# Unit 1: Electrocardiography (ECG) Signals

## I. Pre-reading

### A. New Vocabulary

| Word | Form | Definition / Synonym |
|---|---|---|
| electrocardiogram | n | a record of the heart's electrical activity |
| electrode | n | a conductor that transfers electric current |
| waveform | n | the shape of an electrical signal |
| amplitude | n | height of a wave; signal strength |
| frequency | n | number of waves per second |
| lead | n | electrode arrangement for measuring heart activity |
| cardiac | adj | related to the heart |
| depolarization | n | electrical activation of heart muscle |
| repolarization | n | recovery phase of cardiac muscle |
| arrhythmia | n | irregular heartbeat |
| diagnostic | adj | used to identify a disease |
| artifact | n | unwanted interference in a signal |
| acquisition | n | process of collecting data |
| baseline | n | reference level in a signal |
| interpretation | n | explanation of recorded data |
| portable | adj | easy to carry |
| monitoring | n | continuous observation |
| abnormality | n | irregular or unusual condition |
| correlation | n | connection or relationship between things |
| therapeutic | adj | related to treatment of disease |

### B. Building Vocabulary

| Root | Meaning | Example |
|---|---|---|
| cardio | heart | cardiac, cardiology |
| electro | electricity | electrode, electrotherapy |
| graph | write, record | electrocardiograph, graphic |
| rhythm | regular pattern | arrhythmia |
| form | shape | waveform, transform |
| monitor | watch | monitor, monitoring |
| interpret | explain | interpretation, interpreter |
| therapy | treatment | therapeutic, physiotherapy |

### C. Pre-reading Questions

1. What is the purpose of recording an electrocardiogram (ECG)?
2. What information can ECG provide about the heart?
3. How do engineers help in designing ECG systems?
4. Why is signal filtering important in ECG recording?

## II. Reading

### Electrocardiography in Biomedical Engineering

Electrocardiography (ECG) is one of the most common diagnostic techniques in medicine. It records the **electrical activity** of the heart over time and provides valuable information about its rhythm and function. The recorded signal is called an **electrocardiogram**, which displays characteristic waves representing different phases of the cardiac cycle.

A standard ECG system uses several **electrodes** placed on the patient's chest and limbs to detect voltage differences produced by the heart's electrical impulses. Each pair of electrodes forms a **lead**, and the combination of multiple leads offers a complete picture of heart activity. Biomedical engineers design these systems to minimize **artifacts** caused by movement, electrical noise, or poor contact.

The ECG waveform typically includes the **P wave**, **QRS complex**, and **T wave**. The P wave indicates **atrial depolarization**, the QRS complex corresponds to **ventricular depolarization**, and the T wave represents **ventricular repolarization**. By analyzing these waveforms, clinicians can detect **arrhythmias**, **ischemia**, and other **cardiac abnormalities**.

Modern ECG systems use **digital signal processing** to filter noise, enhance signal quality, and automatically detect irregularities. Biomedical engineers develop **algorithms** for **real-time monitoring** and **data interpretation**, helping physicians make faster and more accurate diagnoses. Portable and wearable ECG devices allow **continuous heart monitoring**, which is especially important for patients with chronic cardiac diseases.

In research, ECG signals are used to study the **correlation** between physiological and psychological conditions. Machine learning models are also applied to predict potential cardiac events based on large ECG datasets. Thus, **electrocardiography** serves not only as a diagnostic tool but also as a foundation for innovation in **biomedical engineering**.

In conclusion, ECG technology represents a vital link between **engineering** and **medicine**. Biomedical engineers contribute by improving **signal acquisition**, **noise reduction**, and **automated analysis** systems, making cardiac care more accurate, efficient, and accessible.

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## III. Post-reading

### A. True (T), False (F), or Not Given (NG)

1. ECG measures mechanical activity of the heart.
2. The QRS complex represents ventricular depolarization.
3. Biomedical engineers design ECG systems to reduce noise.
4. Portable ECG devices can record brain waves.
5. Arrhythmias can be detected by analyzing ECG waveforms.
6. ECG systems never produce artifacts.
7. ECG helps monitor heart activity continuously.

## B. Multiple Choice

1. What does an electrocardiogram record?
   a) Heart electrical activity
   b) Blood flow speed
   c) Lung capacity
   d) Brain signals
2. What do electrodes detect in ECG?
   a) Temperature
   b) Sound waves
   c) Voltage differences
   d) Magnetic fields
3. Which wave represents ventricular repolarization?
   a) P wave
   b) QRS complex
   c) T wave
   d) None
4. What is a common source of ECG artifacts?
   a) Poor electrode contact
   b) High heart rate
   c) Low oxygen
   d) None of the above
5. What advantage do portable ECG devices provide?
   a) Continuous monitoring
   b) Reduced heart rate
   c) Higher temperature control
   d) Stronger electrical signals

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## C. Fill in the blanks

1. The doctor analyzed the patient's ________ to detect heart rhythm.
2. ECG ________ are placed on the chest to detect voltage changes.
3. Engineers work on removing ________ caused by muscle movement.
4. The ________ shows distinct P, QRS, and T waves.
5. Portable ECG devices allow ________ heart monitoring.
6. ________ occurs when the heart beats irregularly.
7. Biomedical engineers design systems to improve signal ________.
8. The ________ team used AI to interpret ECG data automatically.

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