9. Write short notes on any two of the followings:

(i) Electrical activity of heart
(ii) Electrical model of the respiratory system
(iii) Electromyography (EMG)
(iv) Magnetic Resonance Imaging (MRI)

6 × 2 = 12

MEDICAL INSTRUMENTATION
(AEIE 5132)

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) When two wires of different materials are joined together at either end, forming two junctions which are maintained at a different temperature, a thermo-motive force is generated causing a current to flow around the circuit. This arrangement is called _____
(a) thermal pair   (b) thermistor   (c) thermocouple   (d) thermostat.

(ii) _____is not the property of an instrumentation amplifier.
(a) Extremely high input impedance   (b) Very low CMRR
(c) Low bias and offset currents   (d) High slew rate.

(iii) The figure of merit which describes the overall behaviour of the wire under stress is determined from
(a) elastic modulus   (b) gauge factor
(c) elastic factor   (d) gauge resistance.

(iv) The beta-wave in the EEG complex signal lies in the range _____
(a) 1-3 Hz   (b) 3-13 Hz   (c) 13-30 Hz   (d) >100 Hz.

(v) Value of action potential across the cell membrane is approximately
(a) -20 µV   (b)-70 µV   (c) +20 mV   (d) +70 mV.

(vi) If the rate of heart beat is faster than the normal, then it is called
(a) Tachycardia   (b) Arrhythmia
(c) Fibrillation   (d) Bradycardia.

(vii)   After a cell is stimulated, a finite period of time is required for the cell to return to its pre-stimulus state. This period is known as _____
    (a) restoration period   (b) refractory period
    (c) regain period   (d) regenerative period.

(viii)   Einthovan's triangle is related to
    (a) ECG   (b)EEG   (c) EMG   (d) EOG.

(ix)   What should be the frequency response of the amplifiers that are used for the amplification purpose of the electro-physiological signal in medical devices?
    (a) Low frequency response   (b) High frequency response
    (c) Frequency response plays no role   (d) Average frequency response.

(x)   In LEAD-III configuration, electrodes are placed on
    (a) LL-RA   (b) LL-LA   (c)LA-RA   (d) LL-RL.

Group – B

2. (a)   Name different temperature sensors used for body temperature measurement and classify them according to their types.

(b)   A semiconductor temperature sensor, intended to measure the body temperature (T in Kelvin) is connected to a circuit, as shown in the Fig. 1. The output voltage V_0 is 2.1 V. Assume the op-amp to be ideal. The current output of the sensor is given by I = T μA. Find the body temperature T in degree centigrade.
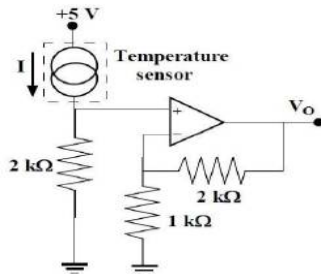

Fig. 1

$$(3+3) + 6 = 12$$

3. (a)   Describe Piezoelectric crystal based blood flow measurement unit using Doppler's effect principle.

(b)   Define the following terms related to a transducer (i) accuracy, (ii) sensitivity, (iii)linearity.

$$6 + (3 \times 2) = 12$$

Group – C

4. (a)   Name the three basic types of electrodes for measurement of bioelectric potentials. For a patient which type of electrode is least traumatic and why? When microelectrodes are needed?

(b)   Classify the different events that take place during the transient response of a cell. Draw the electrical analogue circuit of cell membrane as proposed by Hodgkin–Huxley.

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

5. (a)   Mention the factors that affect the CMRR value of an Instrumentation amplifier. Show the effect of deviation due to any one of the factors of the operation amplifier from its ideal value.

(b)   What is the purpose of electrode paste? How does it create Helmholtz double layer?

$$(3 + 5) +(2 + 2)= 12$$

Group – D

6. (a)   What do you mean by 10 electrode and 12 lead system related to ECG? Classify the electrodes.

(b)   Which frequency band of an EEG signal indicates the consciousness level of human mind? Build an active filter to monitor the consciousness level. What type of electrodes are used for picking of EEG signals and what is 10-20 electrode system used for picking of EEG signals?

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

7. (a)   What is the working principle of radio imaging? Compare ultrasonic imaging with X-ray imaging techniques.

(b)   Draw and explain the various parts of a transmitter and receiver sections in a biotelemetry system.

$$(3 + 3) + (3 + 3) = 12$$

Group – E

8. (a)   What is the difference between electrical macro shock and micro shock? Name any two methods of accident prevention due to electrical shock.

(b)   What are the different types of defibrillators? Draw the general scheme of a typical defibrillator.

$$(2+3) + (3 +4) = 12$$