



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR special/SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF EDUCATION (SCIENCE)

SCH 304: INTRODUCTION TO ANALYTICAL INSTRUMENTATION

DATE: 23/7/2019

TIME: 2:00 – 4:00 PM

INSTRUCTIONS

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A

QUESTION ONE (30 MARKS)

- a) Scientific research has been defined as a systematic investigation of scientific theories and hypothesis. In order to carry out research one has to design an experiment. Define the following terms as related to research.
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|------|----------------------|-----------|
| i) | Experimental design? | (2 marks) |
| ii) | Hypothesis? | (2 marks) |
| iii) | Research proposal | (2 marks) |
- b) In carrying out research through experimental design, data is generated through use of analytical equipment through a defined analytical method. Explain the following terms as applied to data generated during research.
- | | | |
|------|---|-----------|
| i) | Accuracy of results | (2 marks) |
| ii) | Precision | (2 marks) |
| iii) | Sensitivity | (3 marks) |
| iv) | Detection limit of an analytical method | (2 marks) |

- v) Random and systematic errors in measurement (4 marks)
- c) In order to get credible results from measurements in any analytical method, the analytical instrument needs to be calibrated. Explain briefly with the help of illustrations, how each of these methods is used in the calibration of an analytical equipment.
- i) External calibration method (calibration curve or working curve) (3 marks)
 - ii) Standard addition method (4 marks)
 - iii) Internal standard addition method (4 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTION
QUESTION TWO (20 MARKS)

- a) To improve the accuracy of our results and minimize errors, replicate experiments are carried out thus generating data. The data generated is subject to statistical analysis. Explain the following terms applied to statistical analysis of data. Use the appropriate equations to define the terms where possible.
- i) Population mean. (1 mark)
 - ii) population standard deviations (1 mark)
 - iii) Population variances (2 marks)
 - iv) What is the relationship between error and uncertainty? (2 marks)
- b) The following replicate measurements for concentration of salt in urine were carried out in g/L to determine the true value of the measurement; **10, 16, 12, 15, 9, 16, 10, 17, 12, 15**
- i) Use a bar graph to represent this data graphically with the horizontal axis representing the concentration in g/L and the vertical axis representing frequency. (4 marks)
 - ii) Determine the mean (μ), variance (σ^2) and the standard deviation (σ) of the data. (6 marks)
- c) The data above (2b) can fit into a normal distribution curve.
- i) Show graphically how the above figure in 2b(i) can be represented by a probability distribution curve with the vertical axis representing probability and the horizontal axis the variables measured in 2(b). (4 marks)

QUESTION THREE (20 MARKS)

- a) Analog and digital signals are both used to transmit information. State three major differences between analog and digital signals. (3 marks)
- b) In analytical measurements, we have got two signals, noise and analyte signals.
 - i) Describe briefly how noise is generated in the analytical instrumentation. (6 marks)
 - ii) What is analyte signal? (2 marks)
- c) A Fourier Transform is used in the processing of signals in order to minimize noise. Describe these four stages Filtering, Modulating, Sampling and digitizing the analog signal in signal processing by the Fourier Transform. (9 marks)

QUESTION FOUR (20 MARKS)

- a) Describe as much as you can about automation compared with manual operation of analytical instrumentation with reference to the following;
 - i) State and explain the four major steps involved in an analytical process in analytical instrumentation (8 marks)
 - ii) Advantages of automated instrumentation over manually operated instrumentation (4 marks)
 - iii) Why is necessary to include liquid-liquid extraction system (clean up step) in an automated Analyzer (Flow Injection Analysis)? (4 marks)
- b) Differentiate between selectivity and sensitivity in analytical instrumentation. (4 marks)

QUESTION FIVE (20 MARKS)

Various methods are used to reduce noise in order to obtain quality signals from analyte determination in samples. Explain how the following have been used in the reduction of from analyte signals in analytical determinations.

- a) Signal modulation
- b) Signal averaging
- c) Box car averaging
- d) Low pass analog filter
- e) Fourier transform in signal processing