TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MEDICAL ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

EBL 4401: BIOMEDICAL INSTRUMENTATION 1

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2HOURS

DATE: Pick Date Sep 2018

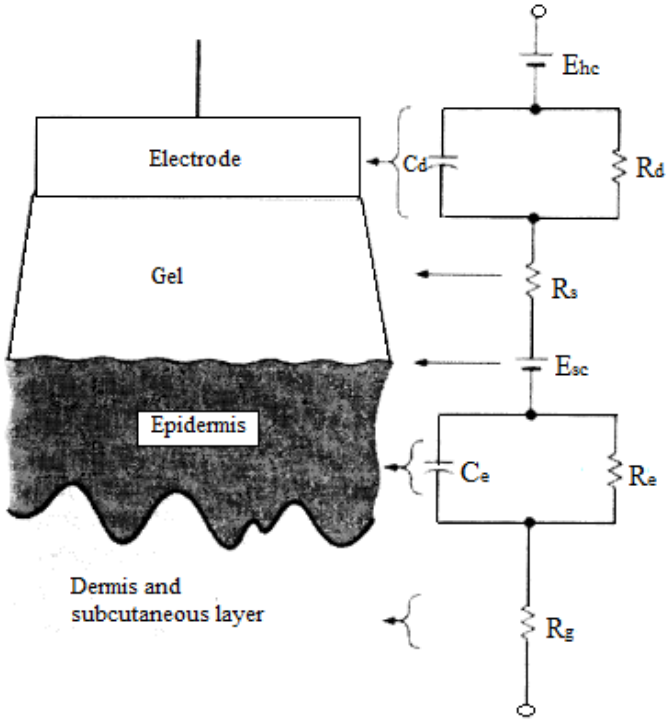
Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **FIVE** questions.
Attemptquestion ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

Question ONE (COMPULSORY)

Consider the circuit model for the electrode – skin interface below. The Ag/AgCl electrode has a half cell potential of $+223$mV, and the ion concentrations in the gel and epidermis are given in the following table:

	Gel(outside the skin)	Epidermis(inside the skin)
$[Na^+]$	10mmol/L	10mmol/L
$[K^+]$	100mmol/L	1mmol/L
$[Cl^-]$	110mmol/L	11mmol/L



a) Find the Nernst potentials for Na^+, K^+, and Cl^- across the gel-epidermis interface. **(6 Marks)**

b) Find the equilibrium potential E_{se} across the gel-epidermis interface, assuming the boundary separating the epidermis from the gel is equally permeable to all ion types. **(4 Marks)**

c) Derive the voltage between the electrode and the subcutaneous body at rest. **(4 Marks)**

d) What electronic design features would you use in the "front end" section of an ECG monitor, to eliminate "AC noise" and other interferences and only allow the ECG waveform to be displayed on a monitor screen. Explain, using diagrams, how your design feature will help to eliminate this problem. If these features were to fail, how would the problem be detected? **(16 marks)**

Question TWO

a) What are the main parameters obtained in blood gases? What parameters are measured with specific electrodes? What are the calculated parameters from the measured ones? **(5 Marks)**

b) Explain how amperometric-based electrodes measure the concentration of different metabolites in blood plasma. **(4 Marks)**

c) Describe how the partial pressure of carbon dioxide in a blood sample is measured using a Stow-Severinghaus electrode. **(11 Marks)**

Question THREE

Present the schematic diagram of the electrochemical cell used for pH measurement with glass electrode and calomel reference electrode, explaining the function of the various components. **(20 Marks)**

Question FOUR

a) Explain why a metal electrode, used for biopotential recording, is considered a transducer? **(2 Marks)**

b) Consider the biopotential measurement with identical electrodes, one for measurement and one for reference.

   i). Show the electrical equivalent circuit and identify each of its components. **(10 Marks)**

   ii). How the half-cell potential of these electrodes can influence the biopotential measurement? **(5 Marks)**

c) What are the characteristics of the Ag-AgCl electrode that make it suitable as a reference electrode in biomedical applications? **(3 Marks)**

Question FIVE

With the aid of a block diagram, explain the functional blocks of the Electrocardiograph. **(20 Marks)**