EEE 319

Bello Haneef 18/ENG04/023 Elect/Elect

1) Describe briefly (with examples) Sensors and actuators for Biomedical Application

Microelectrochemical systems (MEMS) are used in biomedical applications as sensors. Examples of this applications are critical sensors used during surgery, long term sensors for prosthetic devices, and so on.

Here are some indepth applications of sensors in biomedical applications below.

1) Micro sensors for Biomechanics

the following sensors are used

i) Strain guages: these are used to characterize the forces of a body. they are used in orthopedic research and the study of muscles

ii) Accelerometers

these are inertial sensors, they determine impact level and patient posture.

2) Microsensors for Pneumatic Biosystems

The human body is a complex system of pumps valves and vessels & interconnects pressure in many parts of the body is an important parameter to indicate the health and well being of a patient.

So pressure sensors are used in biomedical systems in a lot of applications like determining blood pressure, bladder pressure and cerebral spinal fluid pressure.

3) Micro Sensors for Chemical Biosystems
A lot of organisms have complex chemical processing systems, hence there are a lot of applications in biomedics for chemical sensors.
Some examples are Impedance sensors, electrochemical sensors and Molecular specific sensors.

4) Actuators in Biomedical Systems
In Biomedical systems micro actuators are used, they are used when biological objects or their environment need to be controlled on the microscopic scale.
The ability of a biomedical system to integrate multiple micro actuators, greatly improves and expands its capabilities and functionality.

Below are some examples of actuator in biomedical applications.

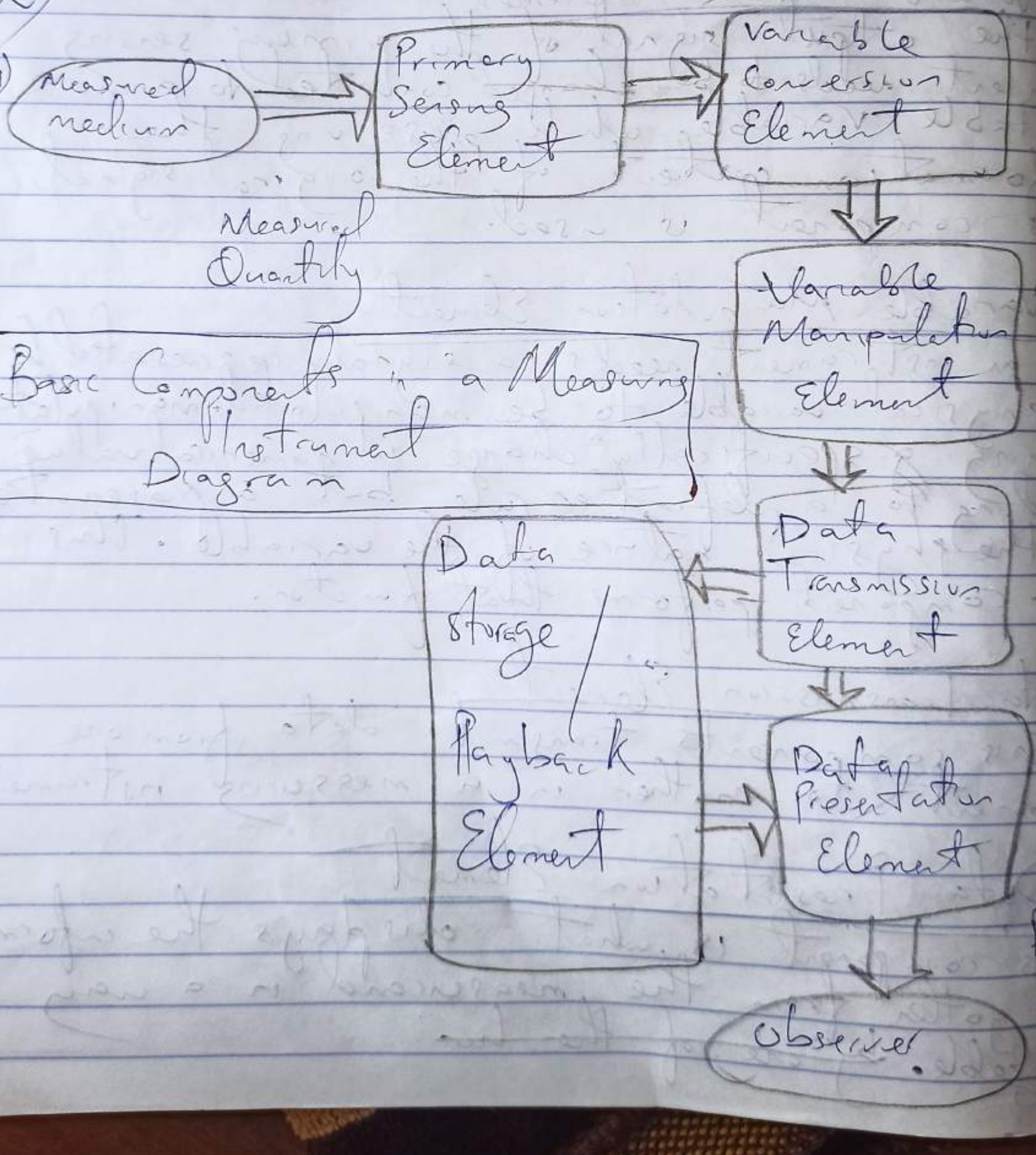
1) Micromanipulators
To manipulate cells, tissues and other biological objects, micromanipulators are driven by a micro actuation ~~system~~ mechanism capable of operating in a conductive solution.

