MEDICAL
ELECTRONICS
Medical Instruments

Classification of Biomedical Equipments
1. Diagnostic equipment
2. Therapeutic equipment
3. Clinical equipment
4. Laboratory equipment
Components in Man – Instrument system

Stimulus

Transducer

Transducer

Transducer

Control feedback

Signal conditioning equipment

Display

Recording, data processing and transmission of data
Man – Instrument system

- Measurement in biomedical instrumentation can be divided into two

1. VO
   - Measurement is made on or within the human body
     - Eg. Device inserted into the bloodstream to measure PH of blood

2. VITRO
   - Measurement is performed outside of the body.
     - Eg. Measurement of blood PH from blood samples.
Sources of Bioelectric potentials

- The systems in the human body generate their own monitoring signals when they carry out their functions.

- These signals provide useful information about their function.

- Bioelectric potentials are actually ionic voltages produced as a result of electrochemical activity of certain cell.

- Transducers are used to convert these ionic potentials into electrical signals.
Resting and Action potentials

- Certain types of cells within the body, such as nerve and muscle cells, are encased in a semi-permeable membrane.

- This membrane permits some substances to pass through while others are kept out.

- Surrounding the cells of the body are the body fluids.

- These fluids are conductive solutions containing charged atoms known as ions.
Resting potentials

- The principle ions are sodium (Na\(^+\)) and potassium (K\(^+\)) and chloride (Cl\(^-\)).
- The membrane of excitable cells permit entry of potassium (K\(^+\)) and chloride (Cl\(^-\)) ions but blocks the entry of sodium (Na\(^+\)) ions.
- So inside the cell is more negative than outside the cell.
- This membrane potentials is called Resting potentials.
- This potential is measured from inside the cell with respect to body fluids.
- So resting potential of a cell is negative.
Resting potentials/Polarization

- This resting potential ranging from -60mv to -100 mv.
- Cell in the resting state is called polarized cell.
Depolarization of cell

- When a cell is exited, the membrane change its characteristic

- The sodium ions are rushed in to the cell.

- At the same time potassium ions try move from inside.

- After a equilibrium state is reached, the sodium is moved back to outside
Depolarization of cell

Cell Membrane

\[\text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \quad \text{Na}^+ \quad \text{K}^+ \]
Action potentials

Cell Membrane

Ground

20 mV
Re Polarization

- Cell comes from de polarized state into a polarized state, called Re polarization.

Ground
-70 mV
Resting and Action potentials
Propagation of Action potentials

- When a cell is exited and generates an action potentials ionic currents to flow.
- This process excite neighboring cells or adjacent area of the same cell
Transducers

- A transducer is necessary to convert one variable into another form.

- Used to measure physiological variables.

- Variable is a quantity that varies with time.

- The term active and passive has different meanings when they are applied to Transducers.
Transducer can be classified into two

- **Active Transducer**
  
  Known principles is used to convert variables into electrical signal

- **Passive Transducer**

  It involves control of an excitation voltage or modulation of a carrier signal
Principles used in Active Transducers

- It can convert electrical signal into physical variables and also in reverse direction.
  1. Magnetic Induction
  2. Piezoelectric effect
  3. Thermoelectric effect
  4. Photoelectric effect
Passive Transducers

- Utilize the principles of controlling a DC excitation or an AC carrier signal.

- It consists of a passive circuit element which changes its value as a function of physical variables to be measured.

- It cannot convert electrical signal into physical variables
Principles used in Passive Transducers

- Using Resistive element
  1. Ordinary Potentiometer
     a. Linear
     b. Rotary
  2. Strain gage
     a. Un bonded
     b. Bonded
     c. Semiconductor strain gage

- Using Inductive element
  1. Variable reluctance Transducer
     LVDT

Using Capacitive element
Transducers for Biomedical field

1. Force transducer
2. Photoelectric displacement transducer
3. Pressure Transducers
4. Flow transducers
5. Transducers with digital O/P
Transducers for Biomedical field

1. Resistive transducers - Muscle force and Stress (Strain gauge), Spirometry (Potentiometer), humidity, (Garmsters), Respiration (Thermistor)
2. Inductive Transducers - Flow measurements, muscle movement (LVDT)
3. Capacitive Transducers - Heart sound measurement, Pulse pick up
4. Photoelectric Transducers - Pulse transducers, Blood pressure, oxygen Analyses
5. Piezoelectric Transducers - Pulse pickup, ultrasonic blood flowmeter
6. Chemical Transducer - Ag-Agfallas (Electrodes, PH electrode)