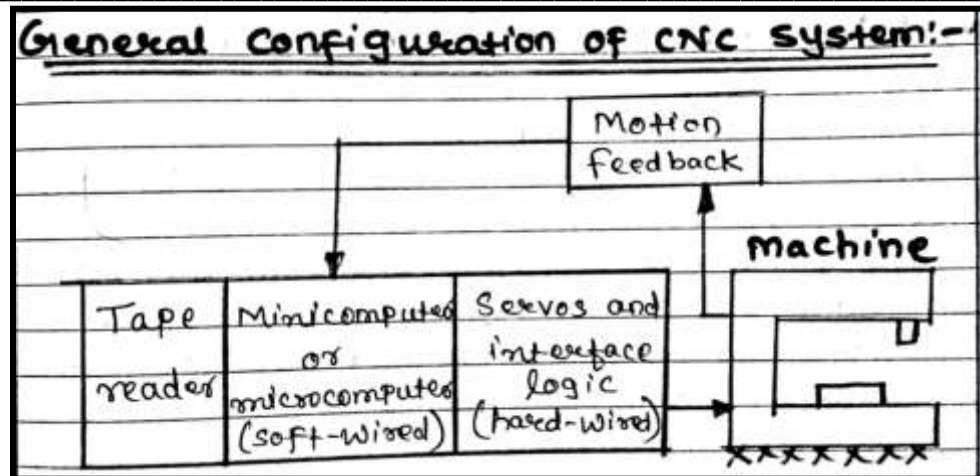
Ans:- [Diagram (any one)- 2 Mark, Explanation-2 Marks]



OR



OR



Block diagram consist of the following points:

2M

- Machine tool with DC servo motor as feedback element. The transducer is added as adaptive control application.
- The auxiliary controller through which the computer can control the machine drives. It is made up of Time Base Generator (TBG) and Analog to Digital Converter (ADC).
- The computer for storing the data and performing the NC and AC (Adaptive control) programs. Interrupt system takes care of simultaneous running of both programs.
- Tape reader for reading the two programs and NC data tapes.

The TBG includes the main clock having pulse frequency of 2.5 MHz it is used for three functions direct feeding of the control loops, generating interrupt pulses and generating reference signal for stator and revolvers.

The controller is connected to the computer with three different lines namely:

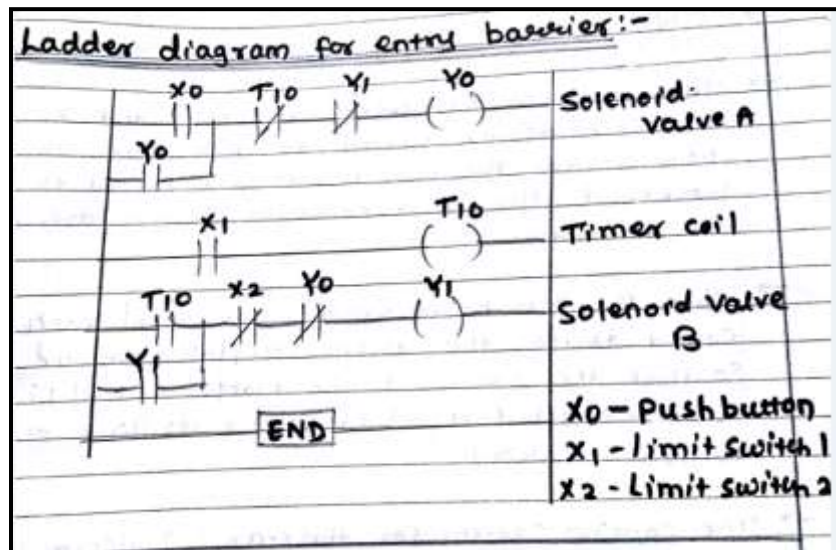
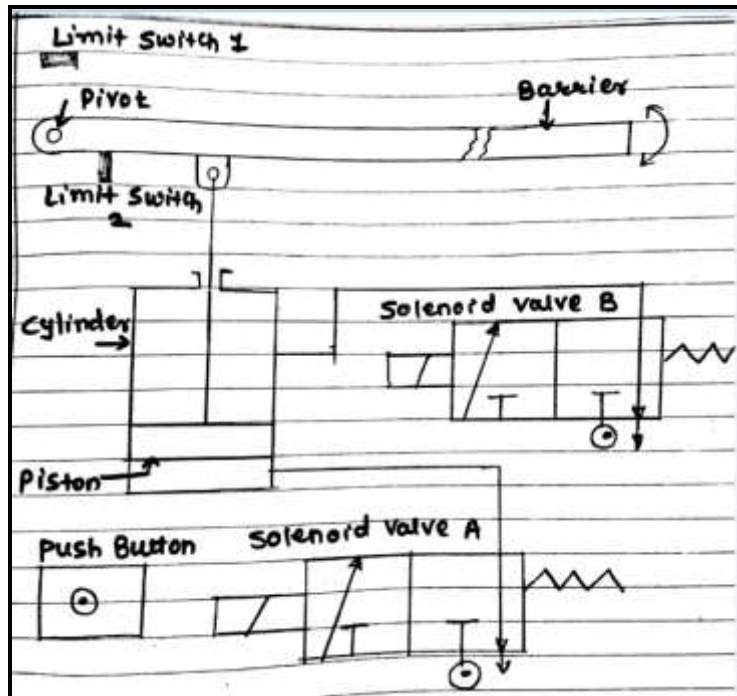
- Interrupt input line.
- Digital output line.
- Digital input line.

