



# TECHNICAL UNIVERSITY OF MOMBASA

---

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

**UNIVERSITY EXAMINATION FOR:**

**BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY**

**ACH 4202 : ANALYTICAL INSTRUMENTATION 1**

**SUPPLEMENTARY/SPECIAL EXAMINATION**

**SERIES: JULY 2021**

**TIME: 2 HOURS**

**DATE: Pick Date Jul 2021**

## **Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of **FIVE** questions. Answer question ONE (Compulsory) and any other TWO questions.

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

---

## **Question ONE**

- (a) Identify any TWO methods for each of the following properties used in instrumental analysis
- (i) Radiation Scattering **(2 marks)**
  - (ii) Thermal Characteristics. **(2 marks)**
- (b) Highlight the role of the following instrumental components
- (i) Photo cell **(1 mark)**
  - (ii) Sensor. **(1 mark)**
- (c) Define the following types of noise, indicating their sources, in instrumental analysis
- (i) Thermal, or Johnson, noise **(2 marks)**
  - (ii) Flicker, or  $1/f$  noise. **(2 marks)**

- (d) Briefly explain the following methods used in the enhancement of signal-to-noise ratio
- (i) Boxcar averaging (3 marks)
  - (ii) Polynomial smoothing. (3 marks)
- (e) Describe instrument sensitivity, indicating associated figures of merit, as criterion for selecting suitable analytical method(s). (6 marks)
- (f) State any FOUR factors that one must consider when defining an analytical problem. (4 marks)
- (g) Highlight the analog-domain mode of encoding information as an electrical quantity. (4 marks)

### Question TWO

- (a) Explain the significance of the signal-to-noise ratio in instrumental analysis. (4 marks)
- (b) Describe the interdomain conversions involving a phototransducer and resulting measurements in analytical instrumentation. (6 marks)
- (c) The concentration of Cd in a marine sediment standard reference material (SRM), determined by Atomic Absorption Spectrometry (AAS) was as follows: 9.2 ppm, 8.5 ppm, 8.8 ppm, 8.4 ppm, 8.7 ppm, and 7.4 ppm. Calculate the mean and standard deviation of the measurements. (10 marks)

### Question THREE

- (a) Briefly describe the following methods for reducing noise
- (i) Analog Filtering (6 marks)
  - (ii) Modulation. (6 marks)
- (b) Highlight the standard addition method for instrument calibration. (8 marks)

### Question FOUR

- (a) (i) Give a brief description of the role of signal conditioning in data acquisition systems. (4 marks)
- (ii) Highlight the importance of analog-to-digital conversion in data acquisition systems. (2 marks)
- (iii) List any FOUR criteria when selecting analog-to-digital conversion hardware. (4 marks)

- (b) Describe instrumental systematic errors and how they are detected and corrected. **(4 marks)**
- (c) Describe skewness and provide the formula for its determination. **(6 marks)**

**Question FIVE**

- (a) Describe the following systems,
- (i) Continuous flow automated systems **(6 marks)**
  - (ii) Discrete automated systems. **(6 marks)**
- (b) Apply the Q test to determine the likely outlier in the following measurements: 2.20, 2.50, 2.80, 3.20, and 4.30. Given  $Q_c = 0.710$  at the 95% confidence level. **(8 marks)**