RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

Bachelor of Science in Applied Sciences
Third Year - Semester II Examination – Jan/Feb 2023

MAT 3312 – STATISTICAL QUALITY CONTROL

Time: Three (03) hours

Answer **all** questions.
Calculators and Statistical tables will be provided.

1. a) Describe the two different meanings given to the word "quality".

(25 marks)

b) Briefly explain 4 categories of quality costs.

(30 marks)

c) Discuss the two types of causes of variation in statistical process control.

(20 marks)

d) Explain how does the control chart play an important role in statistical process control.

(25 marks)

2. Samples of $n = 6$ items are taken from a manufacturing process at regular intervals. A normally distributed quality characteristic is measured and values are calculated for each sample. After 50 subgroups of samples have been analyzed, we have:

$$\sum_{i=1}^{50} \bar{x}_i = 1000\,, \qquad \sum_{i=1}^{50} S_i = 75.$$

Where $\bar{x}_i$ and S_i are the mean and the standard deviation of the i^{th} sample respectively.

a) Compute the control limits for the mean change in process over time ($\bar{x}$- chart) and the standard deviation of the process over time (S- chart).

(40 marks)

b) Assume that all points on both charts plot within the control limits. Determine the natural tolerance limits of the process

(20 marks)

c) If the specification limits of the $\bar{x}$- chart are 19 ± 4 , what are your conclusions regarding the ability of the process to produce items conforming to specifications?

(20 marks)

d) Assuming that if an item exceeds the upper specification limit it can be reworked, while if it is below the lower specification limit it must be scrapped, what percent scrap and rework is the process now producing?

(20 marks)

3. a) Derive the control limits for $\bar{x}$ and R charts.

(20 marks)

b) The Western Electric Company produces incandescent light bulbs. The following data on the number of lumens for 40W light bulbs were collected when the process was in control.

	Observations			
Sample	**1**	**2**	**3**	**4**
1	604	612	588	600
2	597	601	607	603
3	581	570	585	592
4	620	605	595	588
5	590	614	608	604

(i) Estimate the process mean ($\mu = \bar{\bar{x}}$) and standard deviation (σ).

(20 marks)

(ii) Calculate 3-sigma control limits for $\bar{x}$ - chart and R- chart.

(40 marks)

(iii) Calculate Average Run Length (ARL) for the process mean and comment how many samples you have to take from the process to receive an out-of-control signal.

(20 marks)

4. a) A control chart indicates that the current process fraction nonconforming is 0.02. If 50 items are inspected each day, what is the probability of detecting a shift in the fraction nonconforming to 0.04,

(i) On the first day after the shift?

(ii) By the end of the third day following the shift?

(40 marks)

b) A tire manufacturer has been concerned about the number of defective tiers found recently. In order to evaluate the true magnitude of the problem, a production manager selected ten random samples of 20 units each for this inspection. The number of defective tiers found in each sample is as follows;

Sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Number of defectives	1	3	2	1	4	1	2	0	3	1

(i) Develop a control chart for fraction nonconforming with 3-sigma limits. Is the process in-control? If not revise the control limits.

(40 marks)

(ii) If the mean process fraction nonconforming has shifted to 0.15, what is the probability of detecting it in the second sample after the shift?

(20 marks)

5. a) Derive the statistical quality control limits for c – chart and u – chart.

(20 marks)

b) A textile manufacturer wants to setup a control chart for number of defects per 100 square yards of carpet. The following data were collected from a sample of twenty, 100-square-yard pieces of carpet.

Sample	1	2	3	4	5	6	7	8	9	10
Number of defects	11	8	9	12	4	16	5	8	17	10

Sample	11	12	13	14	15	16	17	18	19	20
Number of defects	11	5	7	12	13	8	19	11	9	10

(i) Using these data, set up a c – chart with 3-sigma limits and comment about whether the process is in-control or out-of-control.

(20 marks)

(ii) Suppose that the next five samples had 15, 18, 12, 22 and 21 number of defects, what can you conclude about the process.

(30 marks)

(iii) If the inspection is changed to 75-square-yard for each sample, what are the limits of u – chart.

(30 marks)

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