



TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Electrical and Electronic Engineering

EEE 4519: BIO-MEDICAL INSTRUMENTATION

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: APRIL 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) With the aid of a diagram explain the basic parts of a generalized medical instrumentation system

[13 marks]

b) State Four major difficulties with surface electrodes

[4 marks]

c) Identify and describe any Four sources of noise in human monitoring

[8 marks]

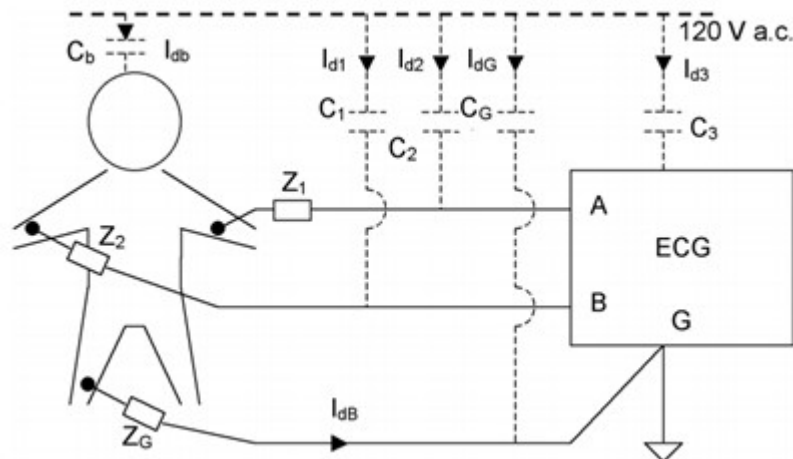


Figure Q1d

d) (i) In an ECG measurement using the setup in Figure Q1d, if the displacement current I_d due to power line interference is 9 nA and difference in the skin electrode impedances of the two limb electrodes are 20 kV, determine the 60 Hz interference voltage across the input terminals of the ECG machine.

(ii) If the displacement current I_{db} through the patient's body is $0.2\mu\text{A}$, determine the common mode voltage at the input terminals of the ECG machine given that the skin-electrode impedance Z_e at the leg electrode is 50 kV and the body impedance Z_b is 500Ω

[5 marks]

Question TWO

a) Explain the working principle of the right led derived circuit of Figure Q2a

[11 marks]

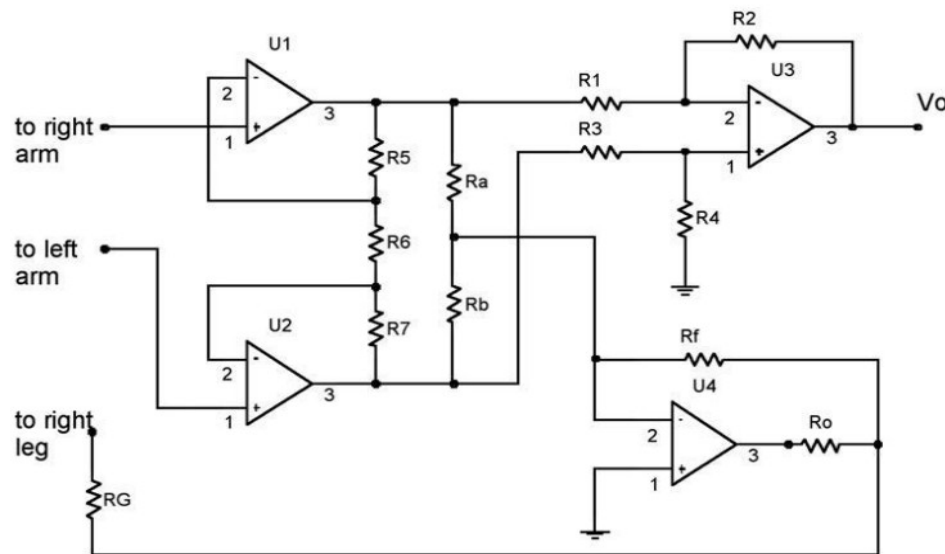


Figure Q2a

b) An Instrumentation Amplifier with input impedances of 5 MW between each input terminal to ground is used as the first stage of an ECG machine. If the difference in the skin-electrode impedance is 20 kW and the common mode voltage induced from power lines on the patient's body is 10 mV, determine the magnitude of the 60-Hz interference appearing across the input terminals of the Instrumentation Amplifier.

[3 marks]

c) For the RLD circuit in Figure Q2a, using the values in (b) (i.e., $I_{db} = 0.2\text{ mA}$, $R_G = 50\text{ kW}$,

(i) If $R_f = 5\text{ MW}$ and $R_a = 25\text{ kW}$, determine the common mode voltage V_{cm} on the patient's body.

(ii) Using this new V_{cm} value from above, calculate the magnitude of the 60-Hz interference appearing across the input terminals of the Instrumentation Amplifier in (b)

Question THREE

- a) With the aid of a diagram explain the
- (i) Construction and principle of operation of and electrocardiograph (ECG)
 - (ii) production of the P, Q, R, S and T waves

[16 marks]

- b) Outline any FOUR variables that represent a patient's vital signs that are commonly measured using an ECG.

[4 marks]

Question FOUR

- a) With the aid of a diagram explain the sources of bio-medical signals in a human body

[16 marks]

- b) Describe the advantages of using depth-of-anesthesia monitoring using EEGs.

[4 marks]

Question FIVE

- a) (i) Outline the reasons why silver - silver chloride electrodes are preferred to pick up signals from a biological object.
(ii) Explain the process of producing silver- silver chloride electrodes

[11 marks]

- b) An AgCl surface is grown on an Ag electrode by the electrolytic process. The current passing through the cell is measured and recorded during the growth of the AgCl layer and is found to be represented by the equation.

$$I = 100\text{mA} e^{-t/10\text{s}}$$

If the reaction is allowed to run for a long period of time so that the current at the end of this period is essentially zero, determine the charge removed from the battery during this reaction.

(i) Determine the amount of AgCl deposited on the Ag electrode's surface by this reaction

(ii) The chloride electrode is now placed into a beaker containing 1 litre of 0.9 molar NaCl solution, determine the amount of AgCl dissolved.

[9 marks]