MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

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Summer 2016 EXAMINATIONS

Subject Code: **17660**   **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the 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.

Mechatronics- 17660

1 . Attempt any FIVE :   20

(a) Draw block diagram of mechatronic system and explain the key elements of mechatronics system .

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
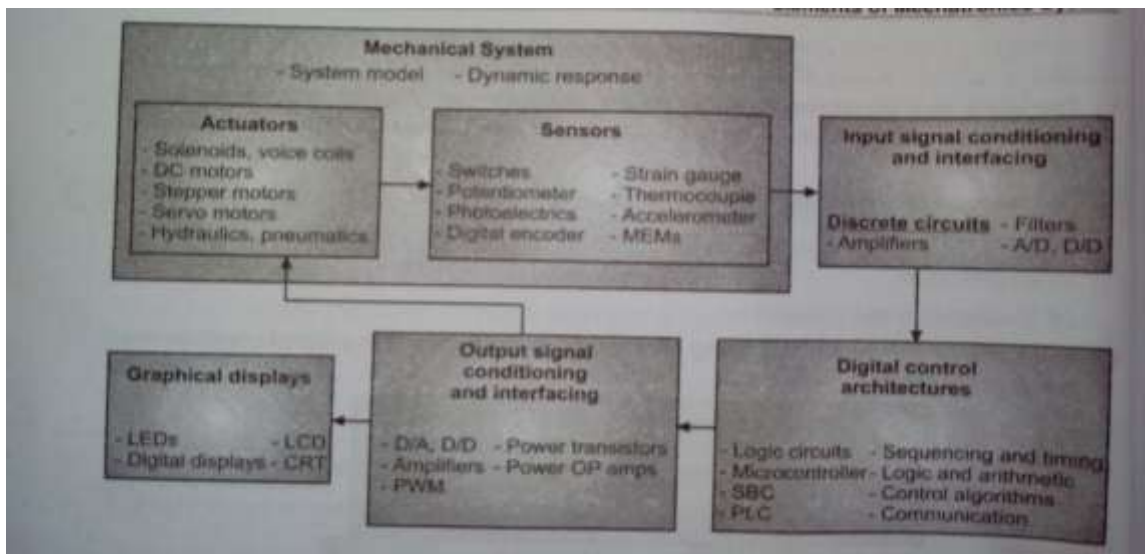
Explanation: **2M**

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

2

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.

(b) Define :Sensor, transducer

    Ans:- (1) Sensor: -   02M

    A sensor is an element in a measurements system that acquires a physical parameter and changes it into electrical signal .Eg. Bellows, Thermocouple.

    (2) Transducer :   02M
     A transducer is a element that converts one energy form to
       Another energy form . Eg. LVDT , strain gauge .

(c) List any four advantages of mechatronic system .

 Ans   **Advantages of Mechatronics system:**   **4M**

1. High level of integration.
2. Increased functionality and better design.
3. More use of electronics and software instead of mechanical function.
4. Assumes responsibility for process and operation with little interference of operators.
5. Uses artificial intelligence and intelligent process control.
6. Multisensory and program environment.
7. High reliability and safety.
8. Improved and less expensive controls.

(d) State and elaborate the importance of mechatronics in various field of Engineering .

Ans:- (Proper answer – 4 mks)

    With the recent advancement and development of digital circuits and computer aided design and manufacturing has lead to considerably improvement in many industrial production and in research as well .With the available automation and control methodologies, along with integrated embedded / VLSI technology, mechatronics has become relevant to industries, machineries and computers products. Automation and control represents a broad topic with applications in many disciplines, including production, industrial and manufacturing engineering, process control,

robotics, instrumentation, home automation and many others based upon sophistication, flexibility and state of art technology. Mechatronics has already emerged to cater to the need for sophistication and flexibility and in fact has become a preferred choice for the current generation of real time automation and control and solutions for traditional mechanical systems .The engineering disciplines are now dilating instead of diverging because of requirement of interdisciplinary knowledge at the production place. The up growing multidisciplinary subject mechatronics is widely used in production houses by the engineers, research scholars, designers and academicians as well. With the advancement in digital technologies cost effective VLSI and ASIC design, simulation software's, advanced networking solutions ,real time tools and techniques ,and many more ,this field is growing very fast
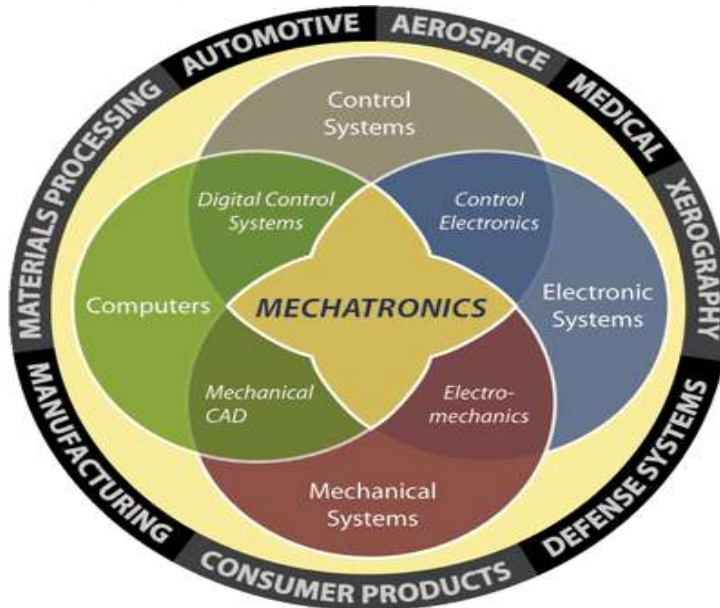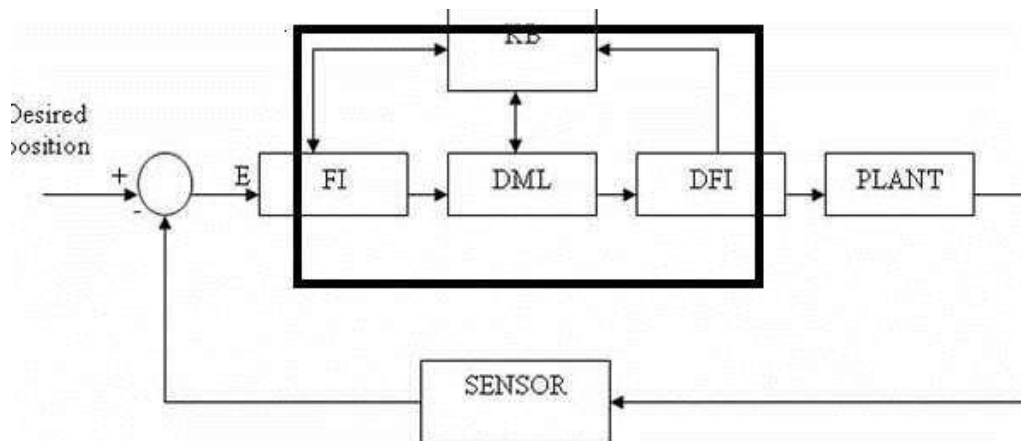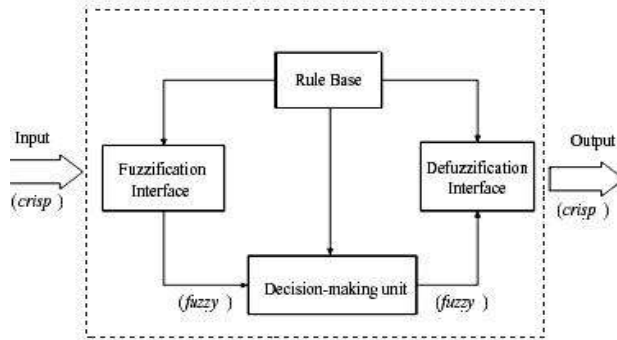

(e) Draw and explain the block diagram of fuzzy logic controller .

Ans:-Diagram:- 2 mks
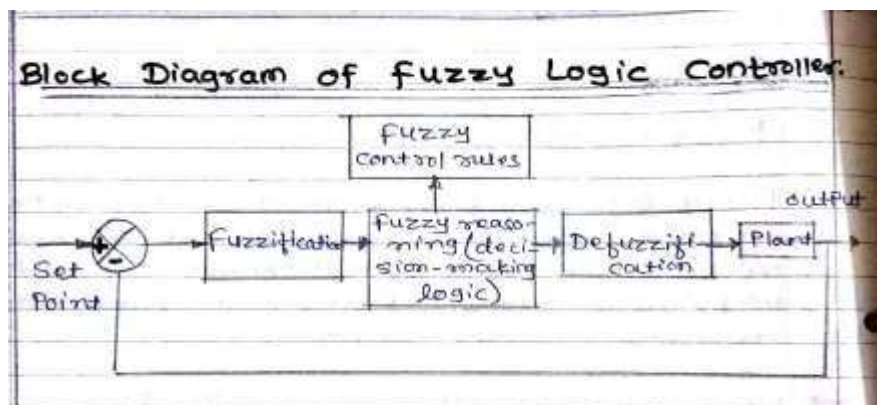
OR

Explanation-   (2 mks)

1.   **Fuzzification:**
It is the action of transforming a given state as crisp input into fuzzy values by evaluating membership function for purpose to be used by a fuzzy interference mechanism. Membership function forms a crucial part in fuzzy rule base model because actually they only define Fuzzification of control variable in other word

   ☐ 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.

