CMR
INSTITUTE OF
TECHNOLOGY

USN | 1 | C | R | | | | | | | |

Internal Assesment Test – 1

Sub: Mechatronics				Code: 15ME753
Date: 7/9/2019	Duration: 90 mins	Max Marks: 50	Sem: 7	Branch (sections): ME (A,B)

Answer FIVE FULL questions. Good luck!

		Marks	OBE	
			CO	RBT
1	Briefly explain the evolution of Mechatronics.	[10]	CO1	L1
2	Discuss in details the operatio/ns involved in the sequential control of a microprocessor based washing machine.	[10]	CO1	L1
3	Define Mechatronics. With a block diagram, briefly explain the generalized measurement system.	[10]	CO1	L1
4	Differentiate between Open loop and Closed loop control system.	[10]	CO1	L2
5	With a sketch, explain the working of an automatic camera using a microprocessor.	[10]	CO1	L1

CI CCI HOD

1st IAT Solution

1)

Evaluation of Mechatronics:

The technology has evolved through several stages that are termed as levels. The evolution levels of Mechatronics are:

a. Primary level Mechatronics (first)
b. Secondary level Mechatronics (second)
c. Tertiary level Mechatronics (third)
d. Quaternary level Mechatronics (fourth)

a. Primary level Mechatronics (first):

- In the early days Mechatronics products were at primary level containing I/O devices such as sensors, and actuators that integrated electrical signals with mechanical action at the basic control level.

Examples: electrically controlled fluid valves and relays

b. Secondary level Mechatronics (second):

- This level integrates microelectronics into electrically controlled devices.

Examples: cassette player.

c. Tertiary level Mechatronics (third):

- This incorporates advances feedback functions into control strategy, thereby enhancing the quality in terms of sophistication.
- Mechatronics system at this level is called **'smart system'.**
- The control strategy includes microelectronics, microprocessor and other „application specific integrated circuits" (ASIC).

Examples: DVD player, CD drives, automatic washing machine, CD drives, etc.

d. Quaternary level Mechatronics (fourth):

This level includes intelligent control in Mechatronics system.

The level attempts to improve smartness a step ahead by introducing intelligence and fault detection and isolation (FDI) capability system.

Examples: artificial neural network and fuzzy logic technologies.

2) Block diagram of a microprocessor based processor control system of Automatic washing machine:

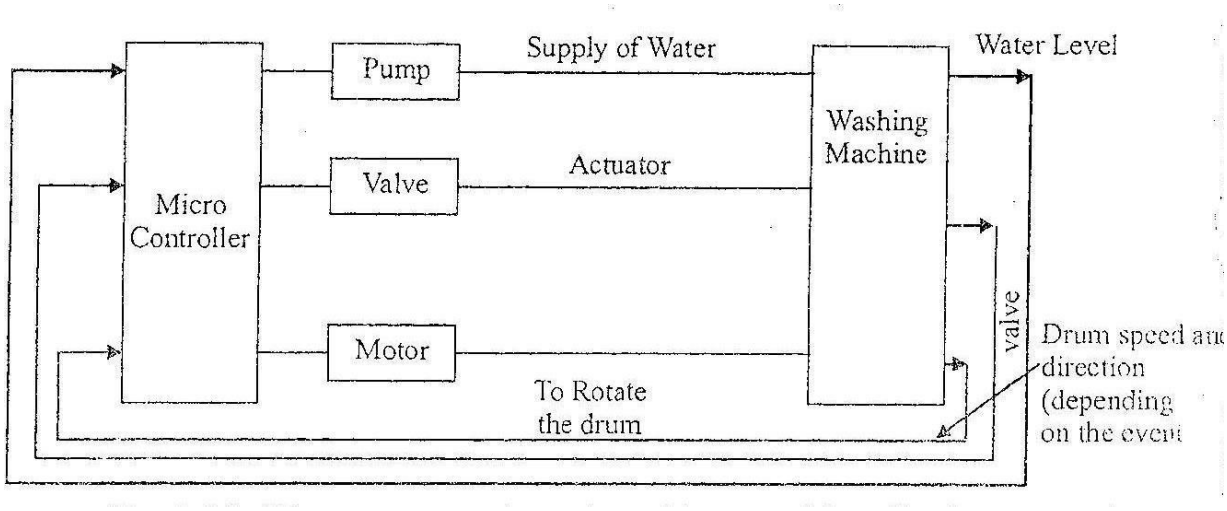


Fig 10: Automatic Washing Machine

Working:

- This is a sequential control system wherein control is exercised based on event, or parameter etc.,

i.e., control action will be executed one after another event.

