TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY (BTAC 14S & BTAC 15S2)
ACH 4202: ANALYTICAL INSTRUMENTATION I
SPECIAL SUPPLEMENTARY EXAMINATION
SEPT. 2017
TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

This paper consists of FIVE questions

Answer question ONE (COMPULSORY) and any other TWO questions

Question 1

a) Discuss briefly the following terms
   - **i)** Factor **(2 marks)**
   - **ii)** Non-inverting input **(2 marks)**
   - **iii)** Noise **(2 marks)**
   - **iv)** Detection Limit **(2 marks)**

b)
   - **i)** Explain the main factors that must be considered in the design of an experiment. **(3 marks)**
   - **ii)** Give two advantages that analytical sensitivity has over calibration sensitivity **(2 marks)**

c) Analysis of calibration data for the determination of Iron based on its absorption spectrum yielded the equation:-

$S = 1.25C_{Fe} + 0.104$

Where C_{Zn} is concentration of Iron in ppm

S= measure of the relative intensity of iron line

The following replicate data was obtained.

Fe $_{ppm}$	No. of replications	mean value of S	ss
5.0	10	5.45	0.10
1.0	10	1.02	0.015
0.000	24	0.0185	0.0056

Determine:-
   - **i)** Calibration sensitivity **(1 mark)**
   - **ii)** Analytical sensitivity at 1 and 5 ppm Fe **(2 marks)**
   - **iii)** Detection limit (3 d.p) **(2 marks)**

d) Explain how measurements of current and voltage signals are affected by ammeters and voltmeters respectively and how this can be minimized. Use equations where necessary.

i)   Current   (3 marks)
    ii) Voltage   (3 marks)
  e) Explain briefly three electrical domains.   (3 marks)
  f) State three applications of operational amplifiers.   (3 marks)

Section B Answer any TWO questions in this section (40 marks)
Question 2

a) Briefly define the following terms
    i)   Input transducer   (2 marks)
    ii) Analogue to digital converters (ADC)   (2 marks)
b) Digital circuits are more advantageous to use than analogue circuits. Give two reasons to justify this
    statement.   (4 marks)
c)
    i)   What are Operational amplifiers   (2 marks)
    ii) Discuss five characteristics of operational amplifiers   (10 marks)

Question 3

a)
    i)   State and explain briefly the four types of instrumental noise   (8 marks)
    ii) Explain how each of the noise in i) can be minimized   (2 marks)
b)
    i)   The following data was obtained during measurement of reduction potentials (mV) in a noisy system:
             0.470, 0.450, 0.410, 0.350, 0.378
             Determine the S/N ratio   (6 marks)
    ii) The source of the noise in NMR analysis was found to be Johnson's noise. Explain how in practice this
         noise can be eliminated in NMR.   (4 marks)

Question 4

a) Explain briefly the following terms:
    i)   Differentiate between Local Area Network (LAN) and Wide Area Network (WAN)   (9 marks)
    ii) Laboratory Information Management Systems (LIMS)   (4 marks)
b)
    i)   Explain how regression graphs are useful to an analytical chemist   (4 marks)
    ii) What is continuous non-segmented flow analysis? State any two advantages it has over other
         instrumental systems such as AAS and UV.   (3 marks)

Question 5

a) The selectivity coefficient in a membrane electrode for $Mg2^+$ with respect to K^+ is reported to be 0.052. If
    the concentration of Mg^+ ion is $4.00\times10^{-3}M$ and that of K^+ ion is $0.50\times10^{-3}M$. Assuming that signal from
    blank is insignificant; calculate the % relative error in the determination of Mg2+   .   (5 marks)
b)
    i)   Convert 101011 to a decimal number   (3 marks)
    ii) Convert 142 to a binary number   (4 marks)

c)

    i)   Give any four sources and effects of chemical noise in instrumental analysis   **(4 marks)**

   ii)   Explain how Ensemble averaging enhances S/N ratio in instrumentation   **(4 marks)**