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MATRIC NOS: 18/ENG02/095
COURSE CODE & TITLE: MEASUREMENT AND INSTRUMENTATION (EEE 319

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

A) Sensors for Biomedical application are very critical components in all devices and measurement systems.

Sensors for Biomedical applications

Biomedical Sensors are classified into 2: physical Sensor and chemical Sensor

Physical Sensors

Physical sensors are employed to measure blood presoure, body temperature, blood flow, blood viscosity e.t.c. Physical sensors are divided into 4, they are the Radiation Sensors, mechanical sensors, Thermal Sensors, magnetic Sensors

Radiation Sensors

-> They utilize radiations (x-rays or gamma rays) for imaging and treatment in a variety of biomedical applications

mechanical Sensors

They include ultrasound and pressure Sensors for biomedical application. These Sensor target a large number of physical variations (e.g force, mass, strain, pressure etc

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Thermal Sensors

Are utilized to measure the on-body temperature instruments, which is a vital indicator of a persons health

Magnetic Sensors

Magnetic Sensors are mainly based on the magnetic moment of magnetic material that changes the magnetic field or temperature or cause mechanical stress.

Examples of Sensors for Biomedical application

- Optical Sensors: Are small in size, have high sensitivity have no interference with electromagnetic radiation Thus is why they are used in biomedical application
- Physical Sensor: frequently used in electronic instruments such as X-Ray, PET, MRI, measurement of blood flow/pressure and body temperature.
  - Blood pressure sensor
  - Respiration sensor
  - Heart Sound sensor.

Chemical sensor

They detect the ingredient and concentration of bod liquid such as PH value, Ca^{+} concentration, gluco concentration e.t.c.

ACTUATORS FOR BIOMEDICAL APPLICATION

Actuators track different signals, Operate through different work means and works togeth with a sensor to complete a task. Actuators are responsible for trailering/performing actions that comes with the machine.

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micro-electromechanical-systems (MEMS) based actuators is a magnetic actuator/device that uses the micro-electromechanical systems to convert an electric current into a mechanical output by employing Lorentz force Equation. They transduce certain domains of energy into mechanical movements in the microscopic scale and are increasingly contributing to the areas of biomedical application.

Types of MEMS actuators

- Thermoresponsive actuators
- SMA (Shape memory actuators)
- Electromagnetic Actuators

The applications of these-MEMS-based devices include cardiac devices, microneedles, microsurgeon robots, new drug discovery

Examples of Biomedical applications of Actuators

- Hospital beds: Are specifically designed for the recovery of patients. Actuators here ensure quieter/more peaceful operation and low-maintenance.
- Scanners: CT, MRI, PT Scanning instruments are used for examination & diagnosis purposes. They are powered with linear actuators which allow easy movement in any direction.
- Hospital lifts: used to move patients from one place to another within the hospital and Electrical linear and linear actuators are used here as they help in controlling movement.

Laser positioning equipment: Linear actuators help to control the accuracy and positioning of the beam as beam is directed to areas of injury.

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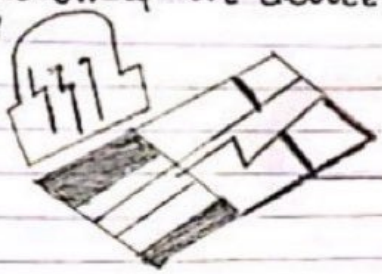
2. Describe with sketches and examples of the components of a basic measuring instrument

A measuring instrument may be defined as a device used for determining the value or magnitude of a quantity or a variable.

