B.Sc. Engg. in EE (7th Semester)
B.Sc. in TE (3rd Semester)

Date: 8th December, 2023
Time: 1:30 pm – 4:30 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4763/EEE 4791
Course Title: Medical Electronics

Winter Semester, A. Y. 2022-2023
Time: 180 Minutes
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** questions. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Describe the action potential propagation and the importance of relaxation time. **12 (CO1, PO1)**

   b) For a neuron the ion concentrations given as follows: **13 (CO2, PO2)**

	t1=13.3 ns		t2=14.5 ns	
ION	**Extracellular**	**Intracellular**	**Extracellular**	**Intracellular**
Na^+	120 mM	150 mM	140 mM	110 mM
K^+	210 mM	200 mM	180 mM	220 mM
Cl^-	155 mM	165 mM	175 mM	155 mM

   Determine the state of the action potential of the neuron between t_1 and t_2 time period by finding out the membrane potential, V_m at each time point.
   Given, $P_{cl} = 40\%$, $P_k = 60\%$, $P_{Na} = 75\%$, Gas Constant $R = 8.31$ J/mol/K, Faraday Constant $F = 96500$ C/mol and temperature is 25° C.

2. a) Two identical piezoelectric sensors of same material are connected with a wire. Sensor A is under **50N** force and sensor B is under **70N** force. Find the direction of charge **(q)** flow. **10 (CO1, PO3)**

   b) For a metal $\mu = 0.35$ and this metal is attached as a strain gauge in a bridge circuit. Due to application of **1 micro-strain** compression, the bridge is unbalanced. If, $R_g = 100K\Omega$ and externally applied voltage, $V_{EX} = 20$ V, calculate: **15 (CO2, PO2)**
   i) The gauge factor of the metal (GF).
   ii) Output voltage (V_0).
   iii) Change in resistance (ΔR).
   The strain-induced piezoresistive effect of the material can be ignored.

3. a) Find the magnetic flux density of a material (B) in a magnetic strength of $B_0 = 0.1$ T. Given magnetic susceptibility $X_m = 0.01$ and $\mu_0 = 4\pi \times 10^{-7}$. **8 (CO1, PO1)**

   b) i) Explain the difference between **T2** and **T2*** decay. **17 (CO2, PO2)**
   ii) What technique is adopted to make the **T2*** decay identical to **T2** decay at the time of echo (TE)?
   iii) Describe the effect of taking Time of echo (TE) too early or too late on the transverse magnetic field reading.

4. a) A specific limb lead arrangement looks at the inferior wall of the heart and leads are connected to write arm and left leg. Identifying the lead configuration, sketch a complete ECG cycle and describe the generation process of P, Q, R, S, T wave based on that. **17 (CO1, PO3)**

b) The frequency range of ECG signal varies from 0.5 to 150 Hz
i) Calculate the thermal noise present inside the bandwidth of ECG signal.
ii) If the ECG signal power is **0.5** mW, calculate the SNR of the ECG signal.
Given, temperature **T = 20**° C and Boltzmann's constant **k = 1.38x10^(-23)** joules/K **8 (CO2, PO2)**

5. a) i) Briefly describe the working principle of X-Ray with a diagram depicting all the parts of an X-Ray tube.
ii) Explain how computed tomography is superior to X-Ray **17 (CO1, PO3)**

b) Identify the EEG rhythms based on the following bandwidth and behavior pattern:
i) 40 Hz and cognitive
ii) 6 Hz and activated cortex
iii) 3 Hz and sleep stages
iv) 5 Hz and quiet **8 (CO2, PO2)**

6. a) Identify the purpose of gradient coils present in an MRI machine in slice selection and describe the process of increasing or decreasing slice thickness. **8 (CO1, PO1)**

b) Describe in detail the process of frequency and phase encoding to formulate the K Space image from MRI scan. **17 (CO1, PO1)**