

**2020**

**STATISTICS — HONOURS**

**Paper : DSE-A-1**

**(Statistical Quality Control)**

**Full Marks : 50**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

1. Answer **any ten** questions : 1×10
- (a) What are tolerance limits?
  - (b) Why do we draw the central line in a control chart?
  - (c) If a process is said to be in control, what can we say about its variation?
  - (d) Which of the error probabilities does the acceptance control chart take into account?
  - (e) What are the dividing lines between random and non-random deviations in a mean chart called?
  - (f) What does inspection of units assure?
  - (g) What does a control chart display?
  - (h) The steeper the OC curve, the more is the discriminating power of the sampling plan— do you agree?
  - (i) If the cost of replacing a defective item after shipment is Rs. 5 and the cost of inspecting each item before shipment is Rs. 10, what would be the indifference between 100% inspection and replacement of defectives?
  - (j) A sampling process destroys the units sampled, and because the process is continuous it is possible only to collect one sample at a time. What will be the most appropriate chart to use in this case?
  - (k) Which chart will a firm use when measuring nonconformities per unit with variable sample sizes?
  - (l) What are warning limits?
  - (m) For a single sampling plan  $N = 1000$ ,  $n = 50$ ,  $c = 2$ , what is the ASN under rectification plan?
  - (n) In sampling inspection plan by attribute, what does rejectable quality level mean?
  - (o) In a single sampling plan with parameters  $(n, c)$ , how is the consumer's risk affected when  $n$  is increased but  $c$  remains constant?
2. Answer **any four** questions : 5×4
- (a) Describe the difference between an attribute control chart and a variable control chart.
  - (b) Samples of size 5 are selected from a manufacturing process. The mean of the sample ranges is 0.50. Find the estimate of the standard deviation of the population.

**Please Turn Over**

- (c) Sims software purchases CDs from CD International. The CDs are packaged in lots of 1000 each. Todd Sims, president of Sims Software, has agreed to accept lots with 10 per cent or fewer defective CDs. Todd has directed his inspection department to select a random sample of 20 CDs and examine them carefully. He will accept the lot if it has two or fewer defectives in the sample. Develop an OC curve for this inspection plan.
- (d) A process is checked by inspecting at random samples of 4 shafts after a polishing operation, and  $\bar{X}$ -bar and R charts are maintained. A person making a spot check picks out 2 shafts, measures them accurately, and plots the value of each on the  $\bar{X}$ -bar chart. Both the points fall just outside the control limits. He advises the department foreman to stop the process. What can you say about this decision? Give reasons for your answer.
- (e) A  $p$  chart with variable sample sizes yields the following statistics : Process average = 0.50; UCL = 0.80; average sample size is 100. For an observation of value 0.78 drawn from a sample of 90 units, what is your conclusion? Give reasons for your answer.
- (f) Consider an  $\bar{X}$ -bar chart with 3 sigma control limits. Samples of size  $n$  are drawn from it. Suppose that the measured characteristic is normally distributed and has a true average of  $\mu_0$  and standard deviation  $\sigma$ . Indicate how you can find the probability that the control chart will raise an out of control alarm after maximum 3 samples?

3. Answer **any two** questions :

10×2

- (a) How and why do we study the process capability of a production process? What are the important indices for measuring the process capability?
- (b) An improvement in the process has resulted in increase of  $C_{PK}$  from 0.6 to 0.95. Estimate the reduction in % of non-conforming items. Assume that the process average has not changed,  $C_{PK} = C_P$  and the process is in statistical control.
- (c) A sub-group of 5 items is taken from a production process at regular intervals. After 25 sub-groups, it is found that  $\sum \bar{x}_i = 357.5$  and  $\sum R_i = 8.80$ . Find
- control limits of  $\bar{X}$ -bar and R charts;
  - process capability;
  - if specification limits are  $14.40 \pm 0.40$ , what conclusions can you draw and what suggestions can you provide? (Given  $d_2 = 2.326$ )
- (d) (i) The measurement  $X$  on an item follows a normal distribution with known standard deviation. The item is considered acceptable if  $X$  is large. Derive a SSIP for two points specified on the OC curve.
- (ii) Discuss your agreement or disagreement to the statement given below with justification :  
“A statistically controlled process will always produce 100% results within tolerance limits”.
-