Measuring Components

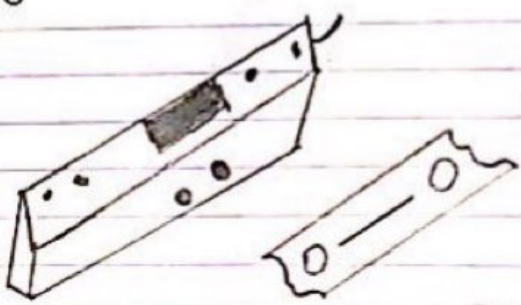
→ Strain gages

They consist of a very fine and thin metallic foil etched in a grid pattern. Which is bonded to a device and used to measure the strain, or amount of deformation of the device when load or pressure is applied



→ Force sensors

Used in bath scales, various other types of scales game consoles, home appliances e.t.c. these sensors are sensors for mass production that use strain gages



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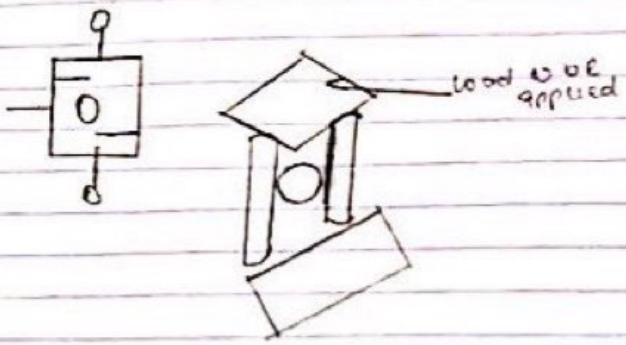
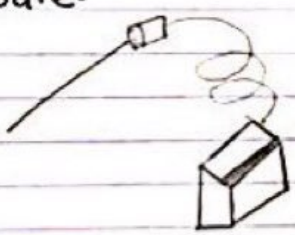
Load cells

They use strain gage to convert tension, compression or mass into electric signals. Load cells, connected to various measuring devices for measuring purposes, display, record, control and keep track of the loads.



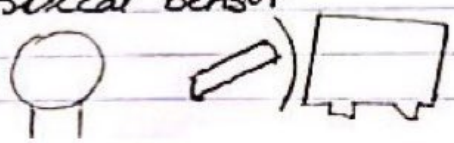
Pressure Sensor

Pressure sensors are sensures that measure pressure as electric signals. The sensors perform displaying, recording, controlling, monitoring the pressure.



Torque transducers

This sensor measures the twist with a strain gau and transmits the output by signal or by using an optical sensor



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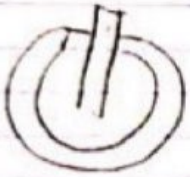
Vector sensor

A sensor that detects the translation power in 3 directions.

The direction of power can be detected by using the vector sensor



Other components of a basic measuring instrument

i) Primary Sensing element: Receives energy from the measured medium and produces an output.
The output is the physical variable.

ii) Variable - conversion element: convert the output signal of the primary sensing element to a more suitable variable

iii) Variable - Manipulation element: This element performs the function of manipulating a signal represented by a physical variable.

iv) Data - Transmission element: transmission of data is necessary and this function is performed here.

v) Data - Presentation Element: Information needs to be communicated to a human being for monitoring control & analysis and this element performs this

vi) Data Storage / playback element: Some applications require a distinct storage / playback which can easily recreate the stored data upon command

