

**BIOMEDICAL INSTRUMENTATION
(AEIE 4241)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

***Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.***

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

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The figure of merit which describes the overall behaviour of the wire under stress is determined from _____.
 - (a) gauge factor
 - (b) elastic modulus
 - (c) elastic factor
 - (d) gauge resistance
 - (ii) Low body temperature is called as _____.
 - (a) Hyperthermia
 - (b) Hypothermia
 - (c) Hypotherm
 - (d) Hypertherm.
 - (iii) Value of resting potential is approximately
(a) -20 μ V (b) -70 μ V (c) -20 Mv (d) -70 mV.
 - (iv) The channel that opens up after a stimulus is applied.
(a) Na⁺ (b) K⁺ (c) Ca²⁺ (d) Both (a) and (b)
 - (v) Faster than the normal rate of heart beat named as _____.
 - (a) Tachycardia
 - (b) Arrhythmia
 - (c) Fibrillation
 - (d) Bradycardia
 - (vi) According to the 10/20 EEG electrode system, an odd number denotes ____ side of the brain?
(a) left (b) top (c) bottom (d) right
 - (vii) The most common form of medical imaging, using high-energy radiation to penetrate skin and tissues but not bone is _____.
(a) X-rays (b) MRI (c) PET (d) Ultrasound
 - (viii) A sensor is connected to an instrumentation amplifier. The preferred value for the common mode rejection ratio (CMRR) of the amplifier, in dB, would be _____.
(a) -10 (b) 0 (c) 10 (d) 100

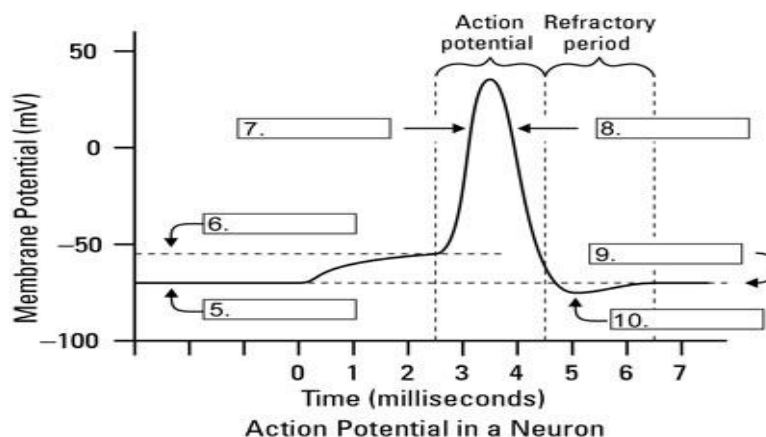
- (ix) In LEAD-II configuration in ECG measurements, electrodes are placed on
 (a) LL-RA (b) LL-LA
 (c) LA-RA (d) LL-RL.
- (x) X-ray imaging combined with computer technique is known as
 (a) EMG (b) ECG (c) USG (d) CT.

Group- B

2. (a) Explain the working principle of ultrasonic flow meter that features compensation against source frequency variation.
 [(C01)(Remember/Understand/IOCQ)]
- (b) Name some of the thermo-resistive transducers that may be used to measure body temperature? What is the normal range of body temperature? What should be the number of wires in RTD to measure body temperature and why?
 [(C01)(Remember/Understand/IOCQ)]
 $6 + (2 + 1 + (1 + 2)) = 12$
3. (a) What are the specifications of a strain gauge? [(C01)(Remember/LOCQ)]
- (b) A piezoelectric pressure sensor has a band-pass characteristic with cut-off frequencies of 0.1 Hz and 1 MHz, and a sensitivity of 100 mV/ kPa. The sensor is subjected to a static constant pressure of 100 kPa. What should be the steady-state output offered by the sensor? Justify the answer.
 [(C01)(Understand/HOCQ)]
- (c) Is it possible to measure the blood flow using an electromagnetic flow meter? Justify your answer.
 [(C01)(Understand/IOCQ)]
 $4 + 5 + (1 + 2) = 12$

Group - C

4. (a) Write the appropriate terminologies to labels 5, 6, 7, 8, 9 and 10 as shown in the following figure.
 [(C02)(Analyze/IOCQ)]



- (b) Write down the various features of the human cell membrane. In the human body cell, why the resting potential is negative? Justify your answer.

[(C02)(Analyze/IOCQ)]

$$6 + (2 + 4) = 12$$

5. (a) What is a biopotential electrode? Draw the electrical equivalent circuit of a polarisable electrode. [(C03)(Remember/LOCQ)]
 (b) Classify the electrodes in terms of (i) Physical shape and dimension (ii) Electrical behaviour (iii) Placements (iv) Applications. [(C03)(Understand/IOCQ)]
(2 + 2) + 8 = 12

Group – D

6. (a) What is the difference between electrocardiograph and electrocardiogram? Which lead shows the voltage difference between the right arm and left leg? Show an electrical interface between the LEAD-I and the instrumentation amplifier. [(C04)(Understand/LOCQ)]
 (b) What are the different Unipolar and Bipolar lead configurations in an ECG? [(C04)(Remember/LOCQ)]
(2 + 2 + 4) + 4 = 12
7. (a) What is biotelemetry? Explain with a neat sketch the block diagram of a telemetry system to send patient's physiological events. [(C03)(Remember/LOCQ)]
 (b) With necessary diagrams show the Goldberger common terminal and Wilson's Central Terminal related to electrode-electronic hardware circuit interface. [(C02)(Analyze/IOCQ)]
(2 + 4) + (3 + 3) = 12

Group - E

8. (a) Draw and explain the model of an electrical danger. What are the physiological effects of current flowing through the body? [(C06)(Understand/Analyze/IOCQ)]
 (b) Draw and explain a defibrillator circuit. [(C05)(Analyze/IOCQ)]
(5 + 3) + 4 = 12
9. (a) Design a band-pass filter to extract beta-wave from the complex EEG waves. Take pass gain Ten (10). [(C03)(Analyze/HOCQ)]
 (b) Explain with a neat diagram the operation of a Ground Fault Circuit Interrupter. [(C06)(Analyze/IOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	27.08	61.46	11.46

Course Outcome (CO):

After the completion of the course students will be able to

1. Explain the fundamental principles and applications of different transducers used for body parameter measurements.

2. Understand the physiology of biomedical systems and different methods in the design of biomedical instruments.
3. Learn the different methods of medical imaging systems, concepts related to the operations and analysis of biomedical instruments.
4. Design signal processing hardware circuits.
5. Learn various therapeutic devices.
6. Aware of the importance of electrical safety and apply it in the design of different assisting, therapeutic and diagnostic medical devices.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;
HOCQ: Higher Order Cognitive Question