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RAJARATA UNIVERSITY OF SRILANKA

FACULTY OF APPLIED SCIENCES, MIHINTALE

B.Sc. (General) Degree

Third Year Semester II Examination - October 2014

MAT 3312 – Statistical Quality Control

Answer **Five** Questions Time: **Three Hours**

Calculators and Statistical Tables will be provided

1. (a) Discuss the logic underlying the use of 3-sigma limits on Shewhart control charts. How will the chart respond if narrower limits are chosen? How will it respond if wider limits are chosen?

(b) An automatic screw machine turns out round-head bolts with a specified shank diameter of 9.00 ± 0.04 mm . The process has been operating in control at an estimated μ of 9. 00 mm and $\overline{R}$ of 0.0206 mm. The sample size is 4.

(i) Compute the $\overline{X}$ and *R* chart control limits.

(ii) If the mean of the process shifts to 9.02 mm, compute type II error probability that the shift will not be detected on the first sample drawn after it occurs.

(iii) What proportion of defective product is being produced at this new value of μ assuming the product is normally distributed?

2. (a) State various purposes and uses of a *p*-chart.

(b) Describe a *p*-chart and explain why it is based on binomial distribution?

(c) An item is made in batches of 200 each. The batches are fully inspected. The record of the first 25 lots inspected showed that the total of 75 items did not conform to specifications.

(i) Determine the trial control limits for *np* chart.

(ii) Assume all points fall within the control limits. What is your estimate of the process average nonconforming μ_p?

(iii) If this μ_p remains unchanged, what is the probability that the twenty-sixth lot will contain exactly 7 nonconforming units? That it will contain 7 or more nonconforming units?

3. A *c* chart is used to monitor the number of surface imperfections at final inspection on a class of television receiver cabinets. Inspection is on a sampling basis with six consecutive cabinets forming a sample. About 30% of product output is inspected. The most recent 15 samples contained 112 imperfections.

(i) Calculate the central line and control limits for this process.

(ii) Assume there is a sudden shift in the process to a μ_c of 14. What is type II error probability of not detecting this shift on the first sample after the shift occurs?

(iii) Assuming that the shift described in part (i) is sustained until detected, the probability of detecting it within *k* samples is $1 - P(\text{Type II error})^k$. At what value of *k* do we have about a 50/50 chance of detection?

4. Answer to the following questions in brief:

(i) What is control chart? Distinguish between control chart for variables and control for attributes.

(ii) Explain the terms: Control limits, warning limits, producer's risk and consumer's risk.
(iii) Discuss the roll of *c*-chart in statistical quality control.
(iv) What do you mean by process control?

5. (a) Fill in the blanks:

(i) The variation of quality characteristics can be divided under two heads, chance variation, ----------.
(ii) Variables are those quality characteristics of a product or item which are --------.
(iii) A control chart contains, in general, three horizontal lines. They are (1)---------- (2)---------- (3) ----------.

(iv) Control chart for fraction defectives is called ----------.
(v) The theoretical basis for *c*-chart is ---------- distribution.

(vi) The total number of defects in 15 pieces of cloth is of equal length is 90. Then UCL and LCL for *c*-chart are ---------- and ----------.

(vii) In the preparation of R-chart, if $D_3 = 0$, then LCL is ----------.

(b) State True or False.

(i) The control limits for the *c*-chart are $\bar{c} \pm \sqrt{\bar{c}/n}$

(ii) *c*-chart is designed to control the *number of defects per unit*.

(iii) The centre line in control chart represents the expected standard of quality of the product in the process.

(iv) The value D_4 increases as sample size *n* increases.

(v) We can plot *np*-chart when the sample size varies.

6. (i) Explain the following terms briefly:

(a) Average Run Length (ARL).

(b) Operating Characteristic Curve (OC curve).

(c) Process Capability Ratio.

(d) Natural Tolerance Limits.

(e) Upper Specification Limits.

(ii) Give four common patterns that appear in $\bar{x}$ chart. Show these patterns graphically and give one reason for each pattern that results in $\bar{x}$ chart.