



# **MURANG'A UNIVERSITY OF TECHNOLOGY**

## **SCHOOL OF PURE, APPLIED AND HEALTH SCIENCES**

**DEPARTMENT OF MATHEMATICS AND ACTUARIAL SCIENCE**

**UNIVERSITY ORDINARY EXAMINATION**

**2023/2024 ACADEMIC YEAR**

**FIRST YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF  
SCIENCE IN APPLIED STATISTICS WITH PROGRAMMING**

**AMS 440– QUALITY CONTROL**

**DURATION: 2 HOURS**

### **INSTRUCTIONS TO CANDIDATES:**

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

**SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION**

**QUESTION ONE (30 MARKS)**

- a. A quality control process is normally distributed with a mean of 4000 and a standard deviation of 100. Calculate the probability of detecting a change of process mean of 4 values to 4080 using the warning limit and find average run length. (5marks)
- b. In a certain quality control process the average fractional defective was found to be 0.00789 for 27 subgroups each of size 400 taken at intervals of 25 minutes. Calculate the control limits for this process. (4marks)
- c. An investigator wanted to find out where a company packing packets of tea leaves were in a state of control or not. During the process 40 subgroups of size 12 were taken with quality characteristic of interest being the weight of the packets where he found out that the mean of the sample was 7.126g and the sample range equal to 0.008g. Estimate the standard deviations of the weight of the packets (taken  $a_n = 0.3946$ ,  $D_3 = 0$ ,  $D_4 = 2.004$ ). (2marks)
- d. The data below shows the mean and ranges of sample obtained from a population.

Sample No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mean ( $\bar{x}_i$ )	30	44	55	49	36	39	23	44	47	33	43	57	54	33	49
Range ( $R_i$ )	33	49	25	15	30	27	31	21	50	20	30	60	31	41	37

Without constructing the graph, calculate the control limits for modified shewharts  $\bar{x}$ -chart for mean of random sample of size 4 ( $a_n = 0.4299$ )

- e. A manufacturing firm ran a series of fifteen tests to determine whether there was a variation in the quality of products produced. The data points for 15 test 8.4, 8.5, 9.1, 9.3, 9.4, 9.5, 9.7, 9.9, 10.1, 11/7, 11.2, 11.3 and 11.9. Using the quality control for variables, calculate the 3-sigma control limits for the test. (4marks)
- f. Briefly explain how a single sampling procedure is carried out explaining all variables used. (4marks)
- g. Differentiate between the terms producers and consumers' risks are used in acceptance sampling procedure. (2marks)
- h. Twenty pieces of wire mesh from different rolls contain the following imperfections 2,6,4,3,6,7,8,3,4,5, 3,6,8,7,5,3,2,4,9,6  
Using the control limits for the number of defective per unit ascertain whether the process is in a state of statistical control. (4marks)

**SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION**

**QUESTION TWO (20 MARKS)**

- a. The data below shows the mean weights measurements from twelve samples of size 5 obtained from a quality control process.

Weight					
Sample	1	2	3	4	5
1	3.3	3.2	3.4	3.5	3.6
2	3.1	3.0	3.3	3.4	3.5
3	3.0	3.2	3.5	3.4	3.3
4	3.5	3.6	3.7	3.8	3.9
5	3.6	3.7	3.7	3.6	3.5
6	3.4	3.5	3.3	3.2	3.1
7	3.3	2.9	2.5	3.3	3.5
8	2.7	2.8	2.1	3.1	3.6
9	3.5	3.4	3.7	3.8	3.9
10	3.1	3.2	2.8	2.9	2.6
11	3.1	3.4	3.5	3.6	3.7
12	4.0	3.1	3.3	3.4	3.4

Construct the control limits for the sample variances and find out the state of the process.  
(9marks)

- b. The following data refers to visual defects found during the inspection of the first 10 samples of size 100 each.

Sample No	1	2	3	4	5	6	7	8	9	10
No of defectives	12	11	11	13	12	13	14	12	2	10

Construct the shewharts control limits for the np- chart and comment on the state of the process.  
(7marks)

- c. A sample of five items drawn at random from a lot of 100 items out of which 10 are defective. Find the probability of getting at least two defective items.  
(4marks)

**QUESTION THREE (20 MARKS)**

- a. A certain product is given 100% Inspection as it is manufactured and the resultant data summarized in hours as given in the table below which show the defective items for samples of size 200.

Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of defective	48	36	50	47	48	50	42	32	45	33	64	65	70	66	45

Set up a control chart for fractional defectives with a 5% level of significance at both ends. (6marks)

- b. A manufacturing company producing electrical fused transistors of sample size 6 taken every hour gave the following weights in grams.

Weight															
Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	78	72	81	77	59	78	95	42	62	118	109	107	165	44	22
2	87	90	81	84	78	132	138	60	84	153	112	136	44	98	58
3	42	42	19	36	42	51	60	18	15	69	64	61	21	72	67
4	65	45	24	54	51	74	60	20	30	109	90	78	78	64	77
5	75	68	80	69	74	75	72	27	39	113	93	94	88	24	87
6	79	72	33	72	75	27	43	33	43	22	54	88	93	57	97

Construct Control Charts for the mean and ranges for the given data and investigate the state of the process in 60<sup>th</sup> (Hnit  $n = 6$ ,  $a_n = 0.5872$ ,  $D_3 = 0$  and  $D_4 = 2.115$ ) (10marks)

- c. Briefly explain how a double sampling plan is carried out explaining all the parameters used. (4marks)

**QUESTION FOUR (20 MARKS)**

- a. The parameters of a double sampling plan are given by  $N=60$ ,  $n_1 = n_2 = 5$ ,  $c_1 = 0$  and  $c_2 = 1$ . Compute the probability that a lot of 10% defectives will be rejected by this plan. (7marks)
- b. State and briefly explain five benefits of a statistical quality control process. (5marks)
- c. The data below shows the number of defectives per unit from a certain control process dealing with fibre for repairing plastic materials.

2	4	6	9	13	3	4	5	7	6	13	15	9	10	20
7	11	5	7	6	8	5	10	8	4	22	33	14	17	9

Investigate whether the process is a state of control. (5 marks)

- d. Define the following terms as used in inspection sampling procedures.
- i. Lot tolerance percentage defective. (1mark)
  - ii. Acceptance Quality Level (1mark)
  - iii. Average Sample Number (1mark)