



UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

**THIRD YEAR EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE (STATISTICS)**

STAT 325: QUALITY CONTROL METHODS

STREAM: R

TIME: 2 HRS

DAY: WEDNESDAY [2.30 P.M – 4.30 P.M] DATE: 10/04/2024

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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Instructions

Answer question ONE and any other two questions

QUESTION ONE (30 MARKS)

- a) Define the following terms.
- i) Quality (1 Mark)
 - ii) Acceptance sampling (2 Marks)
- b) State three benefits of quality control at Laikipia University. (3 Marks)
- c) Describe two dimensions of quality. (4 Marks)
- d) The diameters of the casting in table below are also an important quality characteristic. A coordinate measuring machine is used to measure the diameter of each casting at five different locations. Data for 10 castings are shown below.

Sample Number	x_1	x_2	x_3	x_4	x_5
1	15.8	16.3	16.2	16.1	16.6
2	16.3	15.9	15.9	16.2	16.4
3	16.1	16.2	16.5	16.4	16.3
4	16.3	16.2	15.9	16.4	16.2
5	16.1	16.1	16.4	16.5	16.0
6	16.1	15.8	16.7	16.6	16.4
7	16.1	16.3	16.5	16.1	16.5
8	16.2	16.1	16.2	16.1	16.3
9	16.3	16.2	16.4	16.3	16.5
10	16.6	16.3	16.4	16.1	16.5

- i) Develop three sigma control limits for the X-bar chart. (5 Marks)
 - ii) Develop three sigma control limits for the Range chart. (4 marks)
 - iii) Construct the X-bar chart and comment on our findings. (3 Marks)
 - iv) Construct the Range chart and comment on our findings. (3 Marks)
- e) A quality control inspector has taken four samples with eight observation each measuring the volume of chips per bag. If the average range for the six sample is 0.5 ounce and the average mean of the observation is 12.5 ounces, develop three sigma control limits for the bottling operations. (3 Marks)
- f) Suppose acceptable quality level = 0.02 with producer's risk= 5% and lot tolerance percent defective= 0.08 with $\beta = 10\%$. Use Larson's nomograph to determine n and c . (2 Marks)

QUESTION TWO (20 MARKS)

- a) What is a control charts and how are they constructed. **(5 Marks)**
- b) Describe the P-charts. **(3 Marks)**
- c) A supply chain engineering group monitors shipments of materials through the company distribution network. Errors on either the delivered material or the accompanying documentation are tracked on a weekly basis. Fifty randomly selected shipments are examined and the errors recorded. Data for ten weeks are shown.

samples	1	2	3	4	5	6	7	8	9	10
No. of defective light bulbs	1	3	3	1	0	5	1	1	1	1
No. of observations in sample	50	50	50	50	50	50	50	50	50	50

- i) Develop a two sigma control limits for P chart using the data. **(5 Marks)**
 - ii) Construct a P chart and comment on your findings. **(4 Marks)**
- d) Three bagging machines at the Crunchy Potato Chip Company are being evaluated for their capability. The following data was recorded:

Bottling machines	X	Y	Z
Standard deviation	0.01	0.2	0.5

If specifications are set between 15.35 and 15.65 ounces, determine which of the machines are capable of producing within specification using process capability index.

(3 Marks)

QUESTION THREE (20 MARKS)

- a) Define the following terms.
 - i) Acceptable quality level **(2 Marks)**
 - ii) Consumer’s risk **(2 Marks)**
- b) The Noise Muffer shop, a high-volume installer of replacement exhaust muffer systems, just received a shipment of 1000 muffers. The following plan for inspecting these muffers calls for a sample size $n=100$ and an acceptance number $c=2$. The contract with the manufacturer calls for an AQL of two defective muffers per 100 and LTPD of five defective muffers per 100.
 - i) Draw the operating curve for this plan. **(8 Marks)**



- ii) Determine the producer’s and consumer’s risk for this plan (3 Marks)
- c) Suppose that Noise King is using rectified inspection for its sampling plan. Calculate the average outgoing quality limit for a plan with $n=110$, $c=3$ and $N=1000$. (5 Marks)

QUESTION FOUR (20 MARKS)

a) process is being controlled with a fraction nonconforming control chart.

Sample	1	2	3	4	5	6	7	8	9	10
Sample sizes	100	80	80	100	110	110	100	100	90	90
Number of non-conforming unit	12	8	6	9	10	12	11	16	10	6

Construct a p chart from the data given above.

(10 Marks)

b) i) Describe the C-Chart.

(3 Marks)

ii) Kinder Land Child Care uses a c-chart to monitor the number of customer complaints per week. Complaints have been recorded over the past 20 weeks.

Weeks	1	2	3	4	5	6	7	8	9	10
No. of Complaints	0	3	4	1	0	0	3	1	1	0
Weeks	11	12	13	14	15	16	17	18	19	20
No. of Complaints	4	3	1	1	1	10	2	1	2	2

i) Develop three sigma control limits using the data.

(3 Marks)

ii) Construct a control charts with three sigma control limits.

(4 Marks)

QUESTION FIVE (20 MARKS)

a) What is the advantages of CUSUM charts?

(4 Marks)

b) The data in the table below represents two observations on molecular weights taken hourly from a chemic process.



Observation	1	2	3	4	5	6	7	8	9
x_{1i}	9.45	7.99	9.29	11.66	12.16	10.18	8.04	11.46	9.20
x_{2i}	9.40	8.00	9.42	10.98	11.20	10.58	9.00	11.68	9.10

The target value of molecular weight is $\mu = 10$ and the process standard deviation is thought to be 1.

- c) Set up a tabular CUSUM for the mean of this process **(9 Marks)**
- d) Construct the CUSUM chart to quickly detect a shift of about one sigma in the process mean. **(7 Marks)**