The interrupt pulses are generated by TBG and supplied to computer through inter

f) How PLC based automatic car parking system works? Explain in brief.

Ans : [Diagram- 2 Marks, Explanation -2 Marks) (Ladder diagram can be optional]

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.

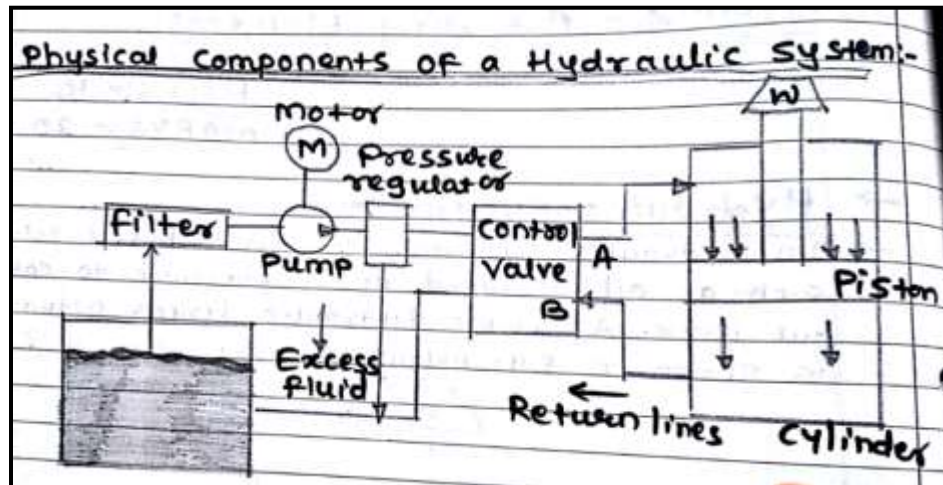
Q6) Attempt any FOUR:

16M

- a) List and explain the components of a hydraulic system.

Ans: [List of componets-1 Mark, Diagram-2 Marks, Explnation-1 Marks]

Components Hydraulic:



