2026

STATISTICS

(Major)

Paper : STA0600104

(Applied Statistics)

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions as directed : 1×8=8

(a) Fisher's ideal index number is the _____ of Laspeyres' and Paasche's index numbers.

(Fill in the blank)

(b) Linear trend of a time series indicates towards

(i) variable rate of growth

(ii) change in geometric progression

(iii) constant rate of growth

(iv) All of the above

(Choose the correct option)

(c) The control chart for fraction defective is called *np*-chart.

(Write True or False)

(d) What is meant by the statement—"NRR of a country is 1·65"?

(e) SQC takes care of the variation due to _____ causes.

(Fill in the blank)

(f) Define price relative.

(g) Mention two demerits of moving average method.

(h) In statistical quality control (SQC), when is *c*-chart used?

2. Answer any *six* questions from the following : 2×6=12

(a) Distinguish between additive model and multiplicative model in the analysis of time series.

(b) Define wholesale price index number.

(c) What do you understand by sampling inspection plans?

(d) Compare GRR and NRR as a measure of population growth.

(e) What do you understand by abridged life table?

(f) What are the important sources of demographic data?

(g) Distinguish between tolerance limit and specification limit.

(h) What do you mean by process control and product control?

(i) Define coefficient of determination (R^2).

(j) State few limitations of index numbers.

3. Answer any *four* questions from the following : 5×4=20

(a) What is a time series? Describe various methods of measuring trend. 2+3=5

(b) Prove that Marshall-Edgeworth index number lies between Laspeyres' and Paasche's index numbers. 5

(c) What is meant by SQC? State clearly the theoretical assumption behind the control chart technique. Give the reason of using 3σ limits in control chart. 1+2+2=5

(d) State the assumptions regarding the population under which a life table is constructed. Also mention the uses of a life table. 3+2=5

(e) Prove the following : 2+3=5

(i) $l_x = \sum_{i=x}^{\omega-1} d_i$ if $l_\omega = 0$

(ii) $T_x = \frac{1}{2} l_x + \sum_{t=1}^{\infty} l_{x+t}$

(f) Describe the multiple linear regression model for k variables mentioning the basic assumptions. 5

(g) Discuss the organization and functions of the central statistical organization (CSO). 5

(h) If $\overline{\overline{X}} = 0 \cdot 8768$, $\overline{R} = 0 \cdot 0026$ and given that $A_2 = 0 \cdot 58$, $D_3 = 0$ and $D_4 = 2 \cdot 115$, compute LCL and UCL for $\overline{X}$ and R-charts. 5

4. Answer any *two* questions from the following : 10×2=20

(a) Explain the least square method of measuring trend. Write down the normal equations for linear and quadratic trend equations.

Fit a straight line trend by the method of least squares to the following data : 5+5=10

Year	:	1966	1967	1968	1969
Production (in '000 tons)	:	20	30	40	20
Year	:	1970	1971	1972	
Production (in '000 tons)	:	50	60	80	

(b) What is cost of living index number? Describe briefly the important steps involved in its construction.

From the data given below, construct the cost of living index number : 5+5=10

Group	*Price relative*	*Weight*
Food	250	45
Rent	150	15
Clothing	320	20
Fuel and lighting	190	5
Misc.	300	15

(c) Distinguish between attributes and variables in the context of SQC. Discuss different types of attribute control charts. 10

(d) Discuss different fertility rates comparing their advantages and disadvantages. 10

(e) Estimate the coefficients of the relation

$$Y = a_1 + a_2 X_2 + a_3 X_3 + U$$

subject to the restriction $\hat{a}_2 = \hat{a}_3$, where data from 23 observations in deviation form yield

$$x'x = \begin{bmatrix} 20 & 0 \\ 0 & 40 \end{bmatrix}, \quad x'y = \begin{bmatrix} 15 \\ 25 \end{bmatrix}$$

Also, obtain a_2 and a_3 without any restriction. 10

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2026

STATISTICS

(Major)

Paper : STA0600204

(Bivariate/Multivariate Analysis, Stochastic Process and Computer Programming)

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions.

1. Answer the following as directed : 1×8=8

(a) Write down the probability density function of the bivariate normal distribution.

(b) An irreducible Markov chain contains

(i) one closed set

(ii) two closed sets

(iii) three closed sets

(iv) All of the above

(Choose the correct option)

(c) Use of more than one main( ) function in every C program is illegal.

(State True or False)

(d) The characteristic function of the multivariate normal distribution having mean vector $\underset{\sim}{O}$ and variance-covariance matrix I, is _____.

(Fill in the blank)

(e) State any one property of transition probability matrix.

