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# MSTE–002

## POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)

## Term-End Examination

## June, 2025

### MSTE-002 : INDUSTRIAL STATISTICS—II

*Time : 3 Hours* *Maximum Marks : 50*

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

*(ii) Attempt any* ***four*** *questions from the remaining question nos.* ***2*** *to* ***7****.*

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

*(iv) Use of Formulae and Statistical Tables Booklet for PGDAST is allowed.*

*(v) Symbols have their usual meanings.*

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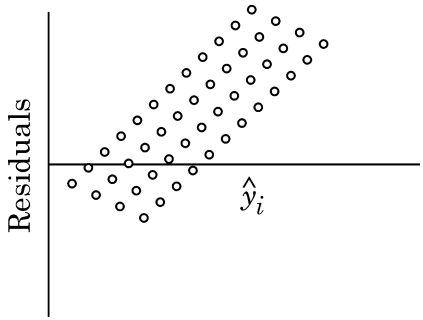
1. State whether the following statements are True *or* False. Give reasons in support of your answer : 5×2=10

   (a) For the following set of equations, the possible basic solutions are three :

$$2x_1 + 3x_2 + 4x_3 = 4$$

$$x_1 + x_2 + 2x_3 = 6$$

   (b) If a researcher obtained a residual plot as follows :




   then we can say that the assumption of homoscedasticity is violated.

   (c) Auto-correlation is the correlation between a dependent variable and an independent variable.

(d) The queuing model M/M/1 indicates that the system has M service channels with Poisson input and exponential distribution for services with parameter 1.

(e) The model given as follows :

$$X_t = a_t + 0.74a_{t-1} - 0.2a_{t-2}$$

is an auto-regressive model of order 2.

2. Use Simplex method to : 10

Maximise :

$$Z = 3x_1 + 2x_2 + 5x_3$$

subject to the constraints :

$$x_1 + 2x_2 + x_3 \leq 430$$

$$3x_1 + 2x_3 \leq 460$$

$$x_1 + 4x_3 \leq 420$$

$x_1, x_2, x_3 \geq 0$ .

3. (a) A company has 3 factories manufacturing the same product and the company has to ship the product to 4 agencies. The shipping cost per unit

product from each