

MEDICAL INSTRUMENTATION
(AEIE 4222)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) A transducer is a device that
 - (a) Amplifies signals
 - (b) Converts one form of energy into another
 - (c) Stores electrical energy
 - (d) Measures resistance
- (ii) The main function of a signal conditioning circuit in a transducer is to
 - (a) Convert analog signals to digital signals
 - (b) Enhance signal quality for measurement
 - (c) Increase temperature sensitivity
 - (d) Convert mechanical signals into electrical signals
- (iii) Heart sounds are typically detected using
 - (a) Thermistors
 - (b) Strain gauges
 - (c) Acoustic transducers
 - (d) Capacitive sensors
- (iv) The resting membrane potential of a typical cell is approximately
 - (a) +70 Mv
 - (b) -70 mV
 - (c) 0 mV
 - (d) +50 mV
- (v) The electrode-electrolyte interface generates a potential called
 - (a) Seebeck potential
 - (b) Half-cell potential
 - (c) Magnetic potential
 - (d) Optical potential
- (vi) The major advantage of microelectrodes is
 - (a) High impedance
 - (b) Large size
 - (c) Ability to measure intracellular potentials
 - (d) Sensitivity to temperature

- (vii) Which imaging technique uses high-frequency sound waves to create images of internal body structures?
 (a) MRI (b) CT scan (c) Ultrasound (d) X-ray
- (viii) Plethysmography is used to measure
 (a) Lung capacity (b) Brain activity
 (c) Blood volume changes (d) Muscle contractions
- (ix) Biotelemetry is primarily used for
 (a) Data storage in hospitals (b) Remote monitoring of biological signals
 (c) Blood transfusions (d) Conducting surgical procedures
- (x) The measurement of blood pH is important for assessing
 (a) Blood pressure (b) Oxygen saturation
 (c) Acid-base balance (d) Haemoglobin levels

Fill in the blanks with the correct word

- (xi) The Doppler Effect is used in _____ blood flow measurement.
- (xii) Einthoven's triangle is a fundamental principle in _____ measurement.
- (xiii) Diathermy is used for _____ therapy in medical applications.
- (xiv) Electrical isolation and _____ help prevent electric shock in biomedical instruments.
- (xv) _____ measurement is essential for assessing oxygen transport efficiency in the blood.

Group - B

2. (a) Differentiate between a sensor and a transducer. [[C01](understand/LOCQ)]
 (b) What are the performance characteristics of transducers? Explain. [[C01](understand/LOCQ)]
 (c) What do you mean by active and passive transducer? Give example of each. [[C01](Remember/LOCQ)]
4 + 4 + (2 + 2) = 12
3. (a) Define Gauge factor and its significance in blood pressure measurement. [[C01](Understand/LOCQ)]
 (b) What is the principal of strain gauge pressure transducer and what are their types? [[C01](Understand/LOCQ)]
 (c) What is a Sphygmomanometer? [[C01](Understand/LOCQ)]
 (d) A physician measures the blood pressure of a person and records the data as 120/80. Interpret the information. [[C01](Understand/LOCQ)]
(2 + 1) + (3 + 2) + 2 + 2 = 12

Group - C

4. (a) Define Resting Potential and Action Potential. Explain the process of Depolarization and Repolarization. [[C02](Understand/LOCQ)]

- (b) What is propagation rate? What is the value of propagation rate in nerve cells? [[CO2](Understand/LOCQ)]
- (c) Draw the action potential waveform and describe absolute and relative refractory period. [[CO2](Analyse/IOCQ)]
- (1 + 1 + 4) + (1 + 1) + (2 + 1 + 1) = 12**

5. (a) What is EEG? Classify different EEG signals according to their frequency range and also mention their significance. [[CO2](Understand/LOCQ)]
- (b) Which types of electrodes are used to measure EEG signal? Describe with diagram. [[CO2](Understand/LOCQ)]
- (c) What is EMG? How it is quantified? [[CO2](Understand/LOCQ)]
- (1 + 3) + (1 + 3) + (1 + 3) = 12**

Group - D

6. (a) What is medical imaging? Show the different imaging techniques and respective applications in biomedical instrumentation? [[CO3](Understand/LOCQ)]
- (b) Define characteristic impedance in ultrasound. [[CO3](Analyse/IOCQ)]
- (c) What is the frequency range of ultrasound normally used in medical field for diagnostic applications? [[CO3](Remember/LOCQ)]
- (d) What are the two types of resolution in an ultrasound system? Explain them. [[CO3](Analyse/IOCQ)]
- (1 + 3) + 3 + 1 + 4 = 12**
7. (a) What is the need of a cardiac defibrillator? Explain with the help of a diagram. [[CO4](Analyse/IOCQ)]
- (b) Why do we require a synchronization function in a defibrillator? [[CO4](Analyse/IOCQ)]
- (c) When implantable defibrillators is recommended for a patient? What are the main system components of an Implantable defibrillator? [[CO4](Understand/LOCQ)]
- (d) What are the types of waveforms used for defibrillator? Which type of waveform is preferred and why? [[CO4](Understand/LOCQ)]
- 2 + 2 + (1 + 3) + (2 + 2) = 12**

Group - E

8. (a) Present the different sections in biotelemetry? Explain with a neat sketch the block diagram of a telemetry system to send patients' physiological events. [[CO5](Understand/LOCQ)]
- (b) State and explain few applications of telemetry in patient care. [[CO5](Understand/LOCQ)]
- (2 + 6) + 4 = 12**
9. (a) What is the function of a blood gas analyser? Why is it necessary to maintain acid-base balance in the body? Indicate the normal blood pH value. [[CO2](Understand/LOCQ)]

- (b) Write the equation giving relationship between potential generated and pH (Nernst equation) for a glass electrode. Define slope factor and draw a graph showing relationship between pH and emf at 25 °C. [[CO2](Understand/LOCQ)]

(3 + 2 + 1) + (2 + 1 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	84.38	15.62	0