2) Surgical Microinstruments
With the aid of Microelectrochemical systems micro actuators are used in surgical instruments for example a scalpel driven by a piezoelectric micro actuator.

3) Micropumps, Microvalves, Microfilters & Microneedles

Precise control of gas and fluid flow is critical for diagnostic, surgical & therapeutic biomedical systems, with the aid of micro actuators and micro electrochemical systems, this is possible.

2) Describe with sketches & examples, the components of basic measuring instrument.

1)


Basic Components in a Measuring Instrument Diagram

i) The measured medium :- this is the medium that is being measured.

ii) Primary Sensing Element

This first receives energy from what is being measured and produces an output depending on the measurand. The output is usually a physical variable e.g displacement or voltage.

iii) Variable Conversion Element

If the output signal of the primary sensing element needs to be ~~changed~~ converted to a more suitable variable while preserving the information content of the original signal, this component is used.

iv) Variable Manipulation Element

If an instrument needs a signal represented by a physical variable to be manipulated, manipulation meaning specifically a change in numerical value according to a defined rule but a preservation of the physical nature of the variable. This ~~compo~~ component performs that function.

v) Data Transmission Element

This components transmits data from one component to another in a measuring instrument.

vi) Data Presentation Element

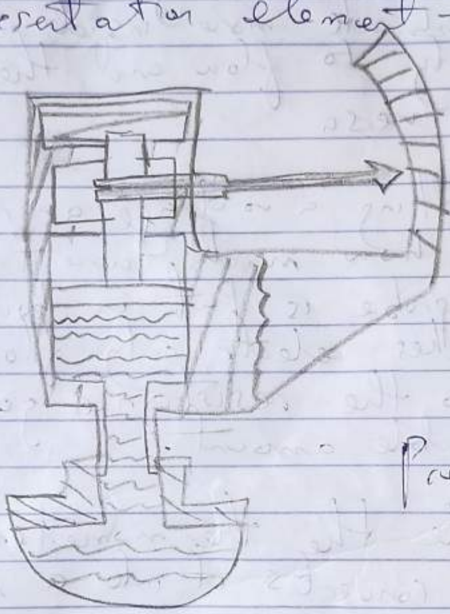
This component is what displays the information gotten from the measurand in a way recognizable. ~~by one of the hu~~

