



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MEDICAL ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

**BACHELOR OF TECHNOLOGY IN MEDICAL ENGINEERING**

**TMD 4201: BIOSENSORS AND TRANSDUCERS**

**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.

Attempt question ONE (Compulsory) and any other TWO questions.

**Do not write on the question paper.**

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## **Question ONE (COMPULSORY)**

- a) Explain what is meant by:
  - i) active transducers,
  - ii) passive transducers, give examples of each. **(4 Marks)**
- b) Explain the construction and operation of the standard hydrogen electrode. Complement your explanation with the schematic diagram of the electrode. **(9 Marks)**
- c) Explain the construction and functioning of the combined electrode used for pH measurement. **(12 Marks)**
- d) A parallel-plate air-spaced capacitor has an effective plate area of  $6.4 \times 10^{-4} m^2$ , and the distance between the plates is 1 mm. if the relative permittivity for air is 1.0006, absolute permittivity is  $8.85 \times 10^{-12} F/m$  calculate the displacement sensitivity of the device. **(5 marks)**

## Question TWO

Figure Q2 shows an enzyme electrode from a glucose biosensor.

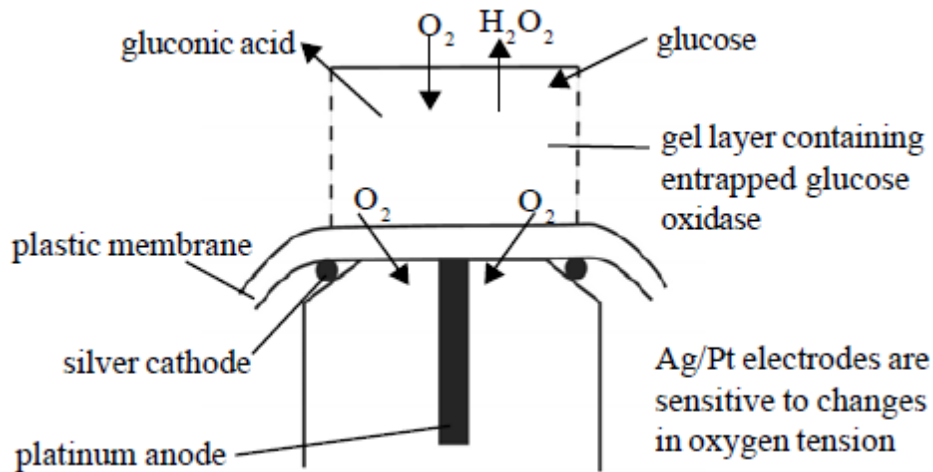


Figure Q2

- Explain what is meant by the term 'biosensor'. (2 Marks)
- This type of biosensor uses the immobilized enzyme 'glucose oxidase'. Describe the action of this enzyme and say why it is immobilised. (3 Marks)
- Describe how the biosensor works to measure blood glucose concentration. (5 Marks)
- How has the development of the glucose biosensor made life easier for sufferers from sugar diabetes? (2 Marks)
- Explain FOUR characteristics that a successful biosensor must possess (8 Marks)

## Question THREE

- With reference to clinical biosensors, state the principle on which a thermistor works and give the mathematical expression of it. (8 marks)
- Explain the working principle of an LVDT. Draw the schematic diagram of an LVDT and explain its transfer characteristic. How will you extract phase and amplitude information for an LVDT (12 Marks)

## Question FOUR

- Explain why a metal electrode, used for biopotential recording, is considered a transducer? (2 Marks)
- The Ag/AgCl (saturated KCl) reference electrode half-cell is useful in many electrochemical experiments, and it can be simply made in the lab. Explain how you could make a Ag/AgCl half-cell in the laboratory that could be used as a reference electrode for voltammetry. Include a labeled drawing and explain its operation. (8 Marks)

- c) Show how the Nernst equation can be used to prove that the potential of this reference half-cell electrode will be constant at constant T when contacting an electrolyte solution. **(6 Marks)**
- d) What are the characteristics of the Ag-AgCl electrode that make it suitable as a reference electrode for biomedical applications? **(4 Marks)**

### Question FIVE

- a) What is the temperature in Fahrenheit of 20 °C? **(2 Marks)**
- b) Self-heating is one of the problems commonly encountered in the use of temperature sensors. Explain how self-heating affects the operation of thermistors and RTDs and how can it be avoided? **(6 Marks)**
- c) The Wheatstone bridge is an electrical circuit suitable for measuring sensors to work with low temperature sensitivity. Why? Show an example and explain its operation. **(8 Marks)**
- d) A temperature measuring system incorporates a platinum resistance thermometer, a Wheatstone bridge, a voltage amplifier, and a pen recorder. The individual sensitivities are as follows:

Transducer	$0.35 \Omega/^{\circ}C$
Wheatstone bridge	$0.01 V/\Omega$
Amplifier gain	$100 V/V$
Pen recorder	$0.1 cm/V$

- i). Determine the overall sensitivity, and
- ii). The temperature change corresponding to a recorder pen movement of 4 cm. **(4 marks)**