MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS

THIRD YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE MATHEMATICS

SMA 366: QUALITY CONTROL METHODS

DATE: 22ND JANUARY, 2025 **TIME: 11.00 AM – 1.00 PM**

INSTRUCTIONS:
*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE (30 MARKS)

a) Distinguish the following terms as used in statistical quality control

i. Quality assurance and Quality management

ii. Process control and product control

iii. Producer's risk and consumer's risk (6 marks)

b) Given that $EWMA_0 = 50$, $S = 2.05$, $\lambda = 0.4$ and $k = 3$ determine the Upper and Lower control limits for the Exponentially Weighted Moving Average. (5 marks)

c) A quality control officer in Malc chain stores claims that 75% of the peanut butter in the store are affected by campylobacter bacteria. A random sample of 48 cans showed that 12 of them were affected. Are these sample results consistent with the claim of the officer at $\alpha = 0.05$ (5 marks)

d) The table below shows the KQ products' length mean and range for 10 randomly taken samples each of size 5

Sample no.	1	2	3	4	5	6	7	8	9	10
Range	1.5	1.9	1.4	1.8	1.6	0.8	1.6	1.3	1.9	1.2
Mean	7	4	8	5	6	4	7	4	7	8

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

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

f) A fiftyfold measurement of a cylinder volume had mean of 19.842 mL and the standard deviation 0.0627 mL. Determine the 99% confidence interval of the mean, assuming a normally distributed data collected. (4 marks)

QUESTION TWO (20 MARKS)

a) The following were the element K concentration in grams per kilogram of a certain fertilizer: 10.4, 11.6, 10.8, 9.6, 11.2, 11.9, 9.1, 10.4, 10.3, 11.6, if its standard deviation $s = 0.91$ determine the Warning limits and Action Limits for $\bar{X} - chart$ when set at 2 and 3 standard deviations respectively. (6 marks)

b) In a random sample of 150 items taken from machine *A*, 50 are found to be defective. In another sample of 250 items taken from machine *B*, 100 items are found to be defective. Do the data reveal significant difference between the two machines as far as the quality output is concerned, at $\alpha = 0.05$? (6marks)

c) Given N=500, n=150 and c=3 construct OC curve for $0.01 \leq p \leq 0.06$ based on Poisson distribution (8 marks)

QUESTION THREE (20 MARKS)

a) Discuss briefly the meaning of single sampling plan, double sampling plan and multiple acceptance sampling plan

(6 marks)

b) Explain three advantages of Cusum control charts over Shewart control charts

(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) Distinguish between assignable causes of variations and common causes of variations in quality control methods (4 marks)

b) Highlight four limitations of acceptance sampling (4 marks)

c) During an examination of the electric gadgets 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)

d) The target value of the Calcium content in a certain food supplement was 34.0 mg/kg. The results from 15 randomly samples of one kilogram packets of food supplements in the market gave $\bar{X} = 31.6\ mg/kg$ and $s = 5.6$. Determine whether the sample results were consistent with the target value at $\alpha = 0.05$ (6 marks)

QUESTION FIVE (20 MARKS)

a) Highlight four quality characteristics of a quality control officer (4 marks)

b) The known optimum concentration for a component y 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 was 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 of 0.5 and 4 times the standard deviation construct CUSUM control chart and state whether the process is in control or out of control. (8 marks)

c) The mobile phones hard-set covers produced by a certain machines were examined and the following table shows the lengths of randomly selected covers per sample

Sample no	Covers length in millimeters				
1	12.016	12.088	11.072	11.971	12.118
2	12.039	12.047	12.214	12.113	12.156
3	11.908	12.058	12.258	12.077	12.149
4	12.167	12.127	12.053	12.137	12.212
5	12.048	12.048	11.731	12.083	12.045
6	11.211	12.013	12.162	12.124	11.682
7	12.908	11.058	12.158	11.177	11.249

Using the X-bar and range charts test the state of the process based on the 5 sample size.

(8 marks)

Table of Control Chart Constants

	X-bar Chart Constants	for sigma estimate	R Chart Constants		S Chart Constants	
Sample Size = m	A_2	A_3	d_2	D_3	D_4	B_3	B_4
2	1.880	2.659	1.128	0	3.267	0	3.267
3	1.023	1.954	1.693	0	2.574	0	2.568
4	0.729	1.628	2.059	0	2.282	0	2.266
5	0.577	1.427	2.326	0	2.114	0	2.089
6	0.483	1.287	2.534	0	2.004	0.030	1.970
7	0.419	1.182	2.704	0.076	1.924	0.118	1.882
8	0.373	1.099	2.847	0.136	1.864	0.185	1.815
9	0.337	1.032	2.970	0.184	1.816	0.239	1.761
10	0.308	0.975	3.078	0.223	1.777	0.284	1.716
11	0.285	0.927	3.173	0.256	1.744	0.321	1.679
12	0.266	0.886	3.258	0.283	1.717	0.354	1.646
13	0.249	0.850	3.336	0.307	1.693	0.382	1.618
14	0.235	0.817	3.407	0.328	1.672	0.406	1.594
15	0.223	0.789	3.472	0.347	1.653	0.428	1.572
16	0.212	0.763	3.532	0.363	1.637	0.448	1.552
17	0.203	0.739	3.588	0.378	1.622	0.466	1.534
18	0.194	0.718	3.640	0.391	1.608	0.482	1.518
19	0.187	0.698	3.689	0.403	1.597	0.497	1.503
20	0.180	0.680	3.735	0.415	1.585	0.510	1.490
21	0.173	0.663	3.778	0.425	1.575	0.523	1.477
22	0.167	0.647	3.819	0.434	1.566	0.534	1.466
23	0.162	0.633	3.858	0.443	1.557	0.545	1.455
24	0.157	0.619	3.895	0.451	1.548	0.555	1.445
25	0.153	0.606	3.931	0.459	1.541	0.565	1.435