RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES
B.Sc. (General) Degree in Applied Sciences
Third Year– Semester II Examination – February/March 2019
MAT 3312– STATISTICAL QUALITY CONTROL

INSTRUCTIONS:
Answer **All** questions
Calculators will be allowed

Time Allowed: **Three** hours

1. (a) Write two definitions for *quality*. (20 marks)

(b) Distinguish between *quality of design* and *quality of conformance*. (25 marks)

(c) Write all *eight dimensions* in quality and briefly explain each of them. (30 marks)

(d) Elaborate on *control charts*. (25 marks)

2. (a) Derive control limits for the *np* – chart. (15 marks)

Why is the *np* chart not appropriate with variable sample size? (05 marks)

Following table shows nonconforming plastic parts manufactured in an injection molding process:

Sample Number	Sample Size	Nonconforming
1	100	10
2	100	15
3	100	31
4	100	18
5	100	24
6	100	12
7	100	23
8	100	15
9	100	8
10	100	8

A control chart is used to control the fraction nonconforming for a plastic part manufactured in an injection molding process. Ten samples yield the data in above table.

(i) Set up a control chart for the number nonconforming (*np* chart) in samples of $n = 100$. (20 marks)

(ii) Does the chart set up in (i) exhibit statistical control? If not, derive revised control limits. (10 marks)

(iii) For the chart established in (ii), what is the probability of detecting a shift in the process fraction nonconforming to 0.30 on the first sample after the shift has occurred? (10 marks)

(b) A maintenance group improves the effectiveness of its repair work by monitoring the number of maintenance requests that require a second call to complete the repair. Data collected for a period of twenty weeks are shown in the following table:

Week	Total Request	Second Visit Required	Week	Total Request	Second Visit Required
1	200	6	11	100	1
2	250	8	12	100	0
3	250	9	13	100	1
4	250	7	14	200	4
5	200	3	15	200	5
6	200	4	16	200	3
7	150	2	17	200	10
8	150	1	18	200	4
9	150	0	19	250	7
10	150	2	20	250	6

Construct a standardized control chart (z – chart) for the data in the above table. (40 marks)

3. (a) A control chart is to be established on a process producing refrigerators. The inspection unit is one refrigerator, and a control chart for nonconformities (*c* chart) is to be used. As preliminary data, 16 nonconformities were found in inspecting 30 refrigerators.

(i) What are the three-sigma control limits? (15 marks)

(ii) What is the α -risk for this control chart? (15 marks)

(iii) What is the β-risk if the average number of defects is actually two? (15 marks)

(iv) Find the average run length if the average number of defects is actually two. (15 marks)

(b) The manufacturer wishes to set up a control chart at the final inspection station for a gas water heater. Defects in workmanship and visual quality features are checked in this inspection. For the past 22 working days, 176 water heaters were inspected and a total of 924 nonconformities reported.

(i) What type of control chart would you recommend here and how would you use it? (10 marks)

(ii) Using two water heaters as the inspection unit, calculate the center line and control limits that are consistent with the past 22 days of inspection data. (15 marks)

(iii) Calculate the warning limits, and upper and lower natural tolerance limits. (15 marks)

4. Derive the control limits of $\bar{x}$ and R charts. (20 marks)

Control charts for $\bar{x}$ and R are maintained on the tensile strength of a metal fastener. After 30 samples of size $n = 6$ are analyzed, it was found that

$$\sum_{i=1}^{30} \bar{x} = 12{,}870 \text{ and } \sum_{i=1}^{30} R_i = 1350$$

(i) Compute control limits of $\bar{x}$ and R charts. (20 marks)

(ii) Assuming that the $\bar{x}$ and R charts exhibit control, estimate the parameters μ and σ. (20 marks)

(iii) If the process output is normally distributed, and if the specifications are 440 ± 40, can the process meet the specifications? Estimate the fraction nonconforming and Process Capability Ratio (PCR). (20 marks)

(iv) 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 percentage of scrapped and percentage of reworked are the process now producing? (20 marks)

5. The following $\bar{x}$ and s charts based on $n = 4$ have shown statistical control:

$\bar{x}$ chart	s chart
UCL = 710 Centre line = 700 LCL = 690	UCL = 18.08 Centre line = 7.979 LCL = 0

(i) Estimate the process parameters μ and σ. (20 marks)

(ii) If the specifications are at 705 ± 15, and the process output is normally distributed, estimate the fraction nonconforming. (20 marks)

(iii) For the chart, find the probability of type I error, assuming σ is constant. (20 marks)

(iv) Suppose the process mean shifts to 693 and the standard deviation simultaneously shifts to 12. Find the probability of detecting this shift on the chart on the first subsequent sample. (20 marks)

(v) For the shift of part (iv), find the average run length. (20 marks)

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