- **Hydraulic pump-** Supply fluid to the components in the system. Pressure in the system develops in reaction to the load. Hence, a pump rated for 5,000 psi is capable of maintaining flow against a load of 5,000 psi
- **Directional control valves** -route the fluid to the desired actuator. They usually consist of a spool inside a cast iron or steel housing. The spool slides to different positions in the housing, and intersecting grooves and channels route the fluid based on the spool's position.
- **Reservoir-**The hydraulic fluid reservoir holds excess hydraulic fluid to accommodate volume changes from: cylinder extension and contraction, temperature driven expansion and contraction, and leaks.
- **Accumulators-** are a common part of hydraulic machinery. Their function is to store energy by using pressurized gas. One type is a tube with a floating piston.
- **Hydraulic fluid-**Also known as *tractor fluid*, hydraulic fluid is the life of the hydraulic circuit. It is usually petroleum oil with various additives. Some hydraulic machines require fire resistant fluids, depending on their applications.
- **Filters-**Filters are an important part of hydraulic systems. Metal particles are continually produced by mechanical components and need to be removed along with other contaminants.
- **Seals, fittings and connections.**

b) What is 'Degree of freedom'? List the function of end effector.

Ans :- [Definition of DOF- 2 Marks, Function of end effectors- 2 Marks] (diagram can be optional)

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.

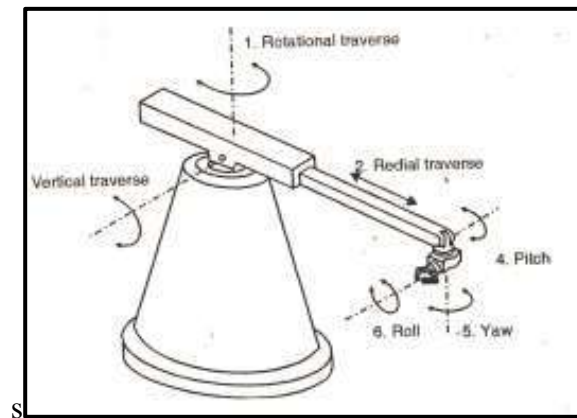


Fig. Degree of freedom (DOF)

End effectors:

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



Fig. End effectors



c) Explain in brief Cartesian robot.

Ans: [Diagram-2 Marks, Explanation-2 Marks]

Explanation:

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. Among other advantages, this mechanical arrangement simplifies the Robot control arm solution. Cartesian coordinate robots with the horizontal member supported at both ends are sometimes called **Gantry robots**. They are often quite large.

- A popular application for this type of robot is a computer numerical control machine (CNC machine) and 3D printing. The simplest application is used in milling and drawing machines where a pen or router translates across an x-y plane while a tool is raised and lowered onto a surface to create a precise design.

Diagram:

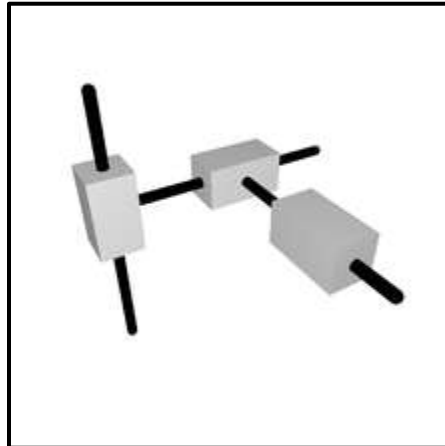


Fig. Cartesian robot

OR

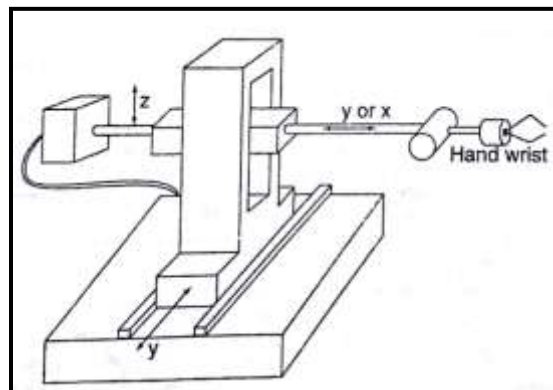
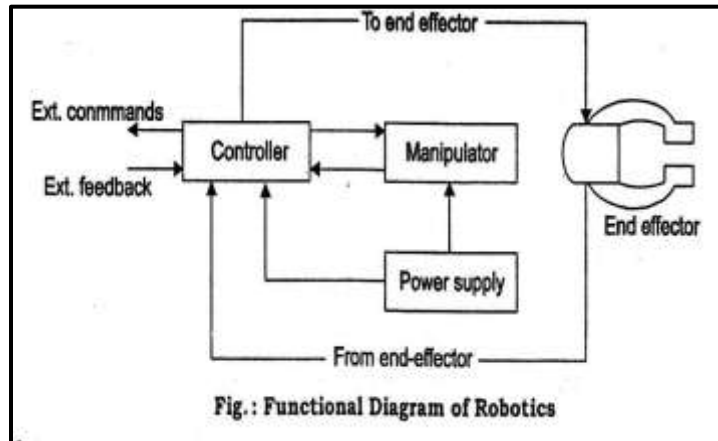