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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

(f) List the types of belts and give one application of each.

Ans : (Any 4 types- 1 mks each)

Sr .no	Type of gears	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 .

(g) Explain in brief Spherical Robot . Why it is called as spherical robot ?

Ans :
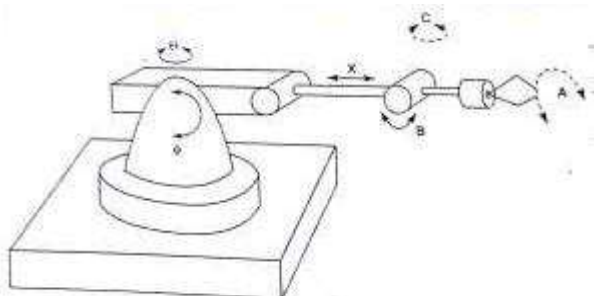
(diagram- 1 mks)

Explanation : (2 mks)

This is also known as a polar coordinate robot. This robot positions the wrist through two rotations and one linear actuations.As shown in above figure the orientation of the tool plate is achieved through three rotations in the wrist with toll of A, pitch of B and yaw of C. The robot is easy to control. For a given maximum reach of the robot, the work envelop is smaller than that of cylindrical robot.

Spherical robot-spherical robot can be moved in any circular movement , so called as spherical robot a spherical robot is a robot with two rotary joints and one prismatic joint; in other words, two rotary axes and one linear axis. spherical robots have an arm which forms a spherical coordinate system. (1 mks)

2. Attempt any FOUR : 16

(a) List any four applications of Hall Effect Sensor .

Ans : (Any 4 applications- 4 mks)
   (1) It is used as a magnetic switch for electric transducer .
   (2) It is used for the measurement of the position , displacement And proximity .
   (3) It is used for measurement of current .
   (4) It is used for the measurement of power .
   (5) To determine the correct alignment of permanent magnets rotor with the windings on the stator in brushless dc motors .
   (6) Monitor angular and linear velocoties and detect motion in security systems , cash machine screens etc.

(b) Draw practical ABS system .list any four advantages of it .

Ans : Diagram : 2 mks
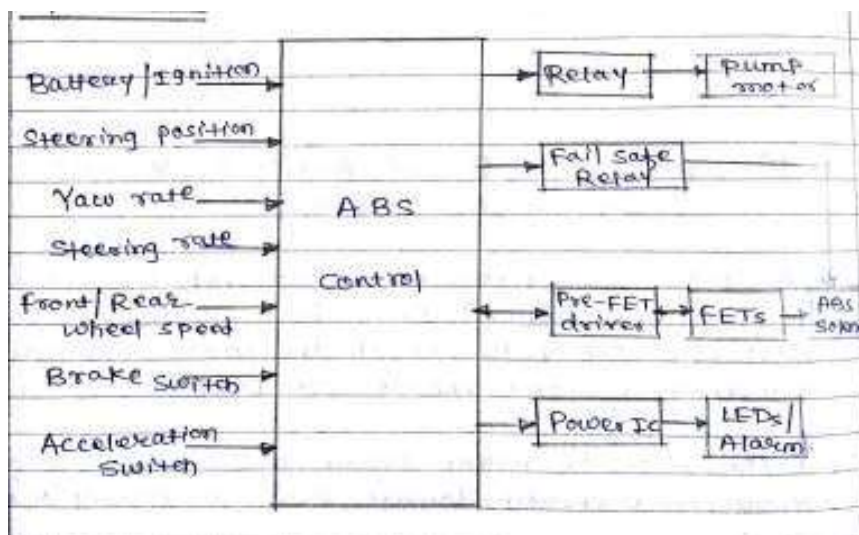
ADVANTAGES OF ABS SYSTEM : (4 points- 2 mks)

(1) It is used to avoid skidding . It requires simple maintenance cares .
(2) The oil itself used cools the moving parts of this system . thus does not require
    Any cooling arrangements .
(3) The safety system for automatic checking and cleaning are easy , because of
    the main parts are screwed
(4) Easy to handle and manual power required is less .
(5) Repairing is easy and also replacement of parts is easy .
(6) It allows the driver to maintain the directional stability and control over
    steering during braking .

(c) Draw and explain MEMS microactuator .

Ans : Diagram- 2 mks, explanation- 2 mks)

- A microactuator is a microscopic servomechanism that supplies and transmits a measured amount of energy for the operation of another mechanism or system. A microactuator acts as a switch or a trigger to activate an external device .As the microelectronics is processing the data received from the microsensors , it is making decision on what to do based on the data which may involve activating an external device . If the decision is reached , the microelectronics will tell the microactuators to activate this device .Microactuators are based on three- dimensional mechanical structures with very small dimensions which are produced with help of lithographic procedures and nonisotropic etching techniques . For an actuators – like displacement the most different principles of force generation are used such as the bimetal effect , piezo-effect , shape memory effect and electrostatic forces .
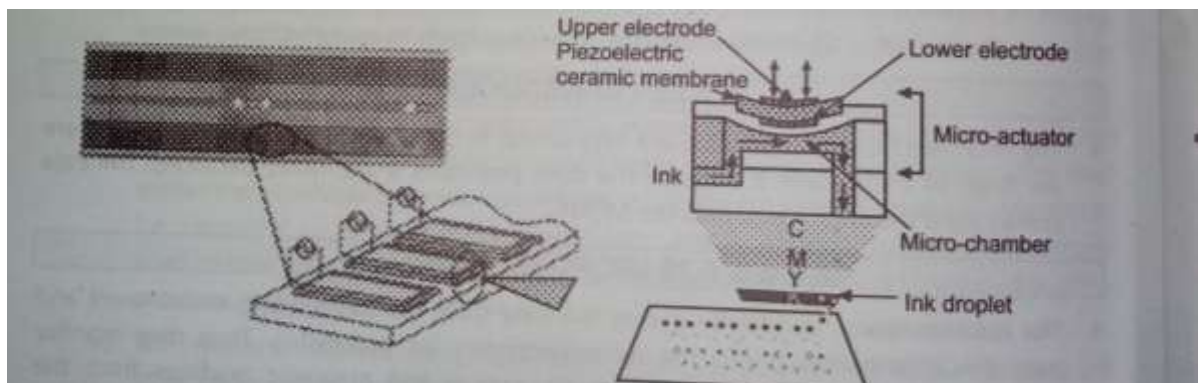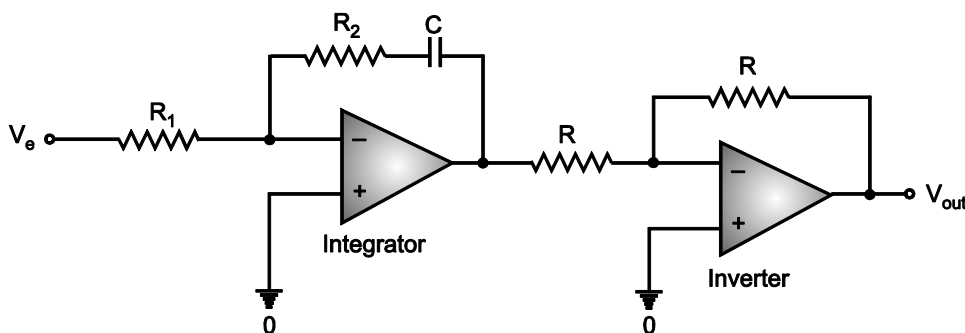

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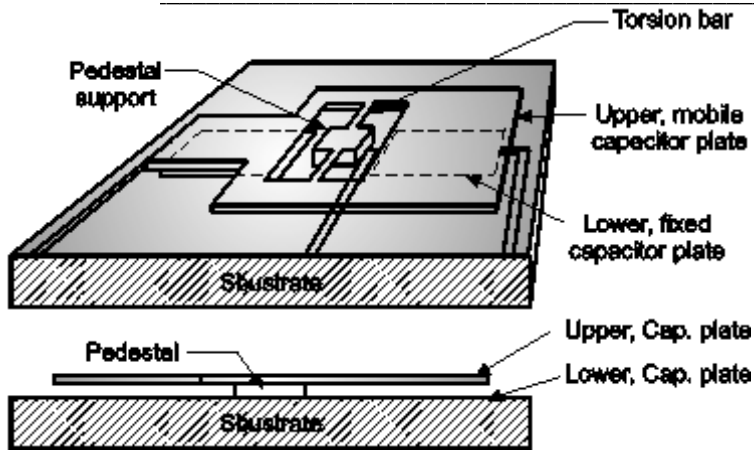
(d) Draw PI controller using Op-Amp and explain in brief .