- The events to be carried out in a domestic washing machine are soaking, washing, rinsing and drying.
- Each of these operations involves a number of steps.
- Soaking involves selection of correct quantity of detergent and water based on the type and amount of cloth.
- This requires opening of the valve to fill the machine drum to required level and closing the valve once the required level of water has reached and rotating the drum in either directions for a pre-set amount of time during the soaking operation.
- This is followed by washing which is a time parameter event.
- Then the rinsing event which measures the pH value using a chemical sensor of water in the drum and compares it with supply of water.
- This event continues till the pH value of the water in the cloth and the supply water are equal.
- Finally drying operation till the minimum percentage of moisture is retained in the cloth.
- All these events were earlier controlled with the help of mechanical system involving a set of camoperated switches.

- ✓ In modern washing machine mechanical system is replaced by digital devices. i.e., a microcontroller and the sequence of instruction; program embedded in the microcontrollers.
- ✓ The amount of detergent, amount of water, pH value are all sensed by the sensor and these sensed qualities are input to the microcontroller.
- ✓ Based on the input and the software embedded, the corresponding output of the microcontroller to carry out the different sequence of operations.

3) Definition 1:

Mechatronics may be defined as" the complete integration of mechanical system with electronics, electrical and computer system into a single system".

Definition 2:

Mechatronics is "the synergistic (Together) combination of mechanical engineering, electronic engineering, control engineering and systems thinking in the design of products and manufacturing processes"

Example: automatic washing machine, digital fuel injection system, engine management system. Etc.,

4)

Measurement system: a group of device/element arranged in rational manner to achieve the act of measurement.

Measurand: is a numerical quantity of physical phenomenon such as force, quantity, displacement, time, velocity, etc,

Measurement: is a represent of physical phenomenon in numerical values.

Generalized measurement system:

Generally a measurement system consists of 3 basic elements.

1. Sensor/transducer.
2. Signal conditioner.
3. Display/read out devices.

In addition to the above, electrical power is also required.

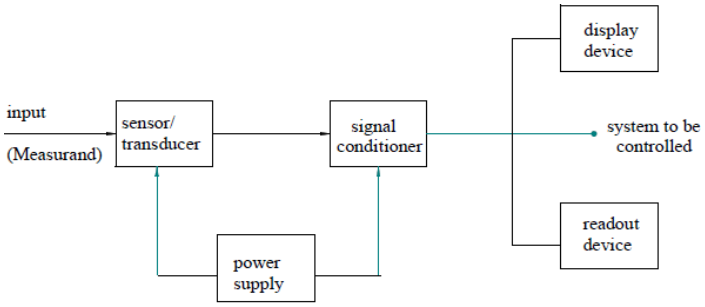
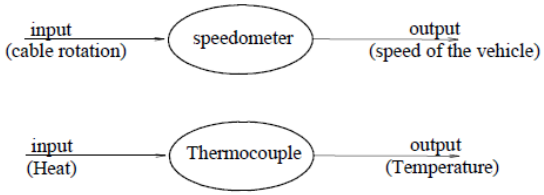


figure: block diagram of generalised measurement system



Functions of each elements of measurement system:

Sensor/transducer unit:

- The heart of any measurement or control system is sensor/transducer.
- Sensor/transducer is a device it converts the one form of energy to another form.
- Sensor/transducer it senses the physical phenomenon to be measure and transform it from one form to another form (generally electrical form).
- The output of this unit is input to the signal conditioner which is next element.

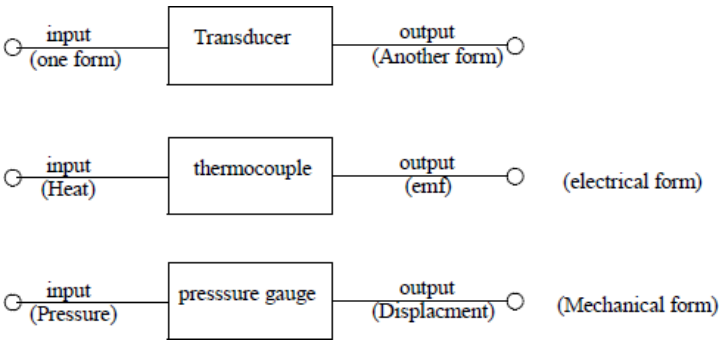


Fig 2: Elements of measurement system

Signal conditioner unit:

- This unit senses the output signals of sensor and converts it into suitable, measurable level of signals.
- An amplifier is acts as a signal conditioner in the figure.

