THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Applied & Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY (DSLT09J)

END OF SEMESTER EXAMINATION

ACH 2310: INSTRUMENTATION III

SERIES: AUGUST/SEPTEMBER 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer booklet*

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

This paper consist of **FOUR** printed pages

H= 6.62 x 10^{-34}J/s

QUESTION ONE (COMPULSORY)

a) (i) Explain the term chromatography (2 marks)

(ii) How are the flow rates achieved in HPLC? (1 mark)

b) State **THREE** conditions that a sample cell should fulfill for analysis in NMR spectroscopy (3 marks)

c) Give three reasons why HPLC is a better tool than GLC (3 marks)

d) Explain the principle of mass spectroscopy (3 marks)

e) State **THREE** ways in which the efficiency of the column can be improved in chromatography (3 marks)

f) In gas chromatographic separation of benzene, toluene and xylene, the area under peak was noted to be 31.0 cm^2, 14.5 cm^2 and 53.2 cm^2, respectively. Calculate the percentage composition of the sample (3 marks)

g) State the **THREE** major classes of chromatographic separation (3 marks)

h) The frequency of radio waves lies between 10^1 and 10^7cm. Calculate the maximum energy of the radio frequency (rf) radiation (3 marks)

i) State any **THREE** types of ions produced in a mass spectrometer (3 marks)

j) Give **THREE** reasons why TMS is used as internal standard in NMR (3 marks)

QUESTION TWO

a) List the main components of a mass spectrometer (7 marks)

b) State **THREE** advantages of mass spectroscopy over other analytical methods. (3 marks)

c) Give any **FIVE** applications of mass spectroscopy (5 marks)

d) In the following mass spectrum of methane, identify species A – E (5 marks)

Absorbance

QUESTION THREE

a) Explain the principle of NMR (2 marks)

b) Identify all the symbols in the equation below which provides the quantum description of

$$M = Y \times [I(I+1)]^{1/2} \bullet \frac{h}{2\pi}$$

NMR: (4 marks)

c) State the main components of an NMR instrument (5 marks)

d) Give **FOUR** important features of the magnet used in NMR (4 marks)

e) Explain why the oscillator coil has to be wound perpendicular to the magnetic field (2 marks)

f) State **TWO** phenomena that occur when radio frequency radiation is passed through the magnetized sample. (2 marks)

g) State most common material used to make the sample holder in NMR (1 mark)

QUESTION FOUR

a) Explain **FIVE** causes of band broadening in chromatography (5 marks)

b) Define the following terms as used in chromatography
   (i) Elution
   (ii) Retention time (4 marks)

c) Briefly explain the principle behind the following:

   (i) Adsorption chromatography
   (ii) Partition chromatography (4 marks)

d) Differentiate between gas-liquid chromatography and gas-solid chromatography (2 marks)

e) State **THREE** factors that are affected by the vacuum pumps in HPLC (3 marks)

f) Give **TWO** most common packing materials in chromatography (2 marks)

QUESTION FIVE

a) State the role of each of the following components of a high performance liquid chromatography instrument:
   (i) Pre-column
   (ii) Vacuum pump (2 marks)

b) List **FOUR** requirements for the pumps used in high performance liquid chromatography (4 marks)

c) Differentiate between isochratic and gradient elution (2 marks)

d) Substances A and B have retention times of 16.40 and 17.63 minutes respectively on a 30.0 cm column. An unretained species passes the column in 1.30 minutes. The peak widths for A and B are 1.11 and 1.21 minutes, respectively. Calculate

   (i) The column resolution (2 marks)
   (ii) Average number of theoretical plates (4 marks)
   (iii) The plate height (2 marks)
   (iv) The selectivity factor for species A and B (4 marks)