INDIAN STATISTICAL INSTITUTE

MS in QMS

TEST ON STATISTICAL PROCESS CONTROL

Date: 10 November 2025 Time: 3 hours Maximum Marks: 50

Answer as many questions as you can. The maximum you can score is 50

1. Why is it important to verify that the characteristic under study follows a normal distribution before calculating process capability indices such as Cp and Cpk? Provide the formula to compute 100(1-α)% confidence interval for the process capability indices Cp and Cpk?

   The coating thickness of 16 powder coated enclosures are given below:

98	105	99	105
84	104	94	85
97	84	103	80
87	77	109	104

   a. Show that the coating thickness is normally distributed using probability plot method?

   b. Estimate the process mean and standard deviation?

   c. Given the specification limits of 100 ± 30 microns, calculate the process capability indices Cp and Cpk?

   d. Compute the 95% confidence intervals for Cp and Cpk? Comment on whether the powder coating process is capable of meeting the specification requirements?

   e. Suppose reworking an enclosure costs: \$20 for coating thickness below the lower specification limit and \$40 for coating thickness above the upper specification limit, estimate the total rework cost for powder coating a batch of 50 enclosures?

[12]

2.

   a. Explain the procedure of designing of a single sampling plan based on AQL and Producer's risk?

   b. A product is shipped in lots of size N = 7000. Design a single sampling plan that satisfies the following conditions: Acceptable Quality Level (AQL) = 2%, Producer's Risk (α) = 4.6%, Sample size (n) is fixed at 40 due to economic constraints:

   Determine the appropriate acceptance number c for the sampling plan?

   Construct the Operating Characteristic (OC) curve for the proposed plan?

   Given that the Lot Tolerance Percent Defective (LTPD) is 12%, compute the Consumer's Risk (β) associated with the plan

[12]

3.

a. Suppose x_i are independent random variable with variance σ^2 and exponentially weighted moving average statistics $z_i = \lambda x_i + (1-\lambda)z_{i-1}$. Show that the variance of z_i is

$$\sigma_{z_i}^2 = \sigma^2 \left(\frac{\lambda}{2-\lambda}\right)[1-(1-\lambda)^{2i}]$$

b. The data given in table below are temperature readings from a chemical process in °C, taken every half an hour. The target temperature is $\mu_0 = 957.35$ °C. Estimate the process standard deviation and set up an EWMA control chart to monitor temperature using $\lambda = 0.2$?

Sample	Temperature	Sample	Temperature
1	953	11	985
2	945	12	973
3	972	13	955
4	945	14	950
5	975	15	948
6	970	16	957
7	959	17	940
8	973	18	933
9	940	19	965
10	936	20	973

[12]

4.

a. What are the different types of inspection defined in the MIL-STD-105E sampling scheme? Describe each type and explain the conditions under which they are applied? Outline the switching rules that govern transitions between normal, tightened, and reduced inspection?

b. What are the inspection levels available in MIL-STD-105E? Explain the purpose of each level and the scenarios in which they are typically used?

c. A supplier ships a component in lots of size N = 5000. The AQL has been established for this product at 2.5%. Determine the normal, tightened, and reduced single and double sampling plans for this scenario across different general inspection levels as per MIL-STD-105E?

d. A product is supplied in lots of size N = 1000. The AQL has been specified at 15%. Identify the corresponding normal, tightened, and reduced single and double sampling plans for various special inspection levels according to MIL-STD-105E?

[12]

5. What are pre-control charts? Explain the working rules associated with pre-control charts.

[5]