Ans:- (Diagram- 2 mks, explanation- 2 mks)

Explanation- The proportional-plus-integral controller is also called as PI controller, which controls the plant by providing the control signal which is the combination of proportional and integral action over the error signal. The integral control improves the steady-state performance but integral action may lead to oscillatory output and hence has poor stability, which is not desirable. So combining proportional and integral action the two constants such as K and Kt can be adjusted in order to optimize the system performance or the output response according to the requirement.

$$V_o = \frac{R_2}{R_1} V_e + \frac{1}{R_1 C} \int_0^1 V_e ds$$

$$V_o(s) = \frac{R_2}{R_1} V_e(s) + \frac{1}{R_1 Cs} V_e(s)$$

$$TF = \frac{R_2}{R_1} + \frac{1}{R_1 Cs}$$

$$= \frac{R_2}{R_1} + \frac{R_2}{R_1} \frac{1}{R_2 Cs} = Kp + \frac{K_p K_i}{s}$$

where K_p = proportional band = R_2/R_1

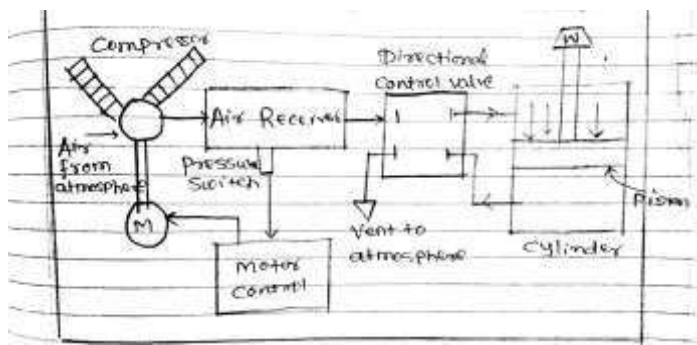K_i = integration gain = $1/R_2 C$

The transfer function is given by-

$$TF \quad = \quad \frac{V_o(s)}{V_e(s)} \quad = \quad K_p \left(\frac{Ki + s}{s} \right)$$

Further in time domain o/p equation is given as-

$$V_o \quad = \quad K_p e + K_p K_i \int_0^t e \, dt$$

(e) Draw block diagram of pneumatic system. What is role of filter in pneumatic System ?

Ans : (Diagram 2 mks diagram)

- **Air filter**:-These are used to filter out the contaminants from the air **.(2 mks)**

(f) Draw and explain the working principle of Inductive and capacitive Sensor .

Ans :**Inductive sensor :-** 1mks

Principle-Inductive sensors use currents induced by magnetic fields to detect nearby metal objects. The inductive sensor uses a coil (an inductor) to generate a high frequency magnetic field as shown in Figure below. If there is a metal object near the changing magnetic field, current will flow in the object. This resulting current flow sets up a new magnetic field that opposes the original magnetic field. The net effect is that it changes the inductance of the coil in the inductive sensor. The sensors can detect objects a few centimetres away from the end .
(Diagram- 1mks)

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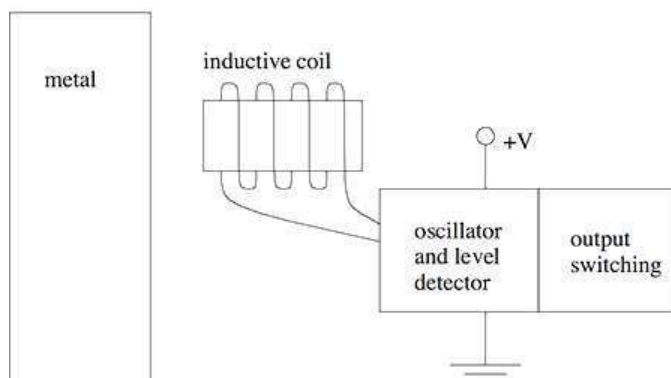
 Capacitive Sensor :- 1 mks
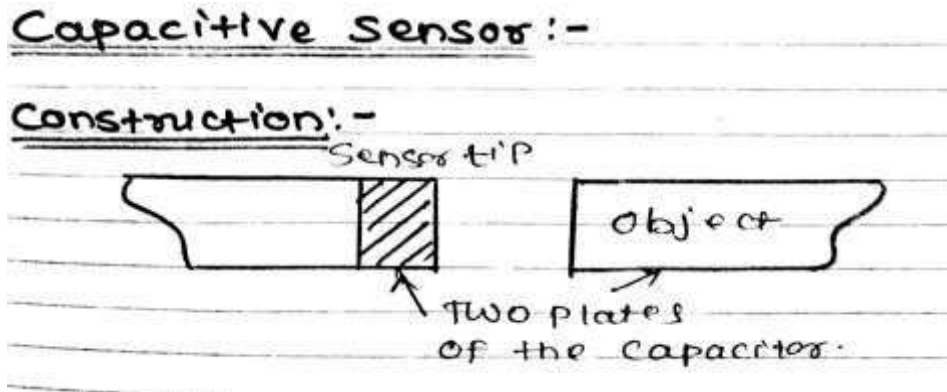
PRINCIPLE- Capacitive proximity sensor is a device actuated by both conductive and non-conductive materials. The pair of plates of a capacitor is separated by some distance.Depending upon the separation, the capacitance measured will be changed. Therefore, proximity of the object can be detected if one of the plates of the capacitor acts as a switch and the other as the metal object whose proximity is to be detected.
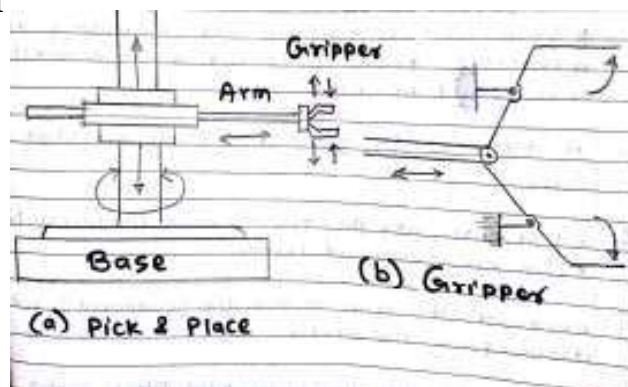
$$C = \varepsilon A/d$$

Where ε is permittivity of dielectric material .A is area of plate d is distance between plates

3 . Attempt any FOUR . 16

 (a) Draw block diagram of pick and place robot .List the required movement of it.

Ans: **Diagram: 02M**

Explanation: 02M

Figure above shows the basic form of a pick and place robot unit. 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.

(b) Draw and explain pneumatic PID controller.

Ans: [Diagram-2 marks, explanation-2 marks]
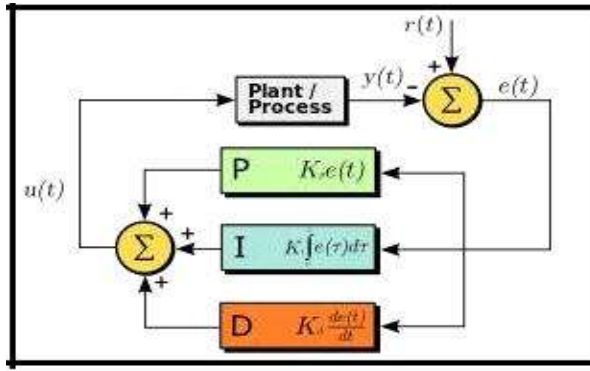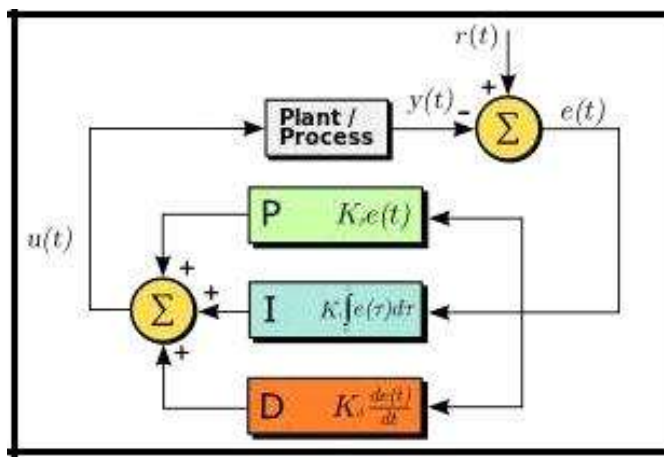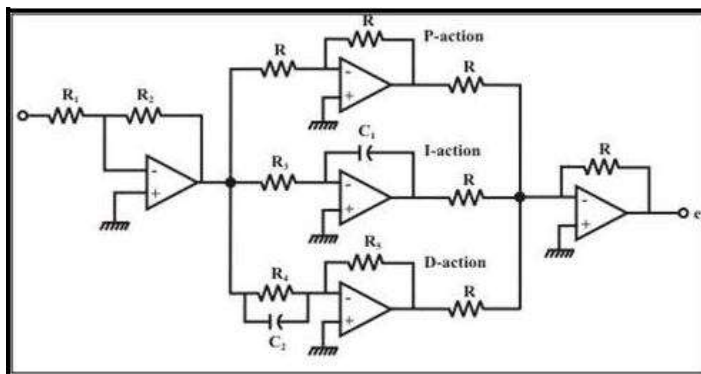 **[Note: Diagram can be block diagram or electronic diagram shown Below]**

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:

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

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:

$$P_{\text{out}} = K_p\, e(t)$$

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:

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

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:

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

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

(c) State the types of Actuators .Draw and explain single acting cylinder.

