RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General Degree) Examination
Third year – Semester I Examination-March/April 2014

STATISTICAL QUALITY CONTROL – MAT 3312

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

Calculators can be used Statistical Tables will be provided

1.

a. Write the three quality characteristics and give two examples for each.

b. Write the seven magnificent tools in statistical quality control and explain two of them in detail.

c. What is meant by total quality management?

d. Write the four quality costs by explaining each in brief.

2. Red baron Airlines serves hundreds of cities each day, but competition is increasing from smaller companies affiliated with major carriers. One of the key competitive priorities is on-time arrivals or departures. Red baron defines on time as any arrival or departure that takes place within 15 minutes of the schedule time. To stay on the top of the market, management has set high standard of 98% on-time performance. The operations department was put in charge of monitoring the performance of the airline. Each week, a random sample of 300 flight arrivals and departures was checked for schedule performance. The following table contains the number of arrivals and departures over the last 30 weeks that did not meet Red Baron's definition of on-time service. What can you tell management about the quality of service? Can you identify any nonrandom behavior in the process? If so, what might cause the behavior?

Samples	Number of Late Planes in Sample of 300 Arrivals and Departures									
1 -10	3	8	5	11	7	2	12	9	1	8
11 - 20	3	5	7	9	12	5	4	9	13	4
21 - 30	12	10	6	2	1	8	4	5	8	2

3. Derive the control limits for p-chart.

As a hospital administrator of a large hospital, you are concerned with the absenteeism among nurse's aides. The issue has been raised by registered nurses, who feel they often have to perform work normally done by their aides. To get the facts, absenteeism data were gathered for the last two weeks, which is considered a representative period for future conditions. After taking random samples of 64 personnel files each day, the following were produced:

Day	Aides Absent	Day	Aides Absent
1	4	9	7
2	3	10	2
3	2	11	3
4	4	12	2
5	2	13	1
6	5	14	3
7	3	15	4
8	4		

Since your assessment of absenteeism is likely to come under careful scrutiny, you would like a type I error of only 1%. You want to be sure to identify any instances of unusual absences. If some are present, you will have to explore them on behalf of the registered nurses.

(i) Design a p – chart.

(ii) Based on your p – chart and the data from the last two weeks, what can you conclude about the absenteeism of nurse's aids.

4. Suppose that a quality characteristic is normally distributed where both mean and standard deviation are unknown. From the first principle derive the Shewhart control limits for $\bar{x}$ and R control charts.

   Samples of $n = 10$ items each taken from a manufacturing process at regular intervals. A quality characteristic is measured, and $\bar{x}$ and R values are calculated for each sample. After 50 samples, we have $\sum_{i=1}^{50} \bar{x}_i = 1500$ and $\sum_{i=1}^{50} R_i = 125$.

   Assume that the quality characteristic is normally distributed.

   (i) Compute control limits for the $\bar{x}$ and R control charts.

   (ii) All points on both control charts fall between the control limits computed in part (i). What are the natural tolerance limits of the process.

   (iii) If the specification limits are 31 ± 4.0, what are your conclusions regarding the ability of the process to produce items within these specifications?

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

5. In the usual notation, derive the control limits of $\bar{x}$ - and S – charts assuming the process is normally distributed.

   The Watson Electric Company produces light bulbs. The following data on the number of lumens for 40-watt 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) Calculate control limits for an S – chart and an $\bar{x}$ - chart and produce control charts.

(ii) Since these data were collected, some new employees were hired. A new sample obtained the following readings: 570, 603, 623, and 583. Is the process still control?

6. Derive the control limits for c-chart.

A control chart is to be established on a process producing refrigerators. The inspection unit is one refrigerator, and a control chart of nonconformities is to be used. As preliminary data, 16 nonconformities were counted in inspecting 30 refrigerators.

(i) What are the 3-sigma control limits?

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

(iii) What is the β-risk if the average number of defects is actually 2

(that is, if $c = 2.0$)?

(iv) Find the average run length if the average number of defects is actually 2.