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MAT NO: 18/ENG04/068
DEPT: ELECTRICAL/ELECTRONICS ENGINEERING

1) Describe briefly (with examples) Sensors and Actuators for Biomedical Applications

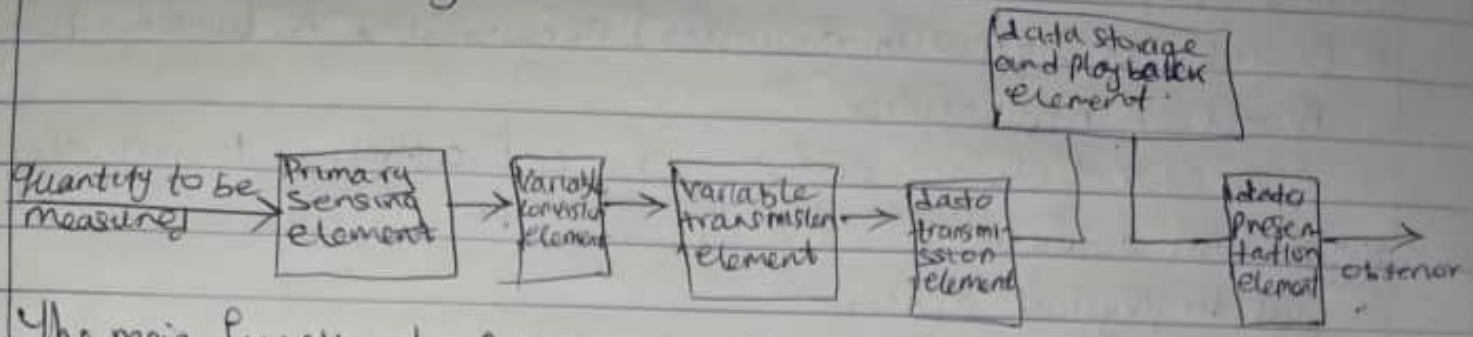
A sensor tends to convert a physical attribute to an electrical signal. An actuator does the opposite; it changes an electrical signal to physical action.

- Examples of Sensors;
a) Alarm Sensor
b) Stud finder
c) occupancy sensor
d) motion detector
e) Proximity Sensor

- Examples of Actuators;
a) Electric motor
b) Screw Jack
c) Hydraullic cylinder
d) comb drive
e) Pneumatic actuator.

Sensors are widely used in biomedical applications. Measuring Patients Vitals are now very quick, easy, fast, accurate because of advancements of electrical application of sensors. example of such sensors are; Respiration sensor, Blood flow sensor, Heart sound sensor, Blood Pressure sensor, e.t.c. The applications for smart actuators in the biomedical field have become more advanced, such as drug delivery using a controlled micropump with which the required drug will be supplied at specific times. Micro grippers that are actuated are used to remove tumors.

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

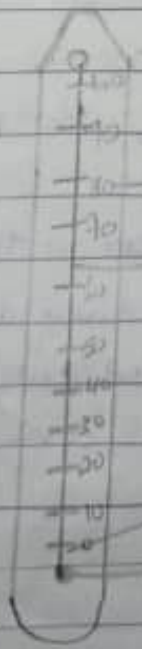


The main functional components of a measurement system are;

i) Primary sensing element
ii) Variable conversion element
iii) Signal conditioning element
iv) Variable manipulation element
v) Data transmission element
vi) Data presentation element

i) Primary sensing element;

The primary sensing element transfers the measured to variable conversion element for further processing. The output signal of a primary sensing element is a physical variable such as displacement or voltage. e.g of primary sensing instrument is Liquid in glass thermometer.



The first element in any measuring system is the primary sensor this gives an output that is a function of the measurand (the input

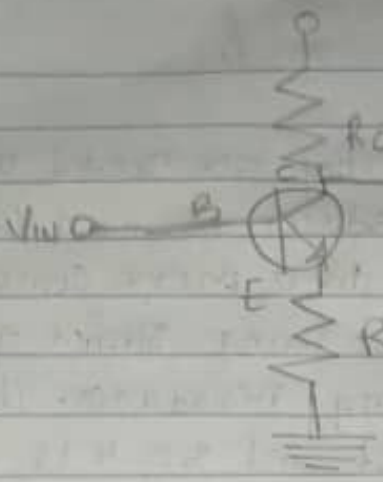
approximately linear.