Ans.   (any 4 types- 2 mks, diagram- 1 mks, explanation- 1 ks)

1) Electromechanical actuators

2) fluid power actuators (a) hydraulic   (b) pneumatic

3) Electrical actuators

4) Mechanical   actuators

5) Active material based actuators .

SINGLE ACTING CYLINDER:

Fig. 4.4 : Single acting cylinder
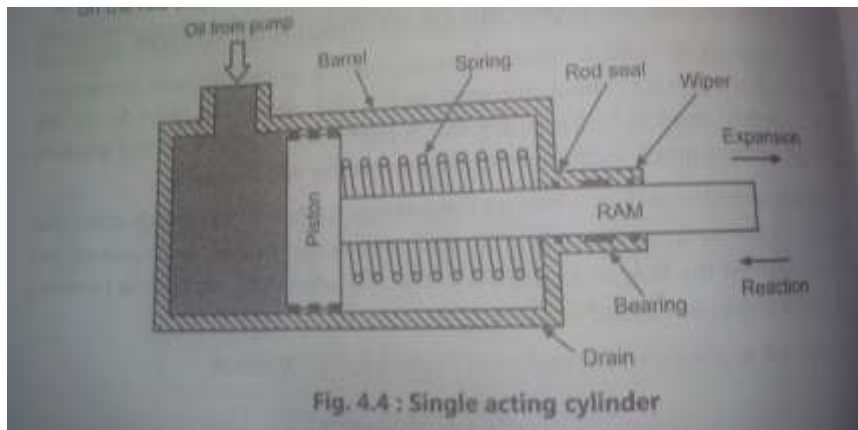
These cylinders produce work in one direction of motion hence they are named as single acting cylinders. The compressed fluid pushes the piston located in the cylindrical barrel causing the desired motion. The return stroke takes place by the action of a spring .generally the spring is provided on the rod side of the cylinder.

 (d) How MEMS accelerometer is used as air bag sensors for car safety? Describe in brief.

**Ans: [Diagram- 2 Mark, Explanation-2 Mark]**

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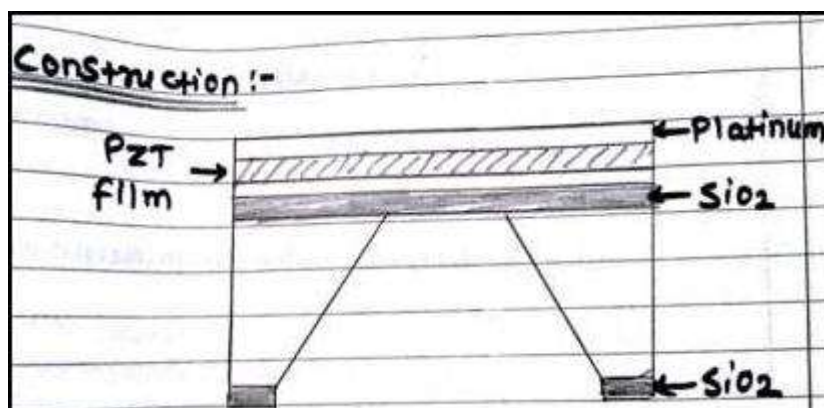
Explanation- Mechanical ignition airbags fit inside the steering wheel pad. When a collision occurs, the inertial sensor moves, setting off a mechanical igniter and inflator to deploy the airbag. As the sensor and igniter were in the same unit, the compact airbag unit easily fit most steering wheels,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

(e) Define degree of freedom .What is the significance of degree of   freedom in robot. ?

Ans : DOF: **-**Degree of freedom is a term used to describe a robot's freedom of motion in 3 dimensional spaces specifically the ability to move forward and backward, up and down, left and right. For each DOF a joint is required.   (1 mks)
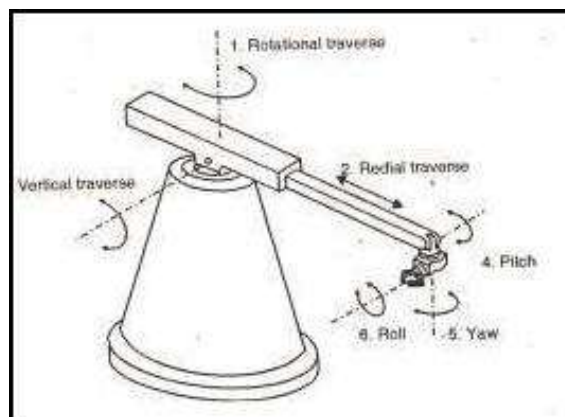
 (optional 1 mks can be given)

Fig. Degree of freedom (DOF)

Significance Of Degree Of Freedom In Robot :   (2 mks)

Degrees of freedom defined modes in which a mechanical device or system can move. The number of degrees of freedom is equal to the total number of independent displacements or aspects of motion. A machine may operate in two or three dimensions but have more than three degrees of freedom. The term is widely used to define the motion capabilities of robots. Consider a robot arm built to work like a human arm. Shoulder motion can take place as pitch (up and down) or yaw (left and right). Elbow motion can occur only as pitch. Wrist motion can occur as pitch or yaw. Rotation (roll) may also be possible for wrist and shoulder. Such a robot arm has five to seven degrees of freedom. If a complex robot has two arms, the total number of degrees of freedom is doubled. In an android, additional degrees of freedom exist in the end effectors, the legs and the head. Fully functional androids and multi-legged mobile robots can have more than 20 degrees of freedom. An example is Project Nao, an intelligent android designed for the consumer market. Nao, which looks superficially like a large space-age doll, has 25 degrees of freedom.

 (f) Draw schematic of PLC based automatic car park barrier system.

