INDIAN STATISTICAL INSTITUTE

MS in QMS

TEST ON STATISTICAL PROCESS CONTROL

Date: 17 November 2023 Time: 3 hours Maximum Marks: 50

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

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1. Answer the following questions briefly

    a. What is the appropriate course of action to take if a sample data point in a pre-control chart falls within the range defined by the pre-control line and the control limits?

    b. Determine the Average Sample Number (*ASN*) for a double sampling plan applied to a lot of size N = 10,000, where the fraction defective is p = 0.04. The parameters of the sampling plan include n_1 = 40, c_1 = 1, n_2 = 50, and c_2 = 3.

    c. Determine the lower control limit for a modified control chart designed to monitor the inner diameter of piston ring holes, aiming to maintain a minimum *Cpk* value of 1.4. The data is gathered in subgroups of 5, and the process has a mean of 74 mm and a standard deviation of 0.01 mm. Assume the specification on inner diameter is 74 ± 0.06 mm.

    d. In the context of the *MIL-STD* 105 *E* scheme, when ten consecutive lots are consistently placed under tightened inspection, what actions or measures should be taken as the appropriate course of action?

[8]

2. The weights (in ounces) of a dry bleach product are recorded from a manufacturing process and are provided in the table below. The desired target value is 16.22 ounces. Calculate the process sigma and establish a tabular cumulative sum (*CUSUM*) chart to promptly identify a shift of approximately 1.5 sigma

Sample Number	Value	Sample Number	Value
1	15.8	7	16.1
2	16.3	8	16.2
3	16.1	9	16.3
4	16.3	10	16.6
5	16.1	11	16.2
6	16.1	12	15.9

[12]

3. The table below presents data on the compressive strength of components produced through an injection molding process. Establish an Exponentially Weighted Moving Average (*EWMA*) control chart with a smoothing constant (lambda) of 0.2, $L = 3$, and a process target of 81.22. Based on the *EWMA* chart, assess whether the process appears to be in a state of statistical control.

Sample Number	Value	Sample Number	Value
1	83.0	6	75.3
2	88.6	7	74.5
3	85.7	8	79.2
4	80.8	9	80.5
5	83.4	10	81.2

[12]

4. Imagine a scenario where a single-sampling plan is employed for receiving inspection. The plan specifies a sample size of $n = 50$ and an acceptance criterion of $c = 3$. The supplier ships the products in lots, each containing $N = 3{,}000$ items. Create the Operating Characteristic (*OC*) curve for this sampling plan. Given that the producer's risk should be limited to 0.005 and the consumer's risk should be 0.1, determine the Acceptable Quality Level (*AQL*) and Lot Tolerance Percent Defective (*LTPD*) values.

[10]

5. Suppose a product is shipped in lots containing N = 5,000 units each. The receiving inspection process employs a single sampling plan with a sample size of $n = 40$ and an acceptance criterion of $c = 2$. Create an Average Outgoing Quality (*AOQ*) curve for this sampling plan and determine the Average Outgoing Quality Limit (*AOQL*). Additionally, construct the Average Total Inspection (*ATI*) curve for the same plan.

[10]

6. A supplier delivers components in lots, with each lot containing $N = 5{,}000$ items. The Acceptable Quality Level (*AQL*) for this product has been set at 1%. Determine the double-sampling inspection plans, including the normal, tightened, and reduced plans, based on *MIL STD 105E*, with the assumption that the general inspection level *II* is the appropriate choice for this situation.

[3]