RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. General Degree
Fourth Year Semester II Examination – September/ October 2013

MAT 3312 – STATISTICAL QUALITY CONTROL

Answer five questions . **Time: 3 hours**

Calculators can be used **Statistical Tables will be provided**

1. Write a brief description under each of the following topics:

   (i) Quality costs

   (ii) Total quality management

   (iii) Shewhart control charts

   (iv) Seven statistical tools in Statistical Process Control.

2. Derive the statistical quality control limits for the p-chart.

   The IRS is concerned with improving the accuracy of tax information given by its representatives over the telephone. Previous studies involved asking a set of 25 questions of a large number of IRS telephone representatives to determine the proportion of correct responses. Historically, the average proportion of correct responses has been 70%. Recently, IRS representatives have been receiving more training. On April 1, the set of 25 tax questions were again asked of 20 randomly selected IRS telephone representatives. The proportions of correct answers were 0.88, 0.76, 0.64, 1.00, 0.76, 0.76, 0.72, 0.88, 0.50, 0.50, 0.40, 1.00, 0.88, 1.00, 0.64, 0.76, 0.76, 0.88, 0.40 and 0.76.

   (i) Construct the p-chart using $\alpha = 0.01$.

   (ii) Does the process in control? Justify your answer.

   (iii) If p value shifted to 0.75, what is probability of detecting the shift in the second sample after shift has occurred?

3. Derive the statistical quality control limits for the c-chart.

A textile manufacturer wants to set up a control chart for irregularities per 100 square meters of carpet. The following data were collected from a sample of twenty 100-square-meter pieces of carpet:

Sample	Irregularities	Sample	Irregularities
1	11	**11**	11
2	8	**12**	5
3	9	**13**	7
4	12	**14**	12
5	4	**15**	13
6	16	**16**	8
7	5	**17**	19
8	8	**18**	11
9	17	**19**	9
10	10	**20**	10

(i) Using these data, set up a c-chart with 3-sigma limits.

(ii) Suppose that the next five samples had 15, 18, 12, 22 and 21 irregularities, what do you conclude?

4. The Marlin Company produces plastic bottles to customer order. The quality inspector randomly selects four bottles from the bottle machine and measures the outside diameter of the bottle neck, a critical quality dimension that determines whether the bottle cap will fit properly. The dimensions (cm) from the last six samples are:

Bottle

Sample	1	2	3	4
1	0.604	0.612	0.588	0.600
2	0.597	0.601	0.607	0.603
3	0.581	0.570	0.585	0.592
4	0.620	0.605	0.595	0.588
5	0.590	0.614	0.608	0.604
6	0.585	0.583	0.617	0.579

(i) Assume that only these six samples are sufficient, and use the data to determine 3-sigma control limits for an R- and $\bar{x}$- chart.

(ii) Suppose that the specifications for the bottle neck diameter are 0.600 ± 0.050 cm, find the process capability and process capability ratio.

(iii) Draw an OC curve for the $\bar{x}$ – chart.

5. Derive control limits for $\bar{x}$ and S charts stating the assumptions.

Samples of $n = 8$ items are taken from a manufacturing process at regular intervals. A normally distributed quality characteristic is measured and $\bar{x}$ and S values are calculated for each sample. After 25 subgroups have been analyzed, we have

$$\sum_{i=1}^{25} \bar{x}_i = 250 \text{ and } \sum_{i=1}^{25} S_i = 75$$

(i) Compute the control limits for the $\bar{x}$ and S control charts. The control limits are to be based on an α - risk of 0.01.

(ii) Assume that all points on both charts plot within the control limits. What are the natural tolerance limits of the process?

(iii) If the specification limits are 9 ± 3.0, what are your conclusions regarding the ability of the process to produce items conforming to specifications?

(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 percent scrap and rework is the process now producing?

6. Explain the following terms:

(i) Quality.

(ii) Consumer.

(iii) Assignable causes.

(iv) Natural Tolerance Limits and Specification Limits.

(v) Process Capability Ratio.

(vi) Average Run Length.