 Ans: [Diagram (any one)-2 Marks, Explnation-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.
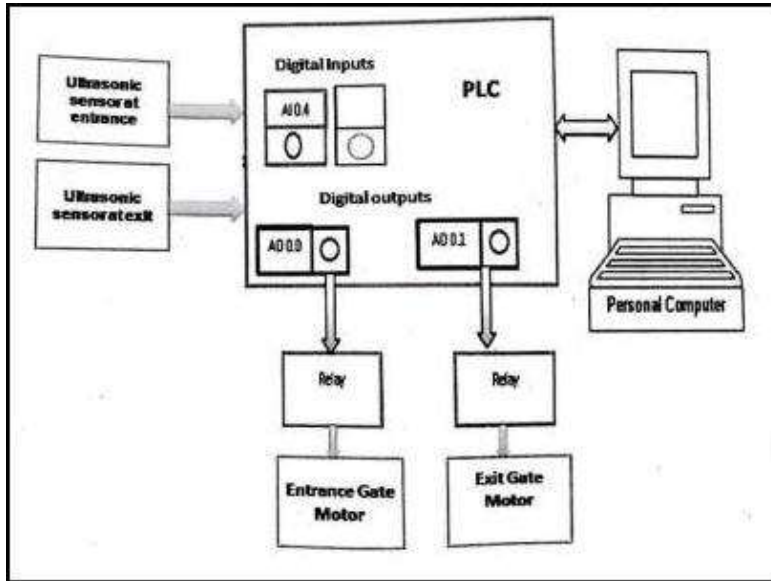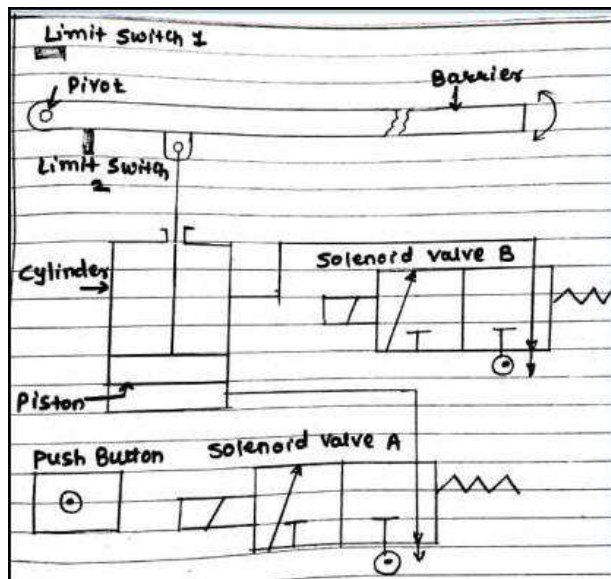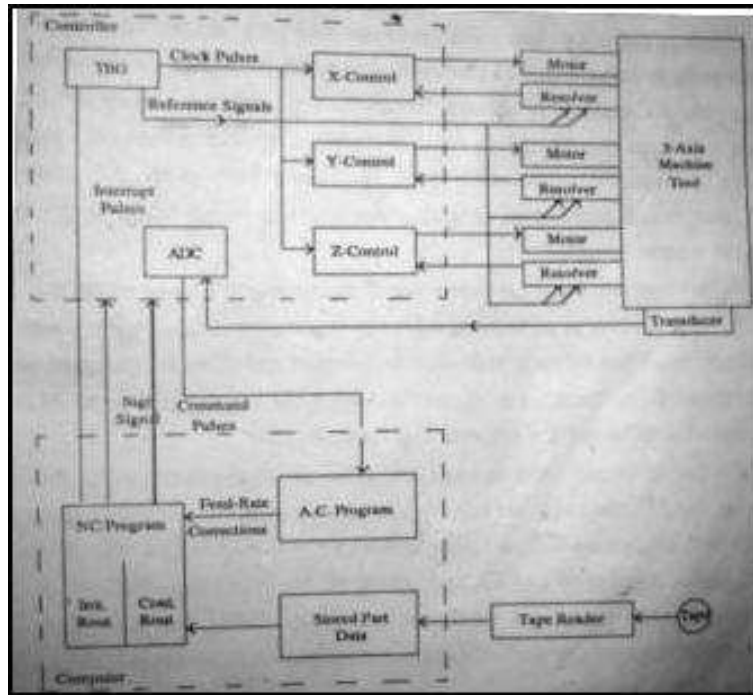

Fig. block diagram of PLC based car parking system

OR

Fig. block diagram of PLC based car parking system

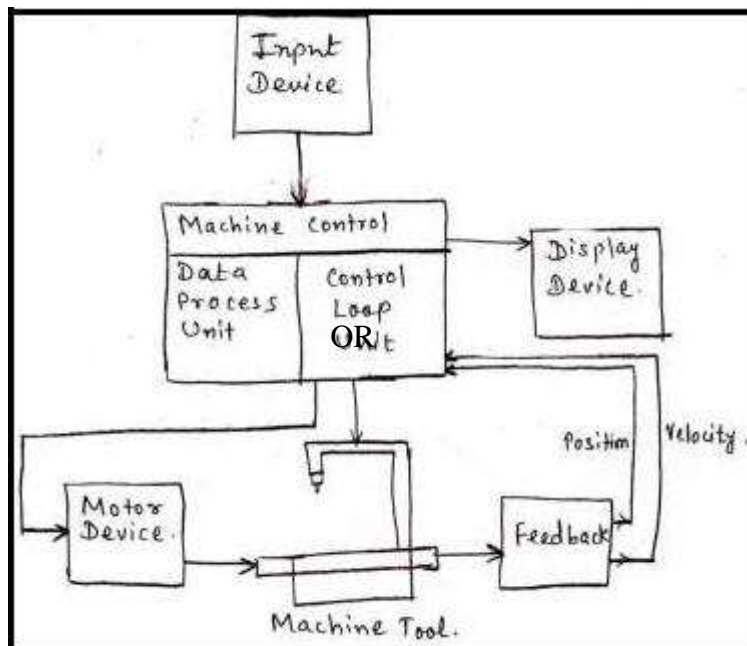**4. Attempt any FOUR :**   **16**
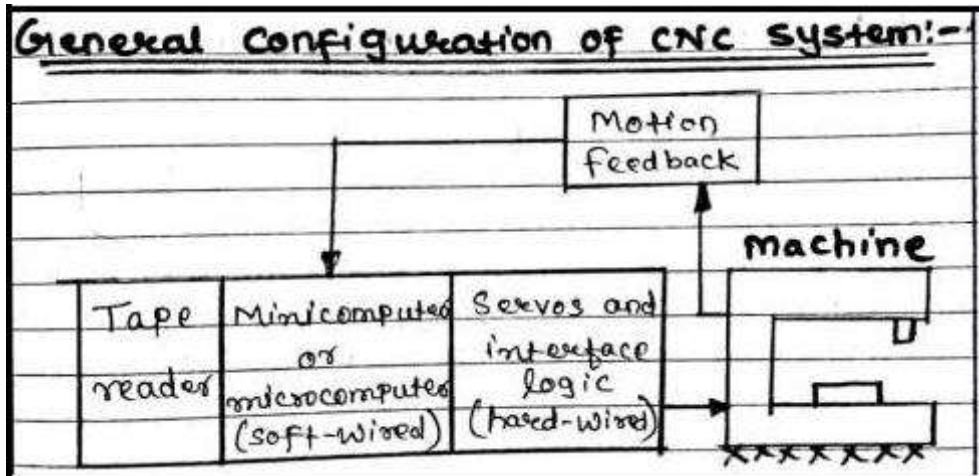
 (a) **Explain   CNC drilling machine with neat diagram.**
 Ans:- [Diagram (any one)- 2 Mark, Explnation-2 Marks]

OR

Block diagram consist of the following points:

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:
        1) Interrupt input line.
        2) Digital output line.
   3) Digital input line.

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

(b) How Torque is calculated using Torsion-bar torque transducer ? Explain.
Ans:- (Proper explanation with formula – 4 mks)

A torsion angle detection apparatus, wherein a pair of optical type of encoders are disposed on the coaxial center at a proper interval in the axial direction, and also, the measured shaft is inserted into the axial center position thereof and is secured to the rotary portion of each of the encoders, so that the torsion angle of the measured shaft

may be detected with high accuracy and high speed response property from the difference in the detection position by each encoder by the use of an optical type of encoder of high resolution. high speed response property.
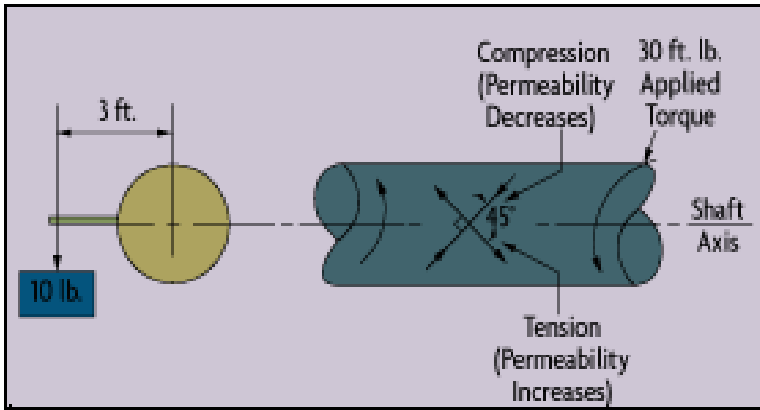
Torque = turning force*diameter of shaft   (Unit- Nmm   or KNmm)
T= F*2 R
Where,
T=torque
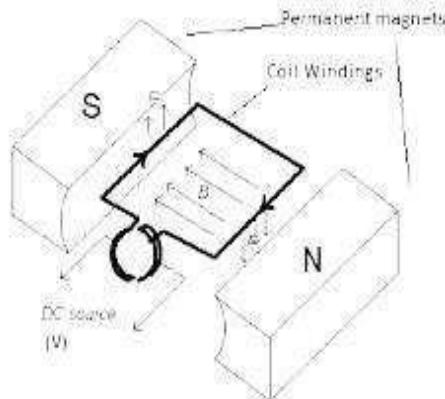F=Turning force
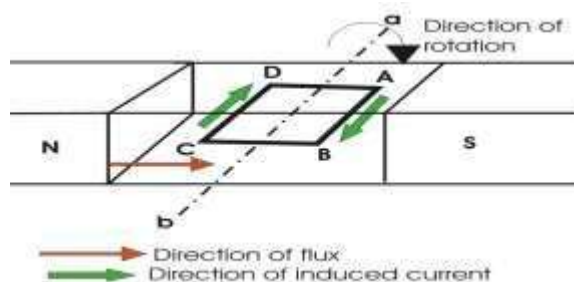S= Radius of the shaft

(c) Draw and explain DC motor speed control using microcontroller.
                    Ans:- **Diagram:-   2 mks**   02

OR

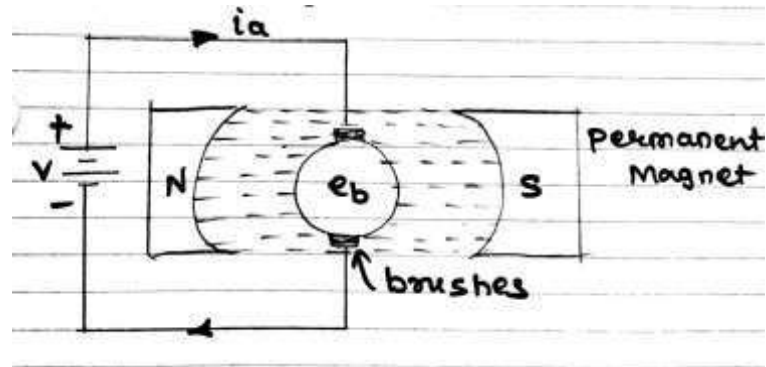**OR**

Working :   (2 mks)

It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule and whose magnitude is given by

$$\text{Force } \mathbf{F = B \; I \; L} \qquad \text{newton}$$

Where, B is the magnetic field in weber/m^2.

