No. of Printed Pages : 5

MST–014

M. SC. (APPLIED STATISTICS)
(MSCAST)
Term-End Examination
December, 2024

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) If a component has the following hazard rate :

   $$\lambda(t) = 0.5t, \quad t \geq 0$$

   then the reliability of the component will be $e^{-t^2/4}$.

(b) The average total inspection (ATI) is equal to the average sample number (ASN), when the rejected lot is 100% inspected.

(c) For controlling the number of defects in a process, the p-chart is used.

(d) An auto-regressive AR(2) model :

$$X_t = 0.80 X_{t-1} - 0.60 X_{t-2} + a_t$$

is stationary.

(e) The C_{pk} index is better than the C_p index because it considers the shifting of variance.

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 and measured their lives. The results are as follows : 10

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

(i) Estimate the process mean and variability.

(ii) Determine the center line and control limits of the control chart for controlling the process mean.

(iii) Plot the control chart for mean. Comment on the status of the process in respect of the process mean.

(iv) If necessary, complete revised control limits.

(Given : $d_2 = 2.059$, $A_2 = 0.729$)

3. A manufacturer of men's jeans purchases zippers in lots of 1000. A single sampling plan with sample size 15 is used and it is decided that if in a lot, more than 2 zippers are found defective, the lot will be rejected. It is also decided that AQL = 0.4 and LTPD = 0.12. If there are 5% defective zippers in each lot, calculate : 10

(i) Probability of accepting the lot

(ii) Producer's risk

(iii) Consumer's risk

(iv) AOQ under acceptance and rectifying sampling plan

(v) ASN

Given : that :

$$\sum_{x=0}^{2} {}^{15}C_x (p)^x (1-p)^{15-x} = \begin{cases} 0.9639 & \text{for } p = 0.04 \\ 0.9797 & \text{for } p = 0.05 \\ 0.7346 & \text{for } p = 0.12 \end{cases}$$

4. The following data, give the average quarterly prices of a commodity for three years :

Year / Quarter	2015	2016	2017
I	13	14	15
II	12	16	15
III	15	18	18
IV	15	17	19

(i) Compute the seasonal indices using ratio to moving average method.

(ii) Do seasonal forces significantly influence the price of the commodity. 8+2

5. The failure density function of life of a component of a system (T) is given by :

$$f(t) = 0.2e^{-0.2t}; \quad t \geq 0$$

Calculate : 2+2+2+2+2

(i) Reliability of the system

(ii) Hazard rate

(iii) Mean time to failure

(iv) Median of the random variable 'T'

(v) What is life of the component if the reliability of 0.90 is desired ?

6. (a) Consider a time series model : 5

$$y_t = 10 + 0.2y_{t-1} + \in_t$$

where $\in_t \sim N(0, 1)$.

(i) Is this a stationary time series ?

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

(b) Define redundancy. 5

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