The following functions of signal conditioners are:

a. **Amplification of signals**: the level of signals from the transducer may be of low level for the next use and hence need to be amplified (increased).

b. **Attenuation**: similarly the level of signals from the transducer may be of higher level for the next use and hence need be attenuated (decreased).

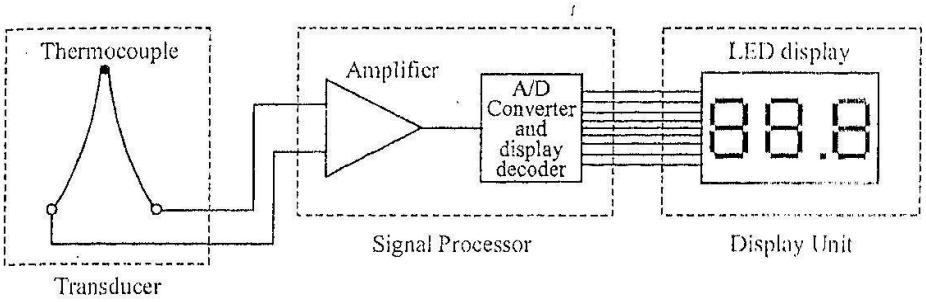
c. **Filtering**: signals from the transducer may contain some other undesirable signals which need to be filtered or eliminated before it is used. Otherwise a corrupt output will be generated.

d. **Analog to digital conversion (ADC):** the signals from the transducer may be analog in nature and if these signals were to be used as input to electronic system/computer system, they need to be converting to digital form. Similarly sometimes we use DAC.

Display/read out unit:

- It displays the output of signal conditioner unit and this display will be the quantitative form of measurand.
- Display unit may be either of analog (dial gauge) and digital (LED) type.

Example of Measurement system: Digital thermometer principle



4)

Definition of Control system:

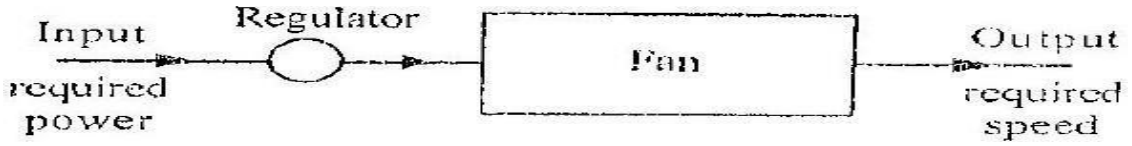
A group of devices/elements which maintains the required output based on the predefined value by controlling the parameter responsible for output.

Classification of control system:

1. Open loop control system (NO FEEDBACK control system).
2. Closed loop control system (WITH FEEDBACK control system).

1. Open loop control system (NO FEEDBACK control system):

In which the output is dependent on the input, but input is independent of output is called



open loop control system.

Fig 4: Open Loop System

Example:

1. **ON/OFF of an electric lamp:** electric lamps are used for lighting the lamp. ON/OFF control is carried out with the help of a switch and the switch is generally operated by an operator depending on the amount of light that exist in that area.

   If the switch is ON, the lamp is glow. If the person operating the switch does not put OFF of the switch, the lamp remain ON until he switched OFF. So it is called open loop control system.

2. **Control the temperature of the room with room heater:** the amount of heat generated by a room heater depends on the amount of input power controlled by a regulator.

   If the power is switch ON, the power supplied to the heater continues and temperature of the room goes on increasing immaterial of whether heat is required in the room or not. Here person is go and OFF the power supply switch and there by cooling the temperature of the room is decreasing.

Advantages of open loop control system:

1. Less costly.
2. Relatively simple.
3. Good reliability.
4. Easy maintenance.
5. Inherently stable.

Disadvantages of open loop control system:

1. Inaccurate since there is no correction of error.
2. Relatively slow in response to change in demand.
3. The control depends on the human judgment.
4. Often leads to waste.
5. Any change in system component not to be taken care automatically.

2. Closed loop control system (WITH FEEDBACK control system):

In which input is depend on the output. i.e., variation in the output influences the input by some means of controlling on the input is called a closed loop system.

