MACHAKOS UNIVERSITY

University Examinations 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

SMA 366: QUALITY CONTROL METHODS

DATE: 1/9/2022 **TIME: 2.00-4.00 PM**

INSTRUCTION:

Answer Question One and Any Other Two Questions

You must have a scientific calculator for this paper.

QUESTION ONE (30 MARKS)

a) Briefly distinguish the following terms as they apply in measurements and statistics

i. Descriptive statistics and Inferential statistics

ii. Confidence interval and significance level

iii. Process control and product control

iv. Producer's risk and consumer's risk

v. Type I error and Type II error in hypothesis testing (10 marks)

b) In a random sample of 600 active antigens in a store, 45 were found to have expired. Determine the population proportion expired. Use 99% level of confidence. (6 marks)

c) The table below shows the mean length and range for 10 randomly taken building blocks samples each of size 5

Sample no.	1	2	3	4	5	6	7	8	9	10
Mean	13.5	12.9	11.4	10.8	11.6	9.8	11.6	11.3	10.9	11.2
Range	0.7	0.4	0.8	0.5	0.6	0.4	0.7	0.4	0.7	0.8

By using mean and range charts determine whether the process is in control (6 marks)

d) By citing examples distinguish between the control charts for variables and control charts for attributes. (4 marks)

e) A quality control officer in Smart chain stores claims that at least 30% of the pasteurized milk in the store is affected by campylobacter bacteria. A random sample of 25 packets showed that 15 of them were affected. Are these sample results consistent with the claim of the officer? Use $\alpha = 0.05$ (4 marks)

QUESTION TWO (20 MARKS)

a) Briefly distinguish between assignable causes of variations and common causes of variations in the production industry (4 marks)

b) A manufacturer of electric gadgets has known from experience that 5% of the gadgets produced are defective, if random sample of 50 gadgets is examined determine the probability that the proportion defective is between 0.10 to 0.25 (5 marks)

c) Given N=500, n=150 and c=3 construct OC curve for $0.01 \leq p \leq 0.06$ based on Poisson distribution (11 marks)

QUESTION THREE (20 MARKS)

a) Briefly explain the meaning of single, double and multiple acceptance sampling plans (6 marks)

b) Explain any three quality characteristics dimensions that would influence the consumer taste and preference. (6 marks)

c) The following data shows the number of defectives and items sampled

Sample no.	1	2	3	4	5	6	7	8	9	10
Sampled	210	215	205	214	210	208	211	203	204	220
Defectives	7	4	8	5	7	4	8	4	7	9

Construct the fractional defective chart and commend whether the process is under control or not (8 marks)

QUESTION FOUR (20 MARKS)

a) During an examination of the iron sheets production in a certain company the following number of defectives were observed per sample; 1,3,4,2,4,3,6,5,4,3,5,1,4,2,3,0,1. Draw the control chart for the number of defectives and commend on the state of the process. (6 marks)

b) Two pharmaceutical companies are manufacturing different t drugs for increasing fertility, drugs P and Q, which were tried on different couples for increasing fertility, 5 couples were given drug P and 7 couples were given drug Q. The conception rate after a period of five years was as given below:

Drug P	2	4	5	3	3	-	-
Drug Q	4	3	4	5	3	2	4

Its t-test output is summarized in table 1

Table 1: Sample t-test output, for the test $H_0 : \mu_A = \mu_B$

	t	df	Sig.(2-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Attendance	-0.2802	10	0.785	0.17	-1.534	1.192

i. Based on the sample t-test output make statistical conclusion

ii. Interpret the 95% CI lower and upper difference values (6 marks)

c) The known optimum concentration for a component *q* in a fattening chemical is 0.18 wt %. The following concentration levels were observed in a randomly sampled 10 bunches of the component whose standard deviation is 0.020.

Sample	1	2	3	4	5	6	7	8	9	10
Conc' %	0.18	0.15	0.19	0.21	0.14	0.21	0.16	0.17	0.16	0.19

By using the allowable slack and action limit as 0.5 and 4 times the standard deviation construct CUSUM control chart and state whether the process is in or out of control.

(8 marks)

QUESTION FIVE (20 MARKS)

a) The following information relates to the lifespan electric bulbs manufactured by two companies A and B:

	Company A	Company B
Mean life (in hours)	1350	1275
Standard deviation (in hours)	75	83
Sample size	150	100

Which brand of bulbs would you recommend for a client taking a risk of 5%? (6 marks)

b) Write down the R script for constructing;

i. $\bar{X}$ & S Control Charts, 3σ

ii. CUSUM and

iii. Exponentially weighted moving average. (6 marks)

c) The mobile phones batteries produced by a certain machines were examined and the following table shows the distribution of defective batteries per sample

0	1	2	3	4	5	6	7	8	Total
11	7	27	56	70	54	22	8	1	256

Fit a binomial distribution and hence determine the expected

i. Frequencies

ii. Mean

iii. Standard deviation (8 marks)