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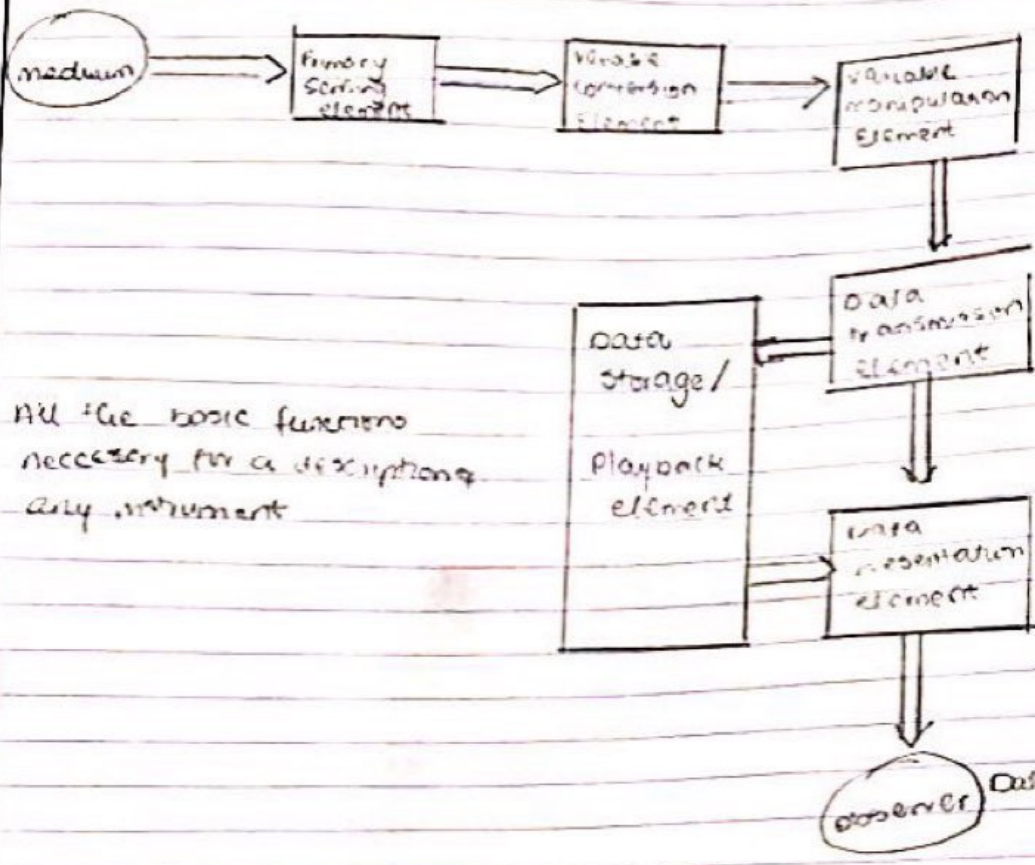

All the basic functions necessary for a description any instrument

Describe briefly case studies of 2 medical measurement instruments

Thermometer

→ used to record body temperature

PROBLEM

Tho they are inexpensive, they are easy to read, require very little maintanance and give accurate Readings they get damaged easily. If dropped and the battery runs down faster than normal.

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Mode of operation of a thermometer

A known measure of liquid (mercury, alcohol) is in a vacuum sealed glass tube. The liquid expands or contracts when heated or cooled. The bulb reservoir is formed by heating one end of the glass tube and pinching it closed

Types of thermometers

- Glass and mercury thermometer
- Digital thermometers (fastest & most accurate)
- pallpic thermometer
- plastic strip thermometer e.t.c.

Solution to problem

Make the thermometer with a harder substance so that when it falls it isn't damaged easily.

Outcome

Thermometers need repair regularly and need to be changed frequently for accurate results.
There was an instant reduction in the amount of failures and repairs needed

3 STETHOSCOPE

Stethoscope is a medical instrument used in listening to sounds produced within the body chiefly in the heart or lungs. Sounds such as heart beats, intestinal movements, breath sounds e.t.c.

PROBLEM

Stethoscopes are still very much useful and still provide some basic answers. The only known

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problem of a stethoscope due to recent discovery is that it can lead a doctor to infection. the Stethoscopes need to be cleaned regularly but due to the busy nature of a doctor he hardly has enough time.

mode of operation

it operates on the transmission of sound from the chest piece, via air-filled hollow tubes to the listeners ears. If the diaphragm is placed on the patient, body sound vibrate the diaphragm, creating acoustic pressure waves which travel up the tubing to the listener's ears.

Solution to problem.

The solution is very easy. In order to avoid transmission of diseases/infections the stethoscope should be changed regularly and if it is being re-used it must undergo disinfection.
Stethoscopes are used repeatedly throughout the day and must be disinfected as to avoid contamination afterall it is being exposed to different patients.

Outcome

it was found that stethoscopes cannot be replaced and has huge usefullness. they need to be cleaned thoroughly / disinfected or changed and as this was done the rest of patients were reduced and patients stopped falling sick / getting diseases significantly.

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