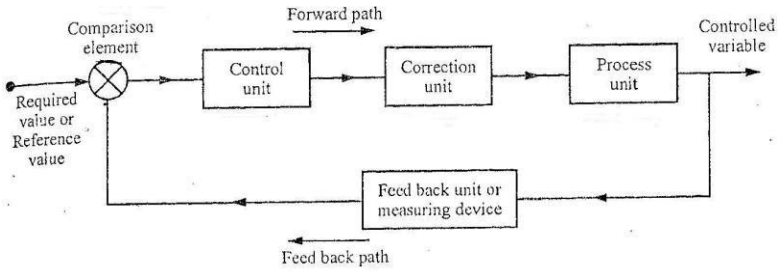


Fig 5: Closed loop control system

Elements of closed loop control system:

The basic elements of a closed loop control system are:

1. Comparison element.
2. Control unit.
3. Correction unit.
4. Process unit.
5. Feedback unit.

Functions of each elements of a closed loop system:

Comparison element: this unit compares the reference value with feedback value and produces an error signal.

Error = reference value – feedback value

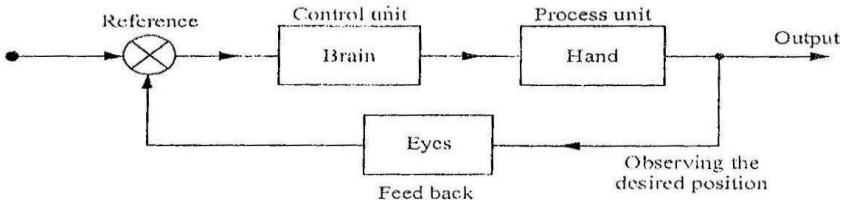
Control unit: Control unit analyses the error signal and decides what action is to be taken.

Correction unit: the modified signal from the control unit will be received by the correction unit which produces a change in the process to correct or change the controlled condition.

Process unit: process unit is the unit which is being controlled.

Examples:

1. Hand reaching an object.



- ✓ This is an example of closed loop control system.
- ✓ A person wants to reach for an object.
- ✓ Position of the object is given as reference, feedback signals and the eyes compares the actual position of the hands with reference to the position of the object.
- ✓ Error signal is given to the brain.
- ✓ Brain manipulates this error and gives signals to the hands.
- ✓ This process continues till the hand reaches the object.

5)

Block diagram of a microprocessor based processor control system of an Automatic camera:

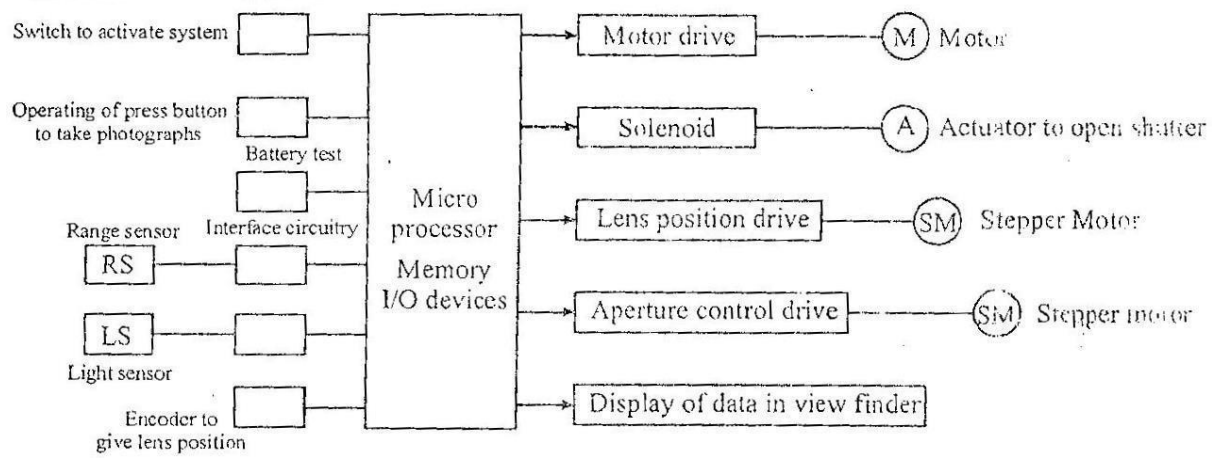


Fig 10: Automatic Camera

Working:

- Camera is used to photograph an object, the switch is pressed which activates the system.
- The range sensor sense the distance of the object to be photographed and this data is input to microprocessor.
- The microprocessor in turn sends on output to motor to drive to position the lens for focusing.
- The position of the lens is input to microprocessor.
- Next the light sensor sends the signal of light intensity on the object to microprocessor.
- Based on this, signals are sent to control the duration of time the shutter have to be kept open.
- All these action and reaction take place within a fraction of second.
- Once the film has exposed, the information is input to the microprocessor which gives output for driving the motor for advancing the film to drive and the camera is ready for the next exposure.