Sarah Odekwo
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Computer Engineering

EEE 319

(1) Describe briefly (with examples) sensors and actuators for biomedical applications.

Sensors:

In medicine and biotechnology, biomedical sensors can detect specific biological, chemical or physical processes and then transmit or report the data. These sensors can also be components in systems that process clinical samples, such as increasingly common lab-on-a-chip devices.

Biomedical sensors are also used to monitor the safety of medicines, food, environmental conditions and other substances that could be encountered.

The ecosystem of medical sensors includes research and development, assembly and manufacturing suppliers, system integrators, distribution, marketing and sales, and end users.

Examples:
- Temperature sensors
- Blood glucose sensors
- Blood oxygen sensors
- ECG (Electrocardiogram) sensors
- Pressure sensors
- Motion sensors
- Image sensors

Actuators:

Actuators are devices that are responsible for moving and controlling a mechanism or system. It turns a control signal into mechanical action. Different types of actuators are used according to the requirement and the actuation needed in medicine and biotechnology.

Biomedical actuators are used in microsurgical procedures, drug delivery using a controlled micropump with which drugs will be supplied at specific times. Microgrippers that are actuated are used to remove tumors. They are also various applications of these actuators in detection, analysis, diagnosis, drug delivery and cell culture.

Examples :
- Micropump
- Microvalve
- Microgripper
- Micromotor
- Microrelays
- Optical switches
- Microshutter

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

(i) **Primary Sensing Element:** This is the element that receives energy from the measured medium and produces an output (depending in some way on the measured quantity). The output is a physical variable.

(ii) **Variable-Conversion Element:** It may be necessary to convert the output signal of the primary sensing element to another more suitable variable while preserving the information content of the original signal. This element performs this function.

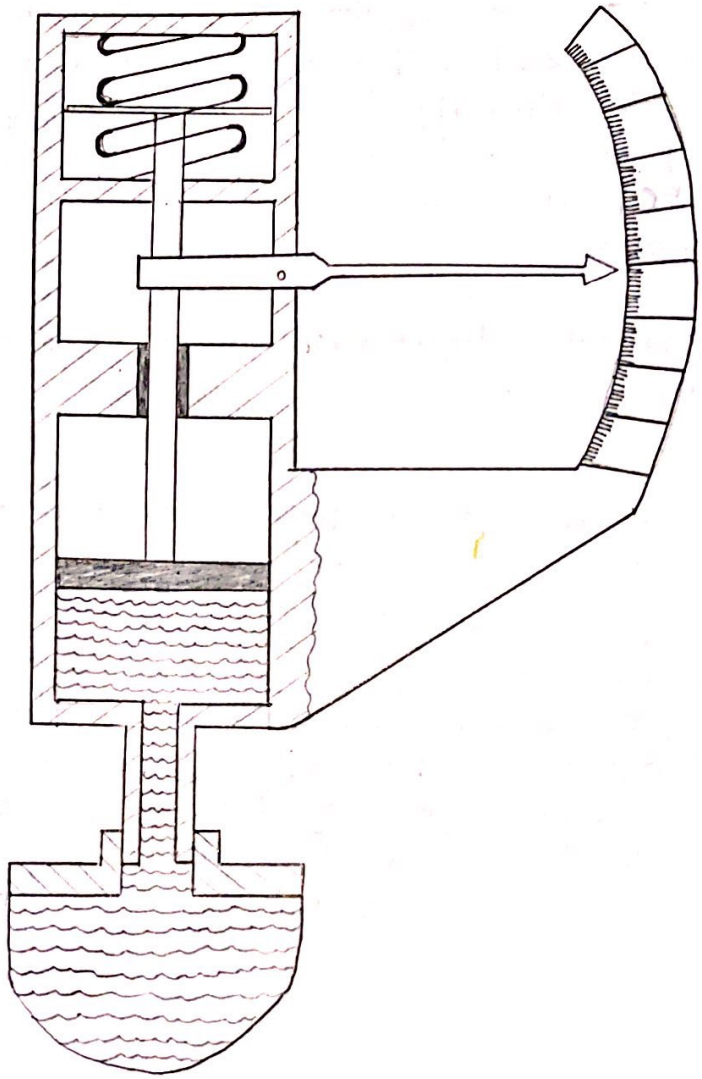
(iii) **Variable-Manipulation Element:** An instrument may require that a signal represented by some physical variable be manipulated in some way. By manipulation, it means specifically a change in numerical value according to some definite rule but a preservation of the physical nature of the variable. This element performs such a function.

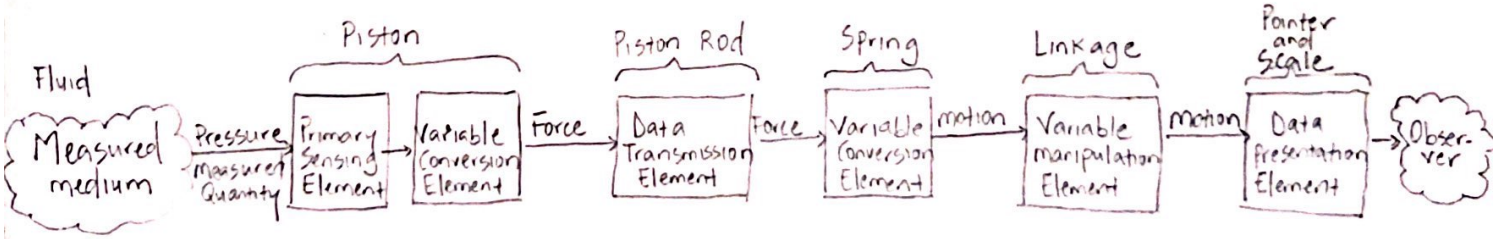
(iv) **Data-Transmission Element:** When functional elements of an instrument are physically separated, it is necessary to transmit data from one to another. This element performs the function.

(v) **Data-Presentation Element:** If the information about the measured quantity is to be communicated to a human being for monitoring, control, or analysis purposes, it must be put into a form recognizable by one of the human senses. This element performs this translation function.

(vi) **Data storage/Playback Element:** Some applications require a distinct data storage/playback which can easily recreate the stored data upon command.

PRESSURE GAUGE





(3) Describe briefly case studies of two medical measurement instruments

(i) Electrocardiographs (ECGs)

Electrocardiographs record the electrical activity generated by heart muscle depolarizations, which propagate in pulsating electrical waves towards the skin. Although the electricity amount is infact very small, it can be picked up reliably with ECG electrodes attached to the skin.

The full **ECG** setup comprises of at least electrodes which are placed on the chest or at the four extremities according to a standard nomenclature.

During examination, heart rate can be recorded, as well as the regularity of the beats.

(ii) Stethoscope

Stethoscopes are used to listen to heart sounds, the lungs, and even blood flow in the arteries and veins.

The part of the stethoscope that is usually pushed against the chest or back, is known as the bell. The bell is flat and round, and is covered by a thin layer of plastic known as a diaphragm. The diaphragm vibrates as sound is produced within the body. These vibrations travel from the bell, up the hollow tube which splits into two, and into hollow ear pieces to be heard as sound by the medical professional.