ii) Variable Conversion element; They are needed where the output variable of a primary transducer is in an inconvenient form and has to be converted to a more convenient form. For instance, the displacement-measuring strain gauge has an output in the form of a varying resistance. The resistance change cannot be easily measured and so it is converted to a change in voltage by a bridge circuit, which is a typical example of a variable conversion element. In some cases, the primary sensor and variable conversion element are combined, and the combination is known as a transducer.

iii) Signal processing elements; They exist to improve the quality of the output of a measurement system in some way. However, signal processing is not a magic cure for problems that results from poor measurement system design. Hence, it is important that the measurement system is designed properly such that the output from measurement sensors is of an appropriate amplitude and free from noise. They are applied in the following field;

- Audio signal processing
- Image processing
- Video processing

iii) Variable manipulation element; Variable manipulation means a change in numerical value of the signal. The function of a variable manipulation element is to manipulate the signal presented to this element while preserving the original nature of the signal. eg; voltage amplifier act as a variable manipulation element. A voltage amplifier in simplest form is any circuit that puts out a higher voltage than the input voltage. We can consider that amplifies given voltage for a larger voltage output.

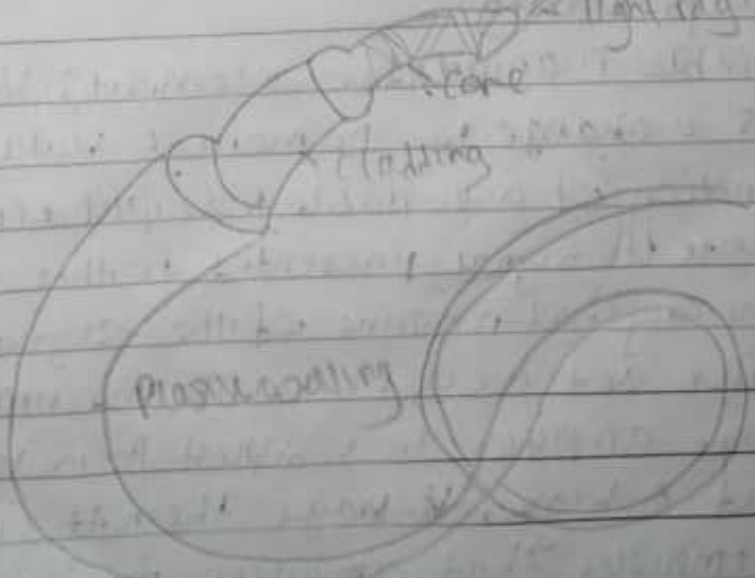


A voltage Amplifier circuit

ii) Data transmission element; The function of the data transmission element is to sense the controlled output quantity and to convert it to a signal which can be used to either monitor the output or to act as a feedback device in a closed loop control system.

Eg; copper wires, optical fibers, wireless communication channels, storage media and computer buses. Data transmitted may be digital messages originating from a data source, for example a computer or a keyboard.

Optical fiber is the technology associated with data transmission using light pulses travelling along with a long fiber which is usually made of plastic or glass. Metal wires are preferred for transmission in optical fiber communication as signals travel with fewer damages



(3) i) Electrocardiograph maching; This is used to record the electrical activity of the heart over a period of time.

The basic Principle of the ECG is that stimulation of a muscle alters the electrical potential of the muscle fibres. Cardiac cells, unlike other cells, have a property known as automaticity, which is the capacity to spontaneously initiate impulses. Normal Ecg values for waves and intervals are as follows;

RR interval; 0.6-1.2 seconds.
P wave; 80 milliseconds.
PR interval; 120-200 milliseconds

The electrodes are connected to an ECG machine by lead wires - The electrical activity of the heart is then measured, interpreted, and printed out - NO electricity is sent into the body. Natural electrical impulses coordinate contractions of the different parts of the heart to keep blood flowing the way it should.

ii) Sphygmomanometer; This is used to measure a patient's blood pressure;

The sphygmomanometer cuff is inflated to well above expected systolic pressure. As the value is opened, cuff pressure (slowly) decreases. When the cuff's pressure equals the arterial systolic pressure, blood begins to flow past the cuff, creating blood flow turbulence and audible sounds. There are ~~two~~ types of sphygmomanometers; # Digital sphygmomanometers are automated, providing blood pressure reading without needing someone to operate the cuff or listen to the blood flow sounds.

Manual sphygmanometers which consist of an aneroid and mercury