vii) **Data Storage / Playback Element**

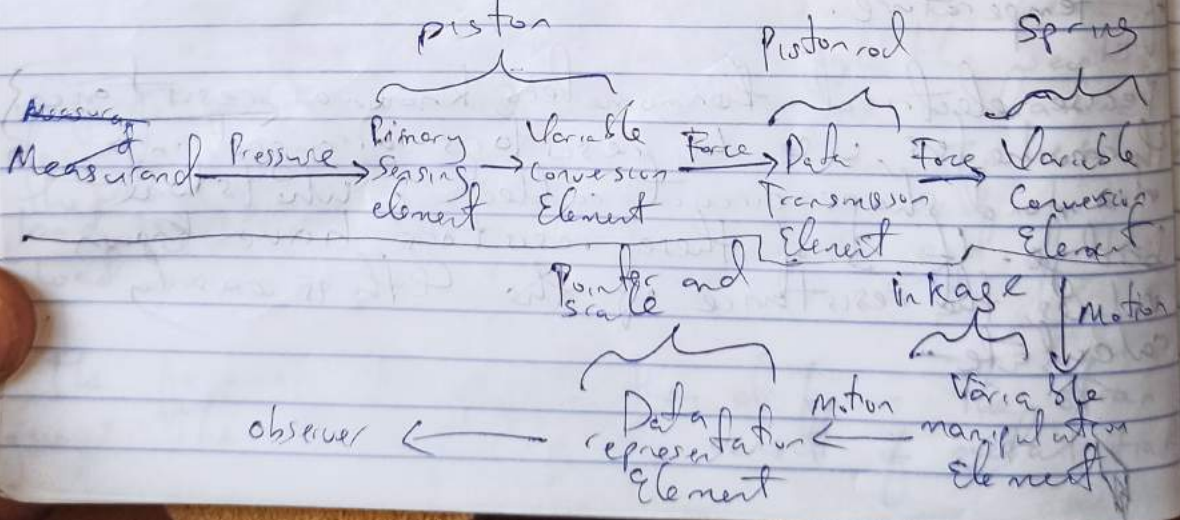
Some instruments have distinct data storage which can easily recreate data stored on demand.

Examples in a Pressure guage

1) Primary sensing element - piston
2) Measurand - ~~pressure~~ fluid
3) Variable Conversion Element - piston
4) Variable Manipulation element - linkage
5) Variable transmission element - piston rod
6) Data presentation element - pointer and scale



Pressure guage



3) Describe briefly case studies of 2 medical ~~instruments~~ measuring ~~st~~ instruments.

~~1) Thermometer~~

1) Electronic thermometers

Electronic thermometers are based on the idea that the resistance of a piece of metal changes as the temperature changes. As metals get hotter, atoms vibrate more inside them, its harder for electricity to flow and the resistance increases and vice versa

It works by putting a voltage across its metal probe and measuring how much current flows through it. If the probe is put in boiling water the water's heat makes electricity flow through the probe easily so the resistance goes up by a precisely ~~meas~~ measurable amount.

A micro chip inside the thermometer measures the resistance and converts it into a measurement of temperature.

Precise electrical thermometers known as resistance thermometers use 4 resistors arranged in a diamond shape circuit called a wheatstone bridge. If 3 of these resistors have known values, the resistance of the 4th is easily calculate.

If the cell resistor is designed in the shape of a temperature probe, a circuit like this can be used as a very precise thermometer. Knowing its resistance allows us to calculate the temperature.

~~Electronic thermometers, the probe act as~~

Basic Components of Electronic thermometer

1) Primary Sensing element — probe
2) Variable Conversion element — microchip
3) Variable Manipulation element — microchip
4) Data presentation element — screen
5) Data Transmission element — microchip

2) Digital Scale

Digital scales work with the use of a strain gauge load cell. They convert the force of a weight to an electric signal.

Its key components are the strain guage, used to measure the strain of an object, a load cell sensor, used to convert a force into an electric signal. The load cell is also known as a force transducer.

When an item is placed on the scale, the weight is first evenly distributed. ~~Under~~ The mechanical design of the digital scale then applies the force of the weight to one end of a load cell. As weight is applied, the end of the load cell bends downwards.

The force of the weight then deforms the strain guage. The strain guage can consist of metal t or foil, bonded to a printed circuit board or other backing.

The load cell sensor then converts the deformation to an electric signal. Because the load cell has an electric charge, as it moves downwards, the electrical resistance changes. The resulting change in resistance becomes an electrical signal.

The signal is run through an analog to digital converter, then passes through a microchip that translates the data.
As a result of this, numbers indicating the weight of the object appear on the LCD display of the digital scale.

Basic Components of Digital Scale

1) Primary sensing element — strain guage
2) Variable conversion element — load cell sensor
3) Variable manipulation element — analog to digital converter
4) Data presentation element — LCD display
5) ~~Data~~ Data Transmission element — Microchip