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MST–014

M. SC. (APPLIED STATISTICS)

(MSCAST)

Term-End Examination

June, 2025

MST-014 : STATISTICAL QUALITY CONTROL AND TIME SERIES ANALYSIS

Time : 3 Hours *Maximum Marks : 50*

Note : *(i) Question No. **1** is compulsory.*

*(ii) Attempt any **four** questions from the remaining Question Nos. **2** to **6**.*

(iii) Use of scientific calculator (non-programmable) is allowed.

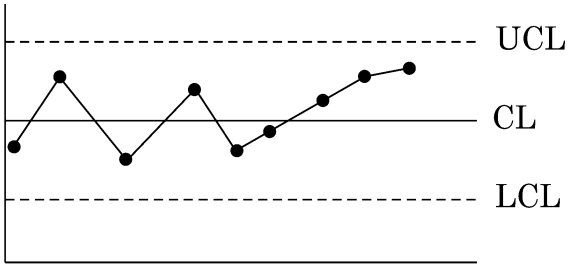
(iv) Symbols have their usual meanings.

1. State whether the following statements are True *or* False. Give reasons in support of your answers : 5×2=10

   (a) A system has three components connected in series having reliabilities

0.4, 0.7, 0.9, respectively, for a mission of 100 hours. To improve the reliability of the system, we should increase the reliability of the best component.

(b) If the control chart of a manufacturing process is as shown in figure below :



then the process is said to be out of control.

(c) If the probability of accepting a lot of satisfactory quality is 0.8124, then the producer's risk will be 0.8124.

(d) A correlogram suggests that the observations with larger lag are positively correlated.

(e) If $C_P < 1$, then the process is capable and products meet the desired specification.

2. A company produces dry cells. The cells will be considered satisfactory if their life is at least 25 hours. To test for the process to be under statistical control, a sample of 4 cells was drawn on 7 consecutive days. The results are as follows : 10

Day	Observations			
1	24	20	25	20
2	16	18	15	12
3	20	25	28	30
4	26	25	26	24
5	20	22	24	26
6	21	40	20	20
7	26	24	20	25

(i) Estimate the process mean and variability.

(ii) Determine the centre line and control limits of the appropriate control chart for controlling the process variability.

(iii) Plot the control charts. Comment on the status of the process in respect of the process variability.

(iv) If necessary, compute revised control limits.

(Given : $d_2 = 2.059$, $D_3 = 0$, $D_4 = 2.282$)

3. A company is producing copper wires of a given specification and the process in under statistical control. The process is sampled in samples of four wires of the same length and the tensile strengths of these wires are measured. The values of $\bar{X}$ and R are computed for each sample and producing $\bar{\bar{X}} = 23$ lbs and $\bar{R} = 3$ after 20 samples. If the specification limits are 25 ± 5, then : 10

(i) Estimate the potential capability index of the process.

(ii) Find the percentage of non-conforming wires.

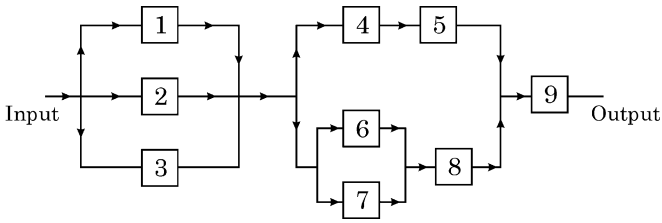
(Given : $d_2 = 2.059$, P(Z <– 2.06) = 0.0197, P(Z < 4.8) = 0)

4. A manufacturer of CFL tubes produces lots of 100 tubes. A buyer uses a double sampling plan with $n_1 = 5$, $C_1 = 0$, $n_2 = 15$ and $C_2 = 1$, to test the quality of the lots. Given that the incoming quality of a lot is 0.02. 10

   (i) Calculate the probabilities of accepting the lot on the first sample and on the second sample.

   (ii) Calculate the probability of final acceptance.

5. The configuration of a system is shown in the following block diagram : 10



Components 1, 2 and 3 are not identical and at least *two* components of this group must be available for system success. The remaining components are independent. The reliability of each component is given below for a mission of 400 hours :

$R_1 = 0.40$, $R_2 = 0.30$, $R_3 = 0.60$, $R_4 = 0.80$, $R_5 = 0.85$, $R_6 = 0.60$, $R_7 = 0.70$, $R_8 = 0.95$, $R_9 = 0.90$.

Evaluate the reliability of the system.

6. Consider the time series model : 10

$$y_t = 5 + 0.8y_{t-1} - 0.5y_{t-2} + \in_t$$

where $\in_t \sim N(0,2)$.

(i) Is this a autoregressive model ? Give reason.

(ii) Check whether it is stationary or not.

(iii) What are the mean and variance of the time series ?

(iv) Calculate autocorrelation function l_1 and l_2.

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