It involves measurement of biological signals like ECG, EMG, or any electrical signals generated in the human body. Biomedical Instrumentation helps physicians to diagnose the problem and provide treatment. To measure biological signals and to design a medical instrument, concepts of electronics and measurement techniques are needed.

**Components of Biomedical Instrumentation System**

Any medical instrument consists of the following functional basic parts:

1. **Measurand**: The measurand is the physical quantity, and the instrumentation systems measure it.
2. **Sensor / Transducer**: The transducer converts one form of energy to another form usually electrical energy.
3. **Signal Conditioner**: Signal conditioning circuits are used to convert the output from the transducer into an electrical value.
4. **Display**: It is used to provide a visual representation of the measured parameter or quantity. Example: Chart recorder, Cathode Ray oscilloscope (CRO).
5. **Data Storage and Data Transmission**: Data storage is used to store the data and can be used for future reference.

**Electrocardiograph (ECG)**

- An Electrocardiogram is a test that records the electrical activity of the heart, shows abnormal rhythms (arrhythmias or dysrhythmias), and detecting heart muscle damage. The apparatus that records the ECG is called the Electrocardiograph. Abbreviated ECG and EKG. An ECG is a simple, noninvasive procedure.
- Electrical signals from the heart characteristically precede the normal mechanical function and monitoring of these signals has great clinical significance.
- ECG provides valuable information about a wide range of cardiac disorders such as the presence of an inactive part (infarction) or an enlargement (cardiac hypertrophy) of the heart muscle.
- Electrocardiographs are used in catheterization laboratories, coronary care units and for routine cardiac diagnostic applications in cardiology.

**Electrocardiogram (ECG or EKG) Test**

- Electrodes are placed on the skin of the chest and connected in a specific order to a machine that, when turned on, measures electrical activity all over the heart. Output usually appears on a long scroll of paper that displays a printed graph of activity on a computer screen.
Exercise Stress Test

A stress test, sometimes called a treadmill test or exercise test, helps a doctor find out how well your heart handles work. The test can show if the blood supply is reduced in the arteries that supply the heart. Heart rate, breathing, blood pressure, electrocardiogram (ECG or EKG), and how tired you feel are monitored during the test.

Advantages:

We can use the ECG to detect abnormalities not just with the electrical activity of your heart, such as heart rhythm disorders, but the ECG can tell us if your heart is enlarged, strong, weak, or damaged.

There is no preparation necessary for an ECG, and it is quick, inexpensive, and painless. An ECG can detect areas of muscle deprived of oxygen and/or dead tissue in the heart.

Electroencephalograph (EEG)
An **Electroencephalogram** (EEG) is a test that detects electrical activity in your brain using small, metal discs (electrodes) attached to your scalp. The apparatus that records the EEG is called the **Electroencephalograph**. Your brain cells communicate via electrical impulses and are active all the time, even when you're asleep. This activity shows up as wavy lines on an EEG recording.

An EEG is one of the main diagnostic tests for epilepsy. An EEG can also play a role in diagnosing other brain disorders.
Why it's done

An EEG can determine changes in brain activity that might be useful in diagnosing brain disorders, especially epilepsy or another seizure disorder. An EEG might also be helpful for diagnosing or treating the following disorders:

- Brain tumor
- Brain damage from head injury
- Brain dysfunction that can have a variety of causes (encephalopathy)
- Inflammation of the brain (encephalitis)
- Stroke
- Sleep disorders
- An EEG might also be used to confirm brain death in someone in a persistent coma. A continuous EEG is used to help find the right level of anesthesia for someone in a medically induced coma.
Risks

- EEGs are safe and painless. Sometimes seizures are intentionally triggered in people with epilepsy during the test, but appropriate medical care is provided if needed.

**EEG Frequency Bands**

Delta is the frequency range up to 4 Hz. It tends to be the highest in amplitude and the slowest waves. It is seen normally in adults in slow-wave sleep. It is also seen normally in babies.

Theta is the frequency range from 4 Hz to 7 Hz. Theta is seen normally in young children. It may be seen in drowsiness or arousal in older children and adults; it can also be seen in meditation.

Alpha is the frequency range from 7 Hz to 13 Hz. It emerges with closing of the eyes and with relaxation, and attenuates with eye opening or mental exertion.

Beta is the frequency range from 14 Hz to about 30 Hz. Low-amplitude beta with multiple and varying frequencies is often associated with active, busy or anxious thinking and active concentration.

Gamma is the frequency range approximately 30–100 Hz.

**Wave patterns**

![Delta waves](image1)

![Theta waves](image2)

![Alpha waves](image3)

![Beta waves](image4)

![Gamma waves](image5)