UNIVERSITY OF EMBU

2017/2018 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE ANALYTICAL CHEMISTRY, INDUSTRIAL CHEMISTRY

SCA 305: STATISTICS FOR CHEMISTS

DATE: APRIL 10, 2018   **TIME: 11:00AM-1:00PM**

INSTRUCTIONS:

Answer Question ONE and ANY other TWO Questions

QUESTION ONE (30 MARKS)

a) Differentiate between the following terms:

    i)   Accuracy and Precision   (2 marks)

    ii)   F-test and Q-test   (2 marks)

    iii)   Homoscedastic and Heteroscedastic   (2 marks)

    iv)   Limit of detection and Limit of quantitation   (2 marks)

    v)   Null hypothesis and Alternative hypothesis   (2 marks)

b) i) Explain why mean is not considered as the best estimator of central tendency as compared to median   (2 marks)

  ii) Explain the significance of slope in calibration curve   (2 marks)

  iii) Discuss the importance of including uncertainty when reporting values obtained in replicate.   (3 marks)

  iv) Explain the experimental design stages.   (3 marks)

c) i) Briefly describe what is instrument limiting error.   (2 marks)

ii) Give six ways on how to minimize systematic errors (3 marks)

iii) Explain three types of experimental errors (3 marks)

iv) Describe what is chi-squared test? (2 marks)

QUESTION TWO (20 MARKS)

a) The following six data was obtained for a particular analyses

5.683,	5.549,	5.548
5.620,	5.536,	5.684

i) Calculate the mean, median, range, standard deviation and variance for the above data. (6 marks)

ii) Calculate the 95% confidence interval about the mean. What does this confidence interval mean? (3 marks)

iii) If the above analysis had a known standard deviation of 0.08, determine whether there is any evidence of significant difference between sample variance and expected variance at $\alpha = 0.05$. Explain your result. (3 marks)

iv) Calculate the absolute and percent relative error and express

v) each answer with appropriate number of significant figures. If true value is

vi) 5.552 (2 marks)

vii) Using an example discuss why it is appropriate to report error as relative as opposed to absolute (2 marks)

b) The numbers of glassware breakages reported by four laboratory workers over a given period are shown below. Is there any evidence that the workers differ in their reliability?

Numbers of breakages: 24, 17, 11, 9 (4 marks)

QUESTION THREE (20 MARKS)

a) Draw a calibration curve plot showing limit of detection (LOD), limit of quantification (LOQ), dynamic range, and limit of linearity (LOL). (5 marks)

b) Solve the following and express the answer with correct uncertainty and

significant number.

i)   (i) $9.23\ (\pm 0.03) + 4.21\ (\pm 0.02) - 3.26\ (\pm 0.06) =$ (2 marks)

ii)   (ii) $\dfrac{91.3\ (\pm 1.0) \times 40.3\ (\pm 0.2)}{21.1\ (\pm 0.2)} =$ (3 marks)

iii)   (iii) The absorbance, A, of a solution is given by $A = -\log T$ where T is the

transmittance. If the measured value of T is 0.501 with a standard deviation of 0.001, calculate A and its standard deviation.   (2 marks)

c)   i) Standard aqueous solutions of fluorescein are examined in a fluorescence spectrometer, and yield the following fluorescence intensities (in arbitrary units):

Fluorescence intensities: 2.1   5.0   9.0   12.6   17.3   21.0   24.7

Concentration, pg ml^{-1} 0   2   4   6   8   10   12

Determine the correlation coefficient, r.   (4 marks)

ii) Discuss six sigma methodologies.   (4 marks)

QUESTION FOUR (20 MARKS)

a) The % w/w Na_2CO_3 in soda ash can be determined by an acid–base titration. The results obtained by two analysts are shown below. Determine whether the difference in their mean values is significant at $\alpha = 0.05$.   (6 marks)

Analyst A	Analyst B
86.82	81.01
87.04	86.15
86.93	81.73
87.01	83.19
86.20	80.27
87.00	83.94

b) The following masses, in grams, were recorded in an experiment
   to determine the average mass Kenyan shilling.
   3.067, 3.049, 3.039, 2.514, 3.048, 3.079, 3.094, 3.109, 3.102
   Determine if the value of 2.514 g is an outlier at $\alpha = 0.05$.   (6 marks)

c) i) The sodium ion content of a urine specimen was determined by using an
   ion-selective electrode. The following values were obtained: 102, 97, 99,
   98, 101, 106 mM. What are the 95% confidence limits for the sodium ion
   concentration?   (6 marks)

   ii) Differentiate between quality control and quality assurance.   (2 marks)

QUESTION FIVE (20 MARKS)

a) i) Use cumulative frequency plot and test whether the data below could have
    been drawn from a normal population:
    109, 89, 99, 99, 107, 111, 86, 74, 115, 107, 134, 113, 110, 88, 104   (6 marks)

    ii) Describe the properties of normal distribution.   (3 marks)

b) A new procedure for test sulfur in fuel. Certified standard gives 0.123%S.
    New test (n=4) gives 0.112, 0.118, 0.115 and 0.119% S. Is there a bias at the
    95% confidence level?   (6 marks)

c) Consider the following data set: 81, 100, 101, 102, 103. Is 81 bad at 95%
    confidence level.   (5 marks)

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