(f) Hotelling T^2 can be regarded as multivariate analog of the square of univariate t.

(State True or False)

(g) Every program segment in C language must end with a _____.

(Fill in the blank)

(h) State the moment generating function of the bivariate normal distribution.

2. Answer any *six* of the following questions : 2×6=12

(a) Find cov $(A\underset{\sim}{X}, B\underset{\sim}{Y})$, where A and B are matrices of constant elements.

(b) Write down the logical operators available in C language.

(c) Define Markov chain with an example.

(d) If $(X, Y) \sim \text{BVN}(\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \rho)$, then state the marginal density functions of X and Y.

(e) Write down the operator precedence for arithmetic operators in C language.

(f) Write briefly on the specifications of Stochastic process.

(g) Let $\underset{\sim}{X} \sim N(\underset{\sim}{\mu}, \Sigma)$, where

$$\Sigma = \begin{pmatrix} 1 & -2 & 0 \\ -2 & 5 & 0 \\ 0 & 0 & 2 \end{pmatrix}, \quad \underset{\sim}{X} = (X_1\ X_2\ X_3)'$$

Are (X_1, X_2) and X_3 independent? Justify your answer.

(h) What is header file? Explain the need of the header file

include <stdio.h> 1+1=2

(i) State any two postulates for Poisson process.

(j) Define the following states of Markov chain :

Absorbing state, Persistent state

3. Answer any *four* of the following questions : 5×4=20

(a) If $\underset{\sim}{X} \sim N_p(\underset{\sim}{\mu}, \Sigma)$, then obtain the distribution of $\underset{\sim}{Z} = D\underset{\sim}{X}$ where D is a $p \times p$ non-singular matrix of constant elements.

(b) Define Poisson process. Prove the additive property of Poisson process. 1+4=5

(c) Describe the nested 'IF-ELSE' statement in C language with the help of a flowchart.

(d) Discuss the applications of Hotelling T^2 based on two samples.

(e) Given the following transition probability matrix :

$$P = \begin{pmatrix} q & p \\ p & q \end{pmatrix}, \text{ where } p+q=1$$

Find the probability of transition from state 0 to 1 in four steps.

(f) If $(X, Y) \sim \text{BVN}(0, 0, 1, 1, \rho)$, then show that $X+Y$ and $X-Y$ are independently distributed.

(g) Describe how to 'jump out' of a loop in C language.

(h) Suppose that the probability of a dry day (state 0) following a rainy day (state 1) is $\frac{1}{3}$ and the probability of a rainy day following a dry day is $\frac{1}{2}$. Given that May 1 is a dry day, find the probability that May 3 is also a dry day.

4. Answer any *two* of the following questions : 10×2=20

(a) Derive the p.d.f. of bivariate normal distribution as a particular case of multivariate normal distribution.

(b) (i) Write a detailed note on applications of Stochastic process. 5

(ii) If $\{N(t)\}$ is a Poisson process and $s < t$, then prove that

$$P\{N(s) = k / N(t) = n\} = \binom{n}{k}(s/t)^k (1 - s/t)^{n-k}$$ 5

(c) (i) Prove that Hotelling T^2 is invariant under a non-singular linear transformation. 6

(ii) For a bivariate normal distribution

$$f(x, y) = k \exp\left[-\frac{2}{3}(x^2 - xy + y^2 - 3x + 3y + 3)\right]$$

find the value of the constant k. 4

(d) (i) Write a detailed note on arithmetic operators available in C language. 4

(ii) Write a C program to determine the correlation coefficient for a bivariate distribution. 6

(e) (i) Write a short note on Markov chain as graphs. 4

(ii) Define matrix of transition probabilities. Let $\{X_t, t \geq 0\}$ be a Markov chain with three states 0, 1 and 2 with transition matrix

$$\begin{pmatrix} 3/4 & 1/4 & 0 \\ 1/4 & 1/2 & 1/4 \\ 0 & 3/4 & 1/4 \end{pmatrix}$$

and the initial distribution

$$P\{X_0 = i\} = \frac{1}{3}; \quad i = 0, 1, 2$$

Find—

$P(X_1 = 1 / X_0 = 2)$

$P(X_2 = 2, X_1 = 1 / X_0 = 2)$

and $P(X_2 = 2, X_1 = 1, X_0 = 2)$

1+1+2+2=6

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2026

STATISTICS

(Major)

Paper : STA0600304

(Operation Research)

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions.

1. Answer the following as directed : 1×8=8

(a) A finite optimal solution cannot be unique.

(State True or False)

(b) The solution to a transportation problem with m-sources and n-destinations is feasible, if the number of allocations is _____.