I is the current in amperes and L is the length of the coil in meter.

The force, current and the magnetic field are all in different directions. If an Electric current flows through two copper wires that are between the poles of a magnet, an upward force will move one wire up and a downward force will move the other wire down. The loop can be made to spin by fixing a half circle of copper which is known as commutator, to each end of the loop. Current is passed into and out of the loop by brushes that press onto the strips. The brushes do not go round so the wire does not get twisted. This arrangement also makes sure that the current always passes down on the right and back on the left so that the rotation continues. This is how a simple DC Electric motor works.

(d)   List types of gears & give their applications.   (one each)

Ans : (Any 4 types with applications – 4 mks)

- The following table gives applications of different types of gears :

Table 4.2

| 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

(e) List four applications of stepper motor .
Ans:- (Any 4 applications- 4 mks)
       1) It is used in computer peripherals like printers ,floppy disk, drivers ,tape drivers .etc
       2) It is used in positioning machine tool
       3) pen in x ,y plotter.
       4) Medical equipments

(f) Draw and explain the PLC ladder diagram for ON-OFF control of lamp.

       Ans :**Diagram:- (Any correct ladder logic) -   (2 mks)**
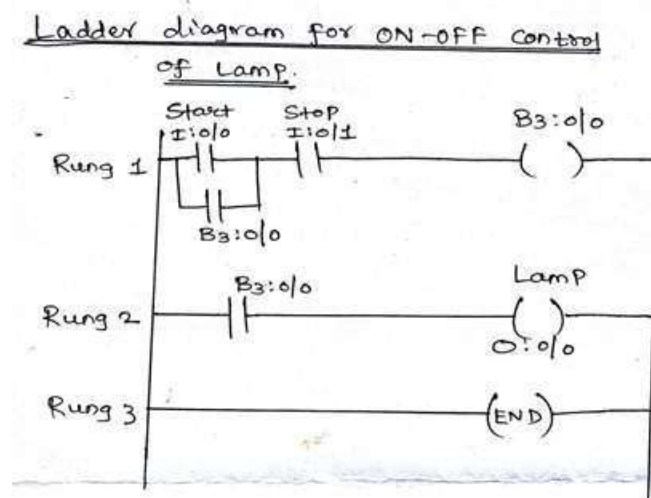
   Explanation:-   **(2 mks)**

     Figure above shows simple ladder diagram for ON- OFF control of lamp.
      I: 0/0 is start button, as soon as it is pressed the contact gets closed and output binary bits B3 : 0/0 goes high (logic 1).

     As soon as B3 : 0/0 is high, lamp O: 0/0 turns ON as shown in rung 2.

     When I:0/1 stop button is pressed, contact gets open and B3:0/0 goes low(Logic 0).

     When B3:0/0 goes logic 0, lamp named O: 0/0 turns off.
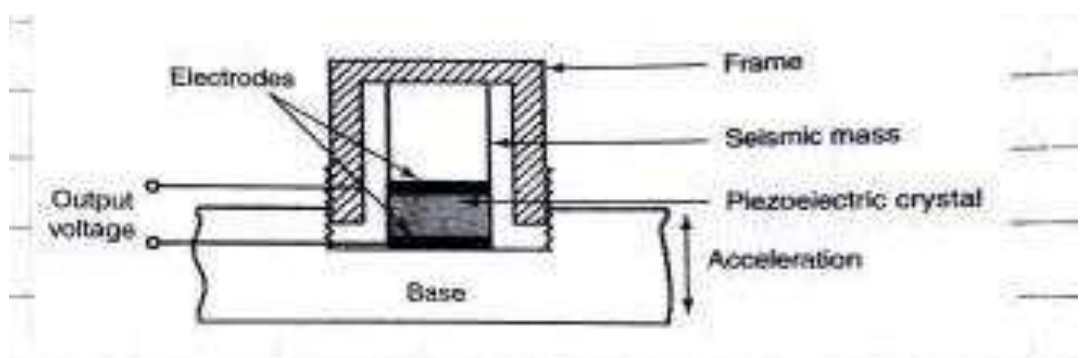
  5. Attempt any FOUR :   16

(a) How the piezoelectric effect is used to measure acceleration ? List the Features of piezoelectric accelerometer .

     Ans : Diagram:-   (1 mks)

Explanation:-   (2 mks)

> The sensor consists of a piezoelectric crystal sandwiched between two electrodes and has a mass placed on it. The unit is fastened to the base whose acceleration characteristics are to be determined.. The mass exerts a force on the crystal and a certain output voltage is generated. When the base is now accelerated downward, the internal reaction force on the base acts upward against the top of the frame. This relieves stress on the crystal and from newton"s second law, since the mass is a fixed quantity, the decreased in force is proportional to the acceleration. The resulting change in the output voltage is recorded and correlated to the acceleration imposed on the base.

Features Of Piezoelectric Accelerometer : (any 2 features- 1 mks)

> 1) able to operate as a switch and can operate upto 100KHz
>
> 2) Cost is less than mechanical switches
>
> 3) no problems of switches of contact bounce
>
> 4) immune to environmental contaminations.

(b) State the functions of (1)Isolators (2) filters (3) Amplifiers (4) data converters   In Mechatronic system.

Ans :- (Function of each- 1 mks)

(1) **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.

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

(3)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

(4) 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.

(c) List the advantages of PLC based car parking system   .(any four)

Ans : (4 mks for 4 advantages)

(1) They offer convenience for vehicles users and efficient usage of space for urban based companies.

(2) Automated car park systems save time , money ,space and simplify the often tedious task of parking.

(3) Auto car lifts move vehicles into safe and secure storage areas until they are needed.

(4) Its is completely an automation system and hence easy to handle.

(d) Draw block diagram of ROBOT system .List functions of an end effector.

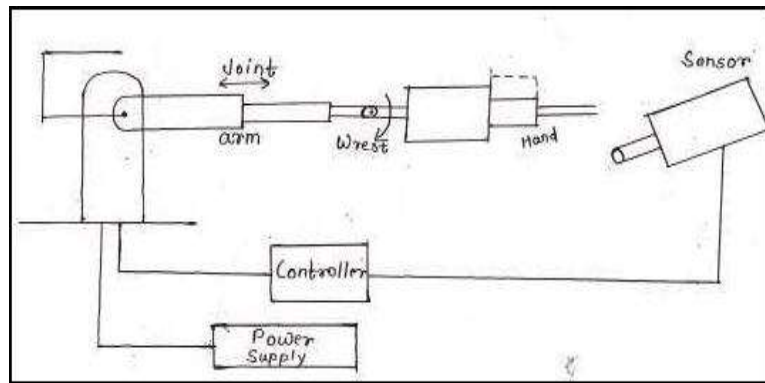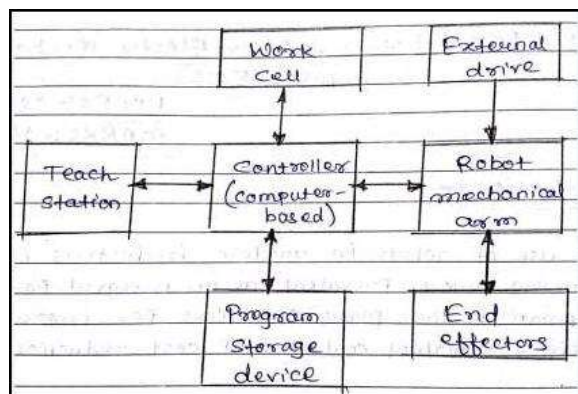Ans: [Block diagram-3 Marks, function of end effector -1 mks]

