

M. SC. (APPLIED STATISTICS)
(MSCAST)

Term-End Examination

December, 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 (non-programmable) calculator 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 house gets electric power supply from a generator or solar panels which are connected in parallel configuration. The reliability of the generator is 0.30 and solar panel is 0.20. The probability that the house has power on any given day will be 0.944.
- (b) Under a rectifying sampling plan, the outgoing quality is the same as the incoming quality.
- (c) For controlling the proportion of defects in a process, we use the p -chart.
- (d) A time series is said to be stationary if the properties of one segment of the time series are different to the other segments of the time series.
- (e) A time series model :

$$y_t = \delta + \phi_1 y_{t-1} + \epsilon_t$$

is a moving average model of order 1.

2. A tomato sauce manufacturing company uses automatic machines to fill 500 ml tomato sauce bottles. A quality control inspector of the company collects 10 samples each of four observations at different times and measures the volume of each filled bottle. The observed data are given as follows :

Sample	Volume of Tomato Sauce per bottle (in ml)			
	Obs. 1	Obs. 2	Obs. 3	Obs. 4
1	497	500	501	499
2	504	510	506	510
3	499	500	510	505
4	520	530	525	520
5	500	501	505	507
6	501	500	501	500
7	505	505	507	503
8	510	510	510	510
9	505	510	501	505
10	515	510	505	505

- (i) Which control chart will be used to control the mean ?

- (ii) Calculate the control limits and plot the control chart. (Given $A_2 = 0.729$ for $n = 4$).
 - (iii) Check whether the process is under statistical control or not.
 - (iv) If it is out of control, obtain the revised control limits.
3. Suppose a tyre supplier ships tyres in lots of size 400 to the buyer. A sampling plan $n = 15$ and $c = 0$ is used for the lots inspection. The supplier and the buyer decided that $AQL = 0.01$ and $LTPD = 0.10$.
- 10
- (i) Which sampling plan (single or double) is used ?
 - (ii) What is the probability of accepting the lot of incoming quality 0.03 ?
 - (iii) If they increased the acceptance number from 0 to 1, then what will be the probability of accepting the lot ?
 - (iv) Find producer's risk.
 - (v) Find consumer's risk.

4. The failure density function of a random variable T is given by : 2+2+2+2+2

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

Calculate :

- (i) Reliability of the system
 - (ii) Hazard rate
 - (iii) Mean time to failure
 - (iv) Median of the random variable T
 - (v) What is the value of T , if the reliability of 0.96 is desired ?
5. (a) Consider a time series model : 6

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

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

- (i) Is this a stationary time series ?
- (ii) What are the mean and variance of the time series ?
- (iii) Calculate the autocorrelation function.

- (b) Compute 4-month moving average for the number of fire insurance claims given as follows : 4

Year	No. of Claims
2010	45
2011	50
2012	52
2013	53
2014	60
2015	62
2016	60
2017	56
2018	70
2019	72

6. (a) A company is manufacturing ball bearings. The customer specified the outside diameter of the ball bearing as 150 ± 4 mm. The quality control team proposes two processes for

manufacturing the ball bearings. After the process stability, the information on both processes is given as follows :

Process	Sample Size	No. of Samples	$\bar{\bar{X}}$	R
A	5	25	150	4
B	5	25	152	2

Calculate potential process capability index (C_p) assuming that the diameters are normally distributed and comment which one is capable to produce the ball bearings of specification limits.

Given : 6

$$d_2 = 2.326 \text{ for } n = 5$$

- (b) Describe simple average method of measuring seasonality. 4

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