Fig. Cartesian robot

d) Draw the block diagram of robot system. Explain the role of sensor in robot system.

Ans: [Block diagram-3 Marks, role of sensor-1 Marks]



OR

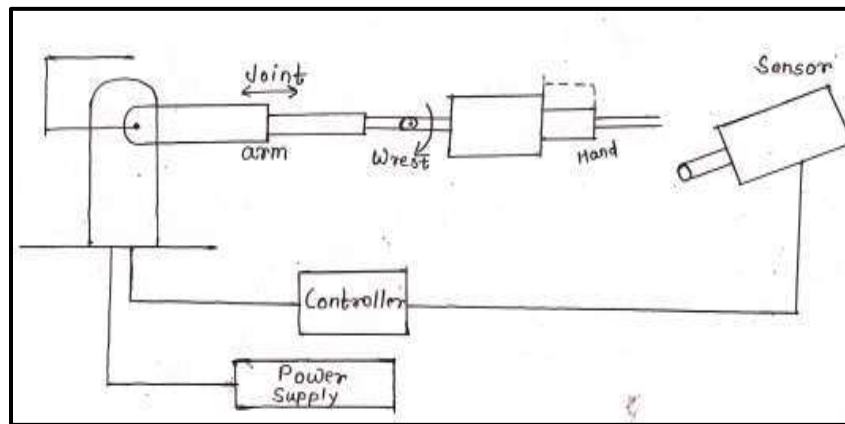


Fig. block diagram of robot system

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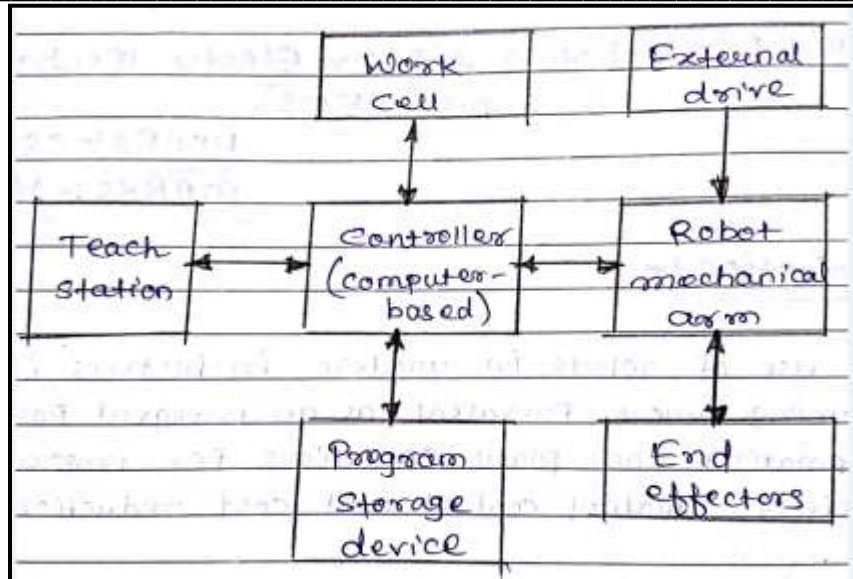


Fig. block diagram of robot system

Uses of sensors in Robotics

The sensors are one of the useful technologies, which play a *vital role* in the robotics field. There are four important categories where uses of sensors are highly required in robotics such as:

- Safety monitoring
- Interlocking in work cell control
- Quality control in work part inspection
- Data collection of objects in the robot work cell

e) Draw the block diagram of PLC based car parking system. Explain its working.

