

CHUKA

UNIVERSITY



UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF  
SCIENCE AND BACHELOR OF ART

MATH 342: QUALITY CONTROL METHODS

STREAMS: BSc, B.A

TIME: 2 HOURS

DAY/DATE: TUESDAY 19/12/2023

11.30 A.M. – 1.30 P.M.

**INSTRUCTIONS:**

- Answer question one and any other two

**QUESTION ONE (30 MARKS)**

(a) Define the following term

- Quality Control
- Control chart
- Acceptance sampling

[6 marks]

(b) Control chart for  $\bar{X}$  and R are maintained on certain dimensions of a manufactured part, measured in mm. The subgroup size is 4. The values of  $\bar{X}$  and R are computed for each subgroup. After 20 subgroups

$$\sum_{i=1}^{20} \bar{X}_i = 412.83 \quad \text{and} \quad \sum_{i=1}^{20} R_i = 3.39$$

**Required**

- Compute the 3 sigma limits for the  $\bar{X}$  and R charts [6 marks]
- Estimate the value of sigma on the assumption that the process is in statistical control

(c) In a capability study of lathe used in turning a shaft to a diameter of  $23.75 \pm 0.1$  mm a sample of 6 consecutive pieces was taken each day for 8 days. The diameters of these shafts are as given below

Day							
1	2	3	4	5	6	7	8
23.77	23.80	23.77	23.79	23.75	23.78	23.76	23.76
23.80	23.78	23.78	23.76	23.78	23.76	23.78	23.79
23.78	23.76	23.77	23.79	23.78	23.73	23.75	23.77
23.73	23.70	23.77	23.74	23.77	23.76	23.76	23.72
23.76	23.81	23.80	23.82	23.76	23.74	23.81	23.78
23.75	23.77	23.74	23.76	23.79	23.78	23.80	23.78

**Required**

- i. Construct the  $\bar{X}$  and R and
- ii. Find out the process capability for the machine [10 marks]

(d) A certain product is given 100% inspection as it is manufactured and the resultant data are summarized by the hour. In the following table 156 hours of data are recorded.

Hours	No. of units inspected	No. of defective units
1	48	5
2	36	5
3	50	0
4	47	5
5	48	0
6	54	3
7	50	0
8	42	1
9	32	5
10	40	2
11	47	2
12	47	4
13	46	1
14	46	0
15	48	3
16	39	0

**Required**

Calculate the control limits using 3sigma control limits and indicate the values that are out of control [8marks]

**QUESTION TWO (20 MARKS)**

- (a) Outline five (5) benefits of statistical quality control [5marks]
- (b) A machine drills hole in a pipe with a mean diameter of 0.532 cm and a standard deviation of 0.002 cm. Calculate the control limits for mean of samples 5. [4marks]
- (c) Given that resistors are produced in lots of 1000, and that the average number of defective resistors per lot is 12.7, what are the upper and lower limits for the control chart appropriate for this process? [3marks]
- (d) A process is in control at  $\bar{X} = 100$ ,  $R = 7.3$  with  $n = 4$ . If the process level shifts to 101.5, with the same range, what is the probability that the next  $\bar{X}$  point will fall outside the old control limits [5marks]
- (e) An  $\bar{X}$  chart is used to control the mean of a quality characteristic. It is known that  $\sigma=6.0$  and  $n=4$ . The center line=200, UCL=209 and LCL=191. If the process means shifts to 188, find the probability that this shift is detected on the first subsequent sample. [3 marks]

**QUESTION THREE (20 MARKS)**

- (a) A purchasing firm orders items using a single sampling plan for which  $n=4$  and  $c=1$ . Calculate the probability of acceptance of a lot of incoming quality of 10% [5 marks]
- (b) A double sampling plan has  $n_1=50$ ,  $c_1=1$ ,  $n_2=90$  and  $c_2=3$ . Compute the probability of acceptance of a 10% defective lot. [15 marks]

**QUESTION FOUR (20 MARKS)**

- (a) A control chart is to be formed for a process in which laptops are produced. The inspection unit is one laptop and control chart for the number of defects is to be used. Preliminary data are recorded and 45 defects are found in 30 laptops.

**Required**

Obtain the control limits for the chart [4 marks]

(b) As part of an overall quality improvement programme, a textile manufacturer decides to monitor the number of defects found in each inspected bolt (large bundle) of cloth. The data from 20 inspections are recorded in the table given below

Bolt of Cloth	Number of Defects	Bolt of Cloth	Number of Defects
1	10	11	22
2	19	12	4
3	5	13	6
4	9	14	9
5	2	15	7
6	8	16	2
7	7	17	5
8	13	18	12
9	3	19	4
10	2	20	2

**Required**

- i. Which control chart should be used in this case? Calculate the control limits for this chart
- ii. Do these data from a controlled process? If not, calculate the revised control limits

[9 marks]

(c) Samples of  $n=6$  are taken from a manufacturing process at regular intervals. After 50 subgroups, we have;  $\sum_{i=1}^{50} \bar{X}_i = 1000$  and  $\sum_{i=1}^{50} S_i = 75$

Assuming that both charts exhibit control and that the quality characteristic is normally distributed

**Required**

- i. Find the Shewhart's control limits for the  $\bar{X}$  and S charts
- ii. Estimate the process standard deviation
- iii. If the process means shifts to 22, what is the probability of concluding that the process is still in control?

[8 marks]

**QUESTION FIVE (20 MARKS)**

Twenty samples of carpets are inspected for varying sample size and the number of defects in each sample is noted in the following table

Sample Number	Number of Carpet inspected	Number of Defects	Sample Number	Number of Carpet inspected	Number of Defects
1	25	12	11	20	9
2	20	5	12	20	12
3	25	7	13	15	14
4	15	7	14	25	6
5	25	10	15	20	7
6	15	4	16	25	12
7	20	6	17	15	5
8	15	2	18	25	6
9	15	4	19	15	8
10	25	10	20	25	4

**Required**

Construct a suitable control chart (*U*-charts) for the number of defects per carpet [20 marks]

.....