# B.E. ELECTRICAL ENGINEERING 4TH YEAR 2ND SEMESTER EXAMINATION, 2019

## SUBJECT: - BIOMEDICAL INSTRUMENTATION

Time: **Three hours**

Full Marks 100
(50 marks for each part)

**Use a separate Answer-Script for each part**

| No. of Questions | PART- I | Marks |
|---|---|---|
| | *Answer any **Five only**.* | |
| 1. | (a) A clinical staff member has attached a patient to an electroencephalograph (EEG machine) for a sleep study. The different types of electrodes for the EEG lead have different source resistances. One has a relatively low resistance of 1,800Ω at EEG frequencies while the other has a higher resistance of 4,900Ω. A ground electrode having a resistance of 2,800Ω is also used.<br><br>The input resistance of each differential input of the EEG machine to ground is 8MΩ and the instrument has a common mode rejection ratio of 100dB. The power line displacement current to the patient is measured as 600nA. The amplitude of the patient's EEG is 18μV.<br><br>(i) How much common mode voltage will be seen on this patient and will it significantly interfere with the EEG signal?<br><br>(ii) How much power line interference will be seen on the patient's EEG? | 8 |
| | (b) Which category of the EEG waves has lowest frequency content? What is the order of its amplitude? | 1+1 |
| 2. | (a) Design a two op-amp narrow-band, RC notch filter for removing power line interference from an ECG. The frequency response of the filter has a center notch frequency of 50Hz and a -3dB bandwidth of 0.4Hz. Use 0.1$\mu$F capacitors in your design and calculate the expected notch depth in decibels. Write clearly the expressions used without any derivation. Draw the complete circuit. | 8 |
| | (b) Why is the bandwidth of a bio-potential amplifier quite limited? | 2 |

| | | |
|---|---|---|
| 3. | A metal microelectrode along with a reference electrode is used to acquire cell voltage.<br><br>(i) Draw an equivalent circuit explaining the origin of each of the electrical elements in the equivalent circuit in coherence with the actual system of electrode-electrolyte interface.<br><br>(ii) Show also the reduced equivalent circuit at very low and very high frequency. | 10 |
| 4. | (a) An electrocardiograph has a broad frequency response so that its amplifier has a first-order time constant of 22 s. The amplifier of electrocardiograph has a broad dynamic range of input voltages, but any input voltage greater than ± 8 mV will be out the range of its display and cut off. While recording the ECG of a patient, a transient occurs that has an amplitude of 20 mV, and this causes the ECG to fall out of the range of the instrument's display. If the ECG R-wave has the amplitude of 3 mV, how long will it take for the entire signal to be visible on the display? | 6 |
| | (b) What are the basic requirements of a biopotential amplifier? | 4 |
| 5. | (a) State the factors on which the shape of overall motor unit action potential in EMG signal depends. | 3 |
| | (b) How is the frequency response of the human heart affected by the presence of sinus tachycardia and bradycardia. | 2 |
| | (c) In the 10 – 20 system of electrode placement for capturing EEG, draw an appropriate diagram to show the positions of electrodes T3, FP1, F8, Pz and O2. | 5 |
| 6. | (a) Explain with appropriate diagram(s) the process of generation and propagation of Action Potentials within neurons. | 8 |
| | (b) Compare neuronal action potential with cardiac action potential. | 2 |

| | | |
|---|---|---|
| 7. | (a) Show that the voltages available in Goldberger leads are greater by 50% than that in original Einthoven leads at any instant. Draw appropriate diagram. | 8 |
| | (b) What is Wilson central terminal voltage? | 2 |

*Ref No: Ex/EE/T/424D/2019*

**B.E.E. 4TH YEAR 2ND SEMESTER EXAMINATION, 2019**

**SUBJECT: -** BIO-MEDICAL INSTRUMENTATION

**Time: Three hours** **Full Marks 100**
**(50 marks for each part)**

**Use a separate Answer-Script for each part**

| No. of Questions | PART-II | Marks |
|---|---|---|
| | **Answer any four, 2 marks for well organized answers** | |
| | **Answer any 4 (12X4=48)** | |
| 1. | What are the different types of noises which play significant roles in biomedical instrumentation? Explain different methods for elimination of such noises. Explain various shielding strategies in this context. | 6+6 |
| 2. | What are the importance of pulse oximetry? Explain the basic principle of optical absorption difference based oximetry. Describe a suitable signal amplifier for this application with explanations. | 2+6+4 |
| 3. | A two dimensional biomedical data is shown in the table given below. Two dimensions are taken as $x$ and $y$. Physical significance of each dimension is not disclosed. Find and choose a suitable principal component for the data set to reduce its dimension. Show the modified data. | 12 |
| 4. | Explain oscillometric and auscultatory methods of blood pressure measurement with necessary diagrams. | 12 |
| 5. | **Write short notes on the following topics** | 6+6 |
| a) | Computed (Axial) Tomography | |
| b) | Impedance plethysmography | |

| x | y |
|---|---|
| 7 | 4 |
| 4 | 1 |
| 6 | 3 |
| 8 | 6 |
| 8 | 5 |
| 10 | 7 |
| 5 | 3 |
| 9 | 5 |
| 7 | 4 |
| 8 | 2 |