Ans: [Diagram (any one)-2 Marks, Explanation-2 Marks]

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.

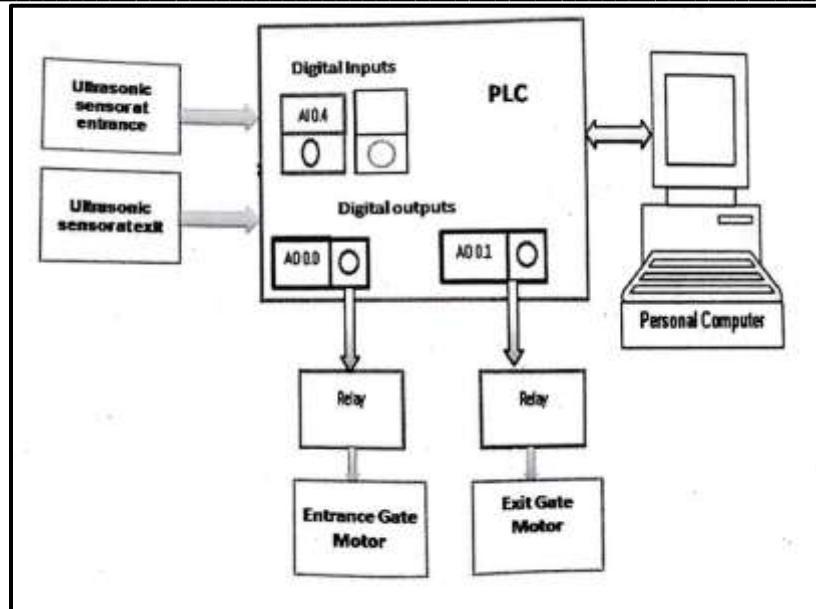


Fig. block diagram of PLC based car parking system

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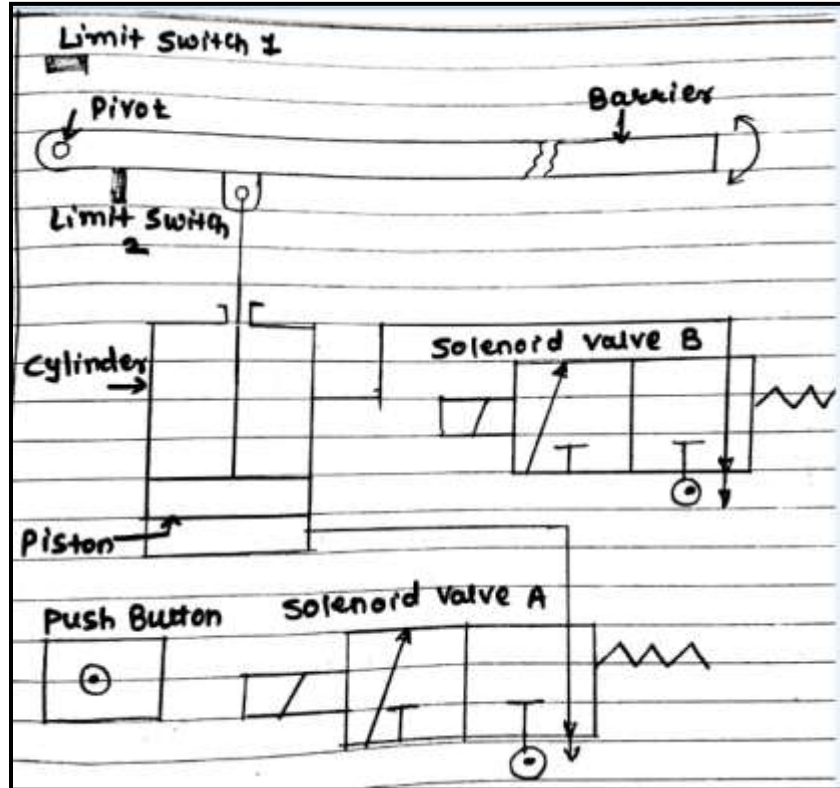


Fig. block diagram of PLC based car parking system