

NATIONAL INSTITUTE OF TECHNOLOGY, CALICUT
SEVENTH SEMESTER B TECH ENGINEERING EXAMINATION, 2002

PM 704 STATISTICAL QUALITY CONTROL

Time: 3hours

Max marks: 100

Use of statistical tables as well as SQC tables is permitted.

Assume suitable data wherever necessary.

1. Answer all questions:

- a) Explain the hypergeometric distribution giving definition, parameters and applications.
- b) Discuss the logic underlying the use of 3-sigma limits on Shewhart Control Charts. How will the charts respond if narrower limits are chosen? How will it respond if wider limits are chosen?
- c) A die casting process uses a five-cavity mould for a part used in an automotive assembly. It is planned to monitor the wall thickness of the part using \bar{x} and R charts. It has been suggested to use all five parts that result from a single "shot" of this machine as the subgroup or sample. What do you think of this sampling strategy? What impact does it have on the ability of charts to detect assignable causes?
- d) What are the Western Electric Handbook rules for detecting nonrandom patterns on control charts?
- e) Explain applications where the control chart for individual measurements is better suited, compared to other control charts.
- f) How can the OC curve for the c-chart be computed?
- g) What are AOQ and AOQL? Explain their significance in acceptance sampling.
- h) Sketch a 'bathtub' curve and mark the various regions on it. Explain how this may be obtained experimentally for equipment that is repairable.

(8 X 5 = 40 marks)

2. a) The errors on invoices of a company making valves for engines is distributed according to a Poisson distribution with parameter $\lambda = 0.02$. What is the probability that an invoice selected at random will contain one error?

(7 marks)

b) Mineral water is filled in containers using a machine. A random sample of 10 containers was selected, and the net contents are: 1.03, 1.04, 1.05, 0.96, 1.05, 1.01, 1.02, 0.98, 1.02, & 0.99 litres. Determine two-sided limits for the fill volume within which 95% of the observations is expected to lie. Assume that the amount of water filled is normally distributed.

(8 marks)

OR

3. a) The output voltage of a battery is normally distributed with mean 6V and standard deviation 0.025V. The car in which the battery is fitted will not start if the voltage is lower than 5.95V or higher than 6.05V. What is the probability that the car will not start if a battery selected at random is used? Consider only the battery, ie neglect the effect of other components.

(7 marks)

b) The variation in tensile strength is an important characteristic for a fibre to be used as reinforcement in composites. When 10 samples of fibre was tested for tensile strength, the results obtained were $\bar{x}_1 = 19.70$, and $S_1^2 = 327.6$. After treating the fibre with the matrix material, another 8 random samples were tested for tensile strength with the results $\bar{x}_2 = 16.16$, $S_2^2 = 313.8$. Can you conclude that the two variances are equal? Use a 0.05 level of significance.

(8 marks)

4. \bar{x} and R values are calculated for each sample of the quality characteristic taken from a manufacturing process, at regular intervals. The subgroup size is 8. After 50 samples, we obtained

$$\sum_{i=1}^{50} \bar{x}_i = 4000 \text{ and } \sum_{i=1}^{50} R_i = 500. \text{ Assume that the quality characteristic is normally distributed.}$$

- Determine control limits for the \bar{x} and R charts.
- If all points on both control charts fall between the control limits computed in part (a), what are the natural tolerance limits of the process?
- If the specification limits are 82 ± 10.0 , what are your conclusions regarding the ability of the process to produce items within specifications?
- What percentage of the product will not be conforming to specification?

(15 marks)

OR

5. A subgroup size of 4 is used to monitor the capacitance of components using an \bar{x} and R chart. The parameters are UCL = 1630, Centre line = 1600 and LCL = 1570 for the \bar{x} chart; and UCL = 93.96, Centre line = 41.18 and LCL = 0 for the R chart. Both charts exhibit control. What is the probability that a shift in the process mean to 1580 will be detected on the first sample following the shift?

(15 marks)

6. The fraction nonconforming of resistors manufactured in a factory is monitored using a control chart with a centre line of 0.005 and 2 sigma control limits. a) If the lower control limit is to be nonzero, how large should be the sample size? b) If we wish the probability of detecting a shift to 0.02 to be 0.50, how large should the sample size be?

(15 marks)

OR

7. A coir mat manufacturer wishes to establish a control procedure on defects in mats it manufactures. Mats are produced in batches of 25, and the same may be treated as an inspection unit. Previous records show that 200 batches had total 1700 flaws. What type of control chart is appropriate? Design the control chart that it has two-sided probability control limits of $\alpha = 0.06$, approximately. Give the centre line and control limits.

(15 marks)

8. Suppose that a single sampling plan with $n = 150$ and $c = 2$ is being used for receiving inspection where the vendor ships the product in lots of size $N = 3000$. Draw the ATI curve for this plan.

(15 marks)

OR

9. An electronic system consists of two subsystems in parallel, each having the following components and characteristics:

Component	Failure rate/hour	Number of components
Germanium transistor	37.0×10^{-6}	3
Integrated circuit	49.0×10^{-6}	2
Electrolytic capacitor	41.0×10^{-6}	1

The components within each subsystem are all necessary for mission success. What is the mission reliability if the mission time is 500h?

(15 marks)