(Fill in the blank)

(c) "For critical activity, the total float value is positive."

(State True or False)

(d) A feasible solution of LPP should

(i) satisfy the problem constraints

(ii) optimise the objective function

(iii) satisfy the problem constraints and non-negativity restrictions

(iv) satisfy the non-negativity restrictions

(Choose the correct option)

(e) Under what situation individual replacement policy is better than group replacement policy?

(f) Identify the type of feasible region given by the following set of inequalities :

$$x - y \leq 1$$
$$x - y \geq 2 \quad , \quad x, \; y > 0$$

(i) A triangle

(ii) A rectangle

(iii) An unbounded region

(iv) An empty region

(Choose the correct option)

(g) What is a lead time?

(h) Economic order quantity (EOQ) results in

(i) equalisation of carrying cost and procurement cost

(ii) minimization of setup cost

(iii) reduced chances of stockouts

(iv) favourable procurement price

(Choose the correct option)

2. Answer any *six* questions from the following : 2×6=12

(a) What is a feasible solution of an LPP?

(b) What is general linear programming? Write it in equation.

(c) Write the names of different types of inventory models.

(d) State the mathematical formulation of a transportation problem.

(e) Define economic lot size problem and Economic Order Quantity (EOQ).

(f) Explain the objectives of replacement policies.

(g) Define storage cost and procurement cost.

(h) What is looping and dangling in a network?

(i) What is float? Give the names of different types of float.

(j) Write two limitations of LPP.

3. Answer any *four* from the following : 5×4=20

(a) A company has two plants, each of which produces and supplies two products : *A* and *B*. The plants can each work up to 16 hours a day. In plant 1, it takes 3 hours to prepare and pack 1000 gallons of *A* and 1 hour to prepare and pack one quintal of *B*. In plant 2, it takes 2 hours to prepare and pack 1000 gallons of *A* and 1·5 hours to prepare and pack a quintal of *B*. In plant 1, it costs ₹ 15,000 to prepare and pack 1000 gallons of *A* and ₹ 28,000 to prepare and pack a quintal of *B*, whereas these costs are ₹ 18,000 and ₹ 26,000 respectively in plant 2. The company is obliged to produce daily at least 10000 gallons of *A* and 8 quintals of *B*. Formulate this problem as an LPP.

(b) What is replacement? Describe some important replacement situations.

(c) Solve the following LPP graphically

Maximize $Z = x_1 + x_2$

subject to constrains

$$-2x_1 + x_2 \leq 1$$
$$x_1 \leq 2$$
$$x_1 + x_2 \leq 3$$
$$x_1, x_2 \geq 0$$

(d) Explain slack and float in network analysis.

(e) Explain transportation problem and show that it can be considered as an LPP.

(f) Define node and activity of a network diagram. What are the different categories of an activity? Describe the precedence network which are used in network models to show precedence requirements of the activities in the project.

(g) Discuss various costs associated with the inventory system.

(h) Explain ABC analysis.

4. Answer any *two* from the following : 10×2=20

(a) Describe the problem of replacement of items whose maintenance cost increases with time, when time is a continuous as well as discrete random variable. Assume that the value of money remains constant.

(b) Solve the following LPP by simplex method :

$$\text{Maximize } Z = 20x_1 + 10x_2 + 15x_3$$

subject to

$$3x_1 + 6x_2 + 4x_3 \leq 48$$
$$x_1 + 4x_2 \leq 18$$
$$x_2 + x_3 \leq 8$$

$$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0$$

(c) Discuss north-west corner rule and least cost method of a transportation problem.

(d) Prove that in the inventory problem of economic lot size with uniform demand and unequal times of production run, the optimal lot size for each production run is given by $Q^\circ = \sqrt{\frac{2DC_0}{C_1}}$ and the optimal total cost (TC_0) is given by $TC_0 = \sqrt{2DC_0C_1}$, all the symbols have their usual meaning.

(Continued)

(e) The following maintenance job has to be performed periodically on the heat exchangers in a refinery :

Task	*Description*	*Precedence*	*Duration* (hours)
A	Dismantle pipe connections	—	14
B	Dismantle header, closure and floating head front	*A*	22
C	Remove tube bundle	*B*	10
D	Clean bolts	*B*	16
E	Clean header and floating head front	*B*	12
F	Clean tube bundle	*C*	10
G	Clean shell	*C*	6
H	Replace tube bundle	*F, G*	8
I	Prepare shell pressure test	*D, E, H*	24
J	Prepare tube pressure test and make the final reassembly	*I*	16

Draw the network diagram and obtain the critical path. Also determine the total float and free float.

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