Fig.: Functional Diagram of Robotics

OR
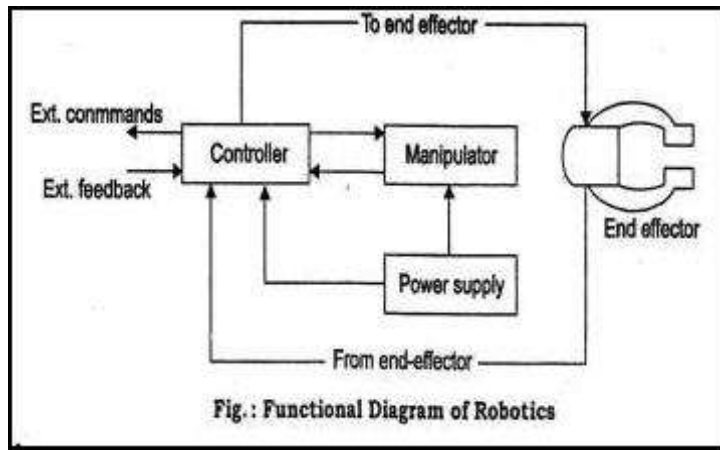
Fig. block diagram of robot system

OR

Functions Of An End Effector : (diagram is optional)

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

Fig. End effectors

(e) With neat block diagram explain the various components of MEMS.

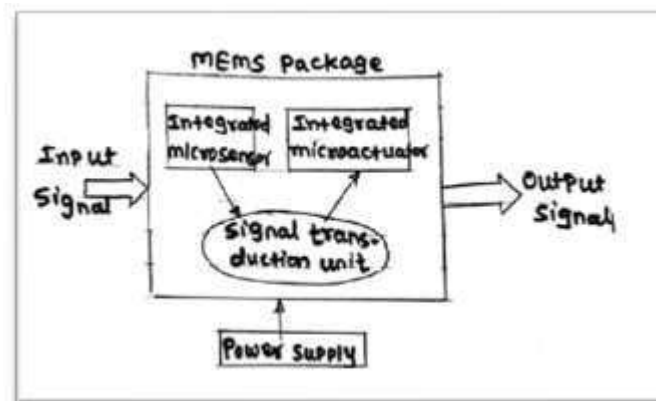Ans :   **Block Diagram:**   (2 mks)

Fig. Block diagram of MFMS

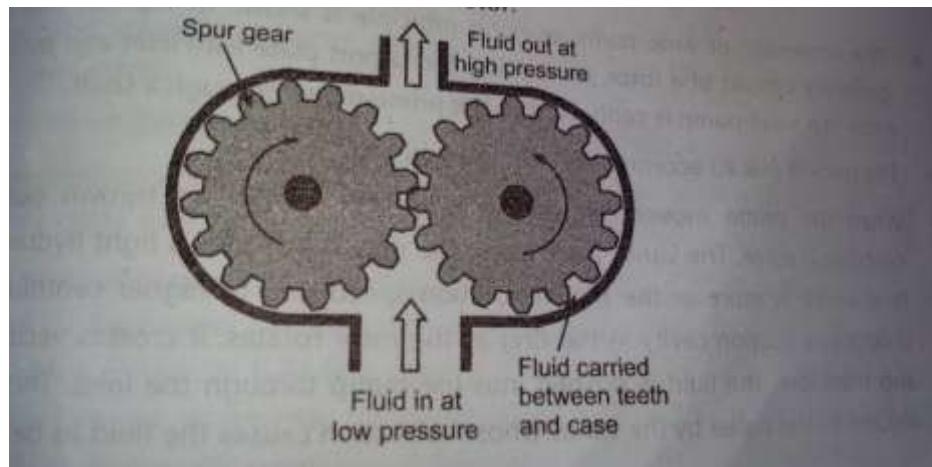**Explanation:**   (2 mks)

1. **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.

2. **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.

3. **Signal transduction unit:** This unit is provided for conditioning the generated signals. The transduction processes includes amplification, filtration and signal conversion.

4. **Output signals:** These are the signals interfaced with the system to be controlled or monitored.

5. Due to monolithic integration of sensors, actuators and signal transduction unit, closed loop control system can be easily developed.

(f) Draw and explain Gear type rotary actuator .

Ans : (diagram 2mks ,explanation 2mks)

Explanation- Rotary actuators convert energy of pressurized fluid into rotary motion .Rotary actuators are similar to electric motors but are run on hydraulic or pneumatic power. It consist of two intermeshing gears inside a housing with one gear attached to the drive shaft. The fluid enters from inlet , causes the rotation of the meshing gears.
The rotating gear carries the fluid from the tank to the outlet pipe. The suction side is towards the portion whereas the gear teeth come out of the mesh. When the gears rotate , volume of the chamber expands leading to pressure drop below atmospheric value .
Therefore the vacuum is created and the fluid is pushed drop below atmospheric value. Therefore the vacuum is created and the fluid is pushed into the void due to atmospheric pressure. The fluid is tapped between housing and rotating teeth of the gears. The discharge side of pump is towards the portion where the gear teeth run into the mesh and the volume decreases between meshing teeth .The fluid exists from the exhaust port.

6. Attempt any FOUR :   16

(a) Explain the implementation of proportional type hydraulic controller .
   Ans:- Diagram:- 2 mks
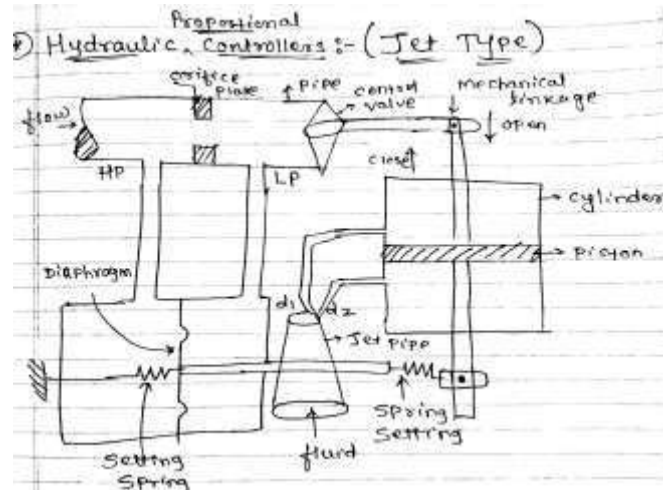
Explanation:2 mks

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.

(b) Compare pneumatic and hydraulic system (four points).
   Ans:-(four relevant points – 4 mks)

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.

(c) Draw and explain LVDT accelerometer.
 Ans: [2 marks for diagram, 2 marks for working]
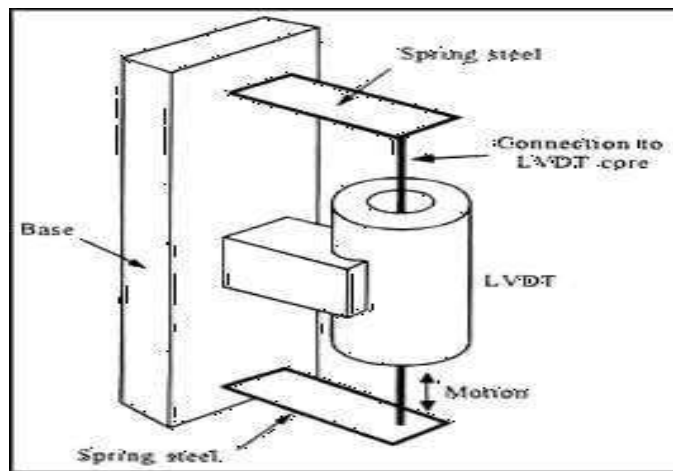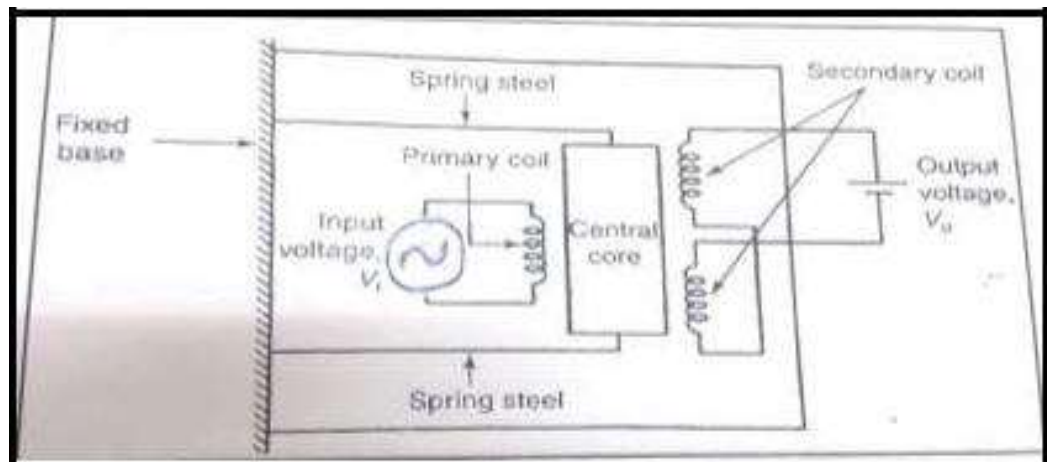
Diagram:


Fig. LVDT accelerometer

OR

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.

(d) List various photoelectric sensors .Explain any one of them in detail .

Ans :   There are two types of photoelectric sensors : (2mks)

    (1)   Reflective -type sensor

   (2)   Transmissive -type sensor

Reflective- Type   Sensor : (any one – diagram- 1mks, explanation- 1 mks)
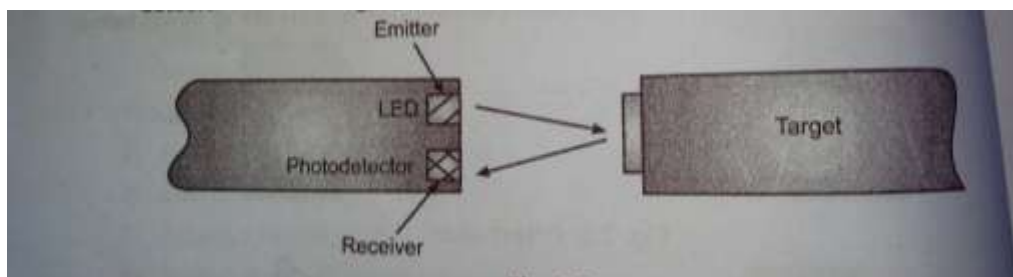
  A reflective –type sensor detects the object based on the reflection of light onto a detector from the target . A code wheel for use with a reflective type optical rotary encoder which can be produced easily and optically read efficiently. The code wheel includes a non-reflective plate, and a reflective plate having a suitable number of notches formed along a periphery thereof and mounted in an overlapping relationship on the non-reflective plate whereby a reflective portion of the code wheel is formed by a face of the reflective plate between each two adjacent notches while a non-reflective portion is formed by a face of the non-reflective plate exposed through the corresponding notch of the reflective plate.

(e) Explain fuzzy logic control in fully automatic washing machine .

Ans :   (Diagram – 2 mks, Explanation- 2 mks)

_____

Fuzzy control for washing machine:
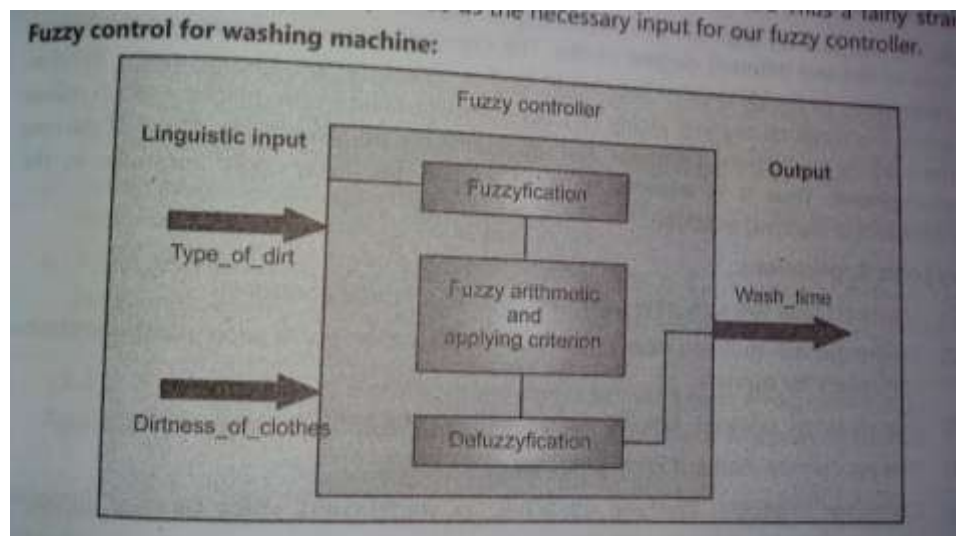
Before the details of fuzzy controller are dealt with the range of possible values for the input and output

variables are determined .These (in language of fuzzy set theory) are the membership functions used to map the real world measurement values to the fuzzy values , so that the operations can be applied on them . Values of the input variables , degree of the dirt and type of dirt are normalized range (1 to 100) over the domain of optical sensor. The decision which the fuzzy controller makes is derived from the rules which are stored in the database . These are stored in set of rules. Basically the rules are if-then statements that are intuitive and easy to understand , since they are nothing but common English statements .Rules used in this project are derived from common sense , data taken from typical home use , and experimentation in a controlled environment .

- The sets of rules used here to derive the output are :

  1. If dirtness of clothes is Large and type of dirt is Greasy then wash time is very long.

  2. If dirtness of clothes is medium and type of dirt is Greasy then wash is very long.

  3. If dirtness of clothes is small and type of dirt is Greasy then wash is very long.

  4. If dirtness of clothes is Large and type of dirt is medium then wash time is long.

  5. If dirtness of clothes is medium and type of dirt is medium then wash time is Medium .

  The rules too have been defined in imprecise sense and hence they too are not crisp but fuzzy values. The two input parameters after being read from the sensors are fuzzified as per the membership function of the respective variables . These in additions with the membership function of the respective variables .These in additions with the membership function curve are utilized to come to a solution .

(f) Explain the working principle of solenoid valve .List the applications of solenoid valve.

_____

Ans :   **Working Principle   (2 mks)**

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.
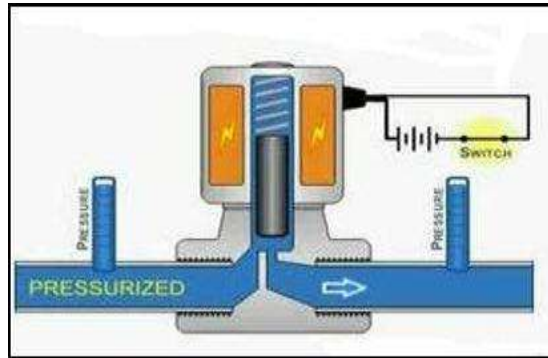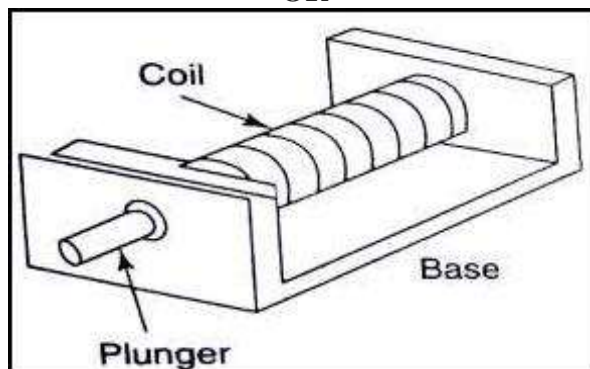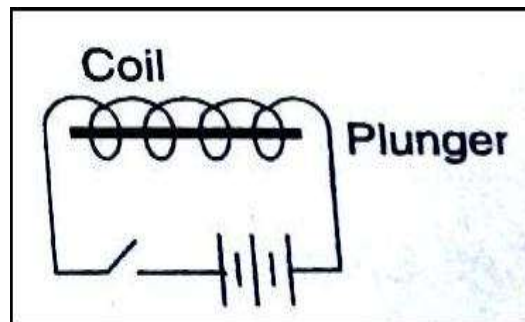
Diagram: 1 mks

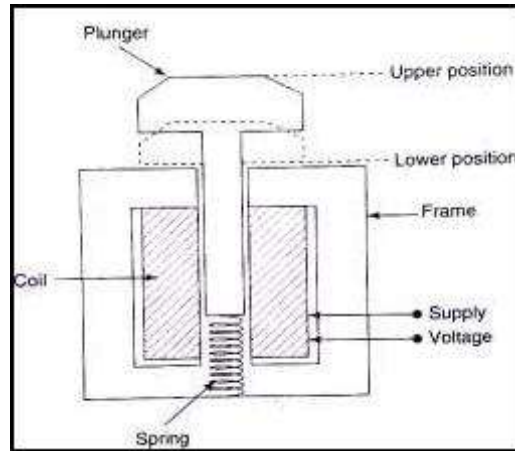**Fig. solenoid valve**

OR

OR

OR

_____

[Note: students can draw any other correct Diagram]

Applications Of Solenoid Valve : (any 2 applications- 1 mks) any other applications to be given marks .

1. Used in machinery devices and equipment such as refrigerators and automatic faucets.

2. Used in heating system.

3. Irrigation sprinkle system.