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

SOLUTION

⇒ Sensors for Biomed Applications

The Sensors used for Biomed Applications are mainly physical Sensors. Physical Sensors makes use of physical Sensing, which is a unique platform, where Sensing devices are responsive towards physical properties e.g. radiation output, flow, heat, pressure, magnetic fields, and parameters related to mass, and energy and convert them into signals for quantification

→ TYPES OF PHYSICAL SENSORS BASED ON THEIR SIGNALS WITH EXAMPLES

1) Radiation Sensors

Radiation Sensors utilize radiation (X-rays or gamma rays) for imaging, and treatment in a variety of biomedical applications. In particular, radiation Sensors are most employed for medical imaging while using ionising radiation. E.g. X-rays & Gamma ray Sensors.

2) Mechanical Sensors

Mechanical Sensors target a large number of physical variation e.g. force, mass, pressure, velocity, and acceleration. The ultrasound waves emitted by transducers pass into the tissues, and are detected using Sensors to monitor health conditions without involving any invasive procedures. e.g. ultrasound, and pressure sensor.

3) Thermal Sensors

These Sensors are used to measure the in-body temperature measurements, which is a vital indicator of person's health.

e.g. Infrared Sensors, thermistor, thermocouple, etc.

4) Magnetic Sensors

In biomedical applications, magnetic Sensors are used to hyperthermia treatments or for drug delivery. These applications may include blood, and organic tissues.

Some of the biomedical applications are listed below:

- i) Test of blood coagulation, and blood flow.
- ii) Cancer cell treatment with silica coated manganese oxide.
- iii) Cell culture measurement in situ.

5) Optic Sensors

Optic sensors used for biomedical applications are classified into fibre optic sensors. Fibre optic sensors can operate as in vivo diagnostic elements, or to assist other endoscopic devices. They are used in oximetry, defecation measurements, etc.

⇒ Actuators for Biomedical Applications. (DESCRIPTION)

Micro-electromechanical system (MEMS) based actuators, which transduce certain domains of energy into mechanical movements in the microscopic scale, are increasingly contributing to areas of biomedical engineering, and healthcare applications. The applications of these MEMS-based devices include cardiac devices, microneedles, lab on a chip devices for fast chemical/biological analysis, microsurgical robots, and in-vivo drug delivery systems for drug release with precision dosage, and timing control. Examples of actuators used for biomedical applications are: Thermoresponsive Actuators, Electromagnetic Actuators, Piezoelectric actuators, Fluid-driven Actuators.

→ BIOMEDICAL APPLICATIONS OF MEMS ACTUATORS

- i) Lab on a Chip (LOC)
- ii) Implantable Drug-Delivery System
- iii) Cardiac Devices
- iv) Surgical, and Endoscopic Tools

(2) Describe with Sketches, and Examples, of the components of a basic measuring instrument.

Solution

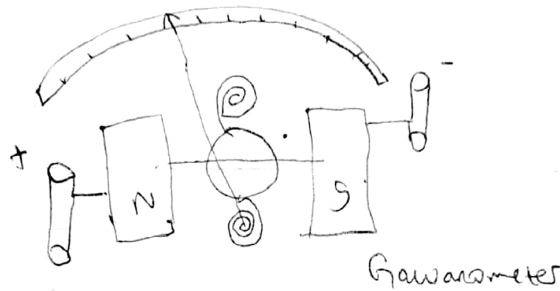
Measuring instrument is the instrument used for measuring the physical, and electrical quantities.

The components of the measuring instruments are classified into 3

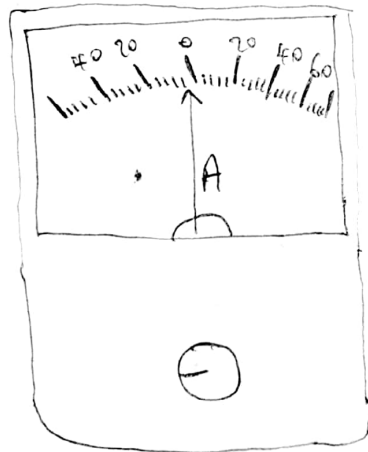
- Electrical Instrument
- Electronic Instrument
- Mechanical Instrument

→ Electrical Instrument is used for measuring electrical quantities like current, voltage, power, etc. The ammeter, voltmeter, wattmeter, are the examples of the electrical measuring instrument.

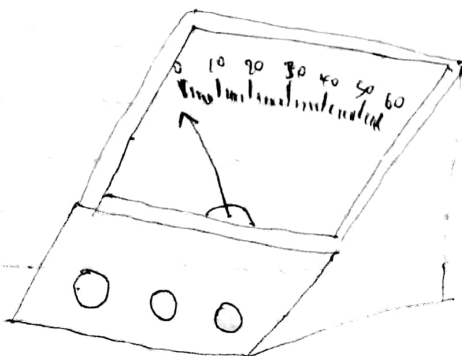
The galvanometer is an example of electrical instruments



Galvanometer



Ammeter



Voltmeter

→ Electrode Instrument

The electrode instrument has a swift response time. The instrument provides the swift response as compared to the electrical and mechanical instruments.

→ Mechanical Instrument used for measuring physical quantities.

(3) Describe briefly the uses of two medical measuring instruments.

(1) SPHYGMOMANOMETER

Sphygmomanometer is used to measure the patient's blood pressure.

It is composed of an ~~inflatable~~ ^{inflatable} cuff, to couple, and then release the artery under the cuff in a controlled manner, a measuring unit, and a mechanism for inflation which may be a manually operated bulb and valve or a pump operated electronically.

→ OPERATIONS

In humans, the cuff is normally placed smoothly and snugly around the upper arm, at roughly the same vertical height as the heart while the subject is seated with the arm protected. It is essential that the correct size of cuff is selected for the patient. Too small a cuff results in too high a pressure, while too large a cuff results in too low a pressure.

→ TYPES

i) Pocket-aneoid Sphygmomanometer

ii) Palm aneoid Sphygmomanometer

iii) Clock-style - aneoid Sphygmomanometer.

2) STETHOSCOPE

The Stethoscope is an acoustic medical device for auscultation, or listening to internal sounds of an animal or human body. It typically has a small disc-shaped resonator that is placed against the skin, and one or two tubes connected to two ears. A stethoscope can be used to listen to the sounds made by the heart, lungs or intestines as well as blood flow in arteries, and veins. In combination with a manual sphygmomanometer, it is commonly used when measuring blood pressure.