

Unit 1: Electrocardiography (ECG) Signals

I. Pre-reading

A. New Vocabulary

Word	Form	Definition / Synonym	Persian Translation
electrode	n	a conductor that transfers electric current	الكترود
waveform	n	the shape of an electrical signal	شكل موج
amplitude	n	height of a wave; signal strength	دامنه
lead	n	electrode arrangement for measuring	لید (آرایش الكترودی)
cardiac	adj	related to the heart	قلبی
depolarization	n	electrical activation of heart muscle	دپولاریزاسیون
repolarization	n	recovery phase of cardiac muscle	رپولاریزاسیون
artifact	n	unwanted interference in a signal	آرتیفیکت / نویز
arrhythmia	n	irregular heartbeat	آریتمی
abnormality	n	irregular or unusual condition	ناهنجاری
diagnostic	adj	used to identify a disease	تشخیصی
acquisition	n	process of collecting data	جمع‌آوری داده
interpretation	n	explanation of recorded data	تفسیر
portable	adj	easy to carry	قابل حمل
monitoring	n	continuous observation	پایش / نظارت
correlation	n	connection or relationship between things	همبستگی
therapeutic	adj	related to treatment of disease	درمانی

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

Root	Meaning	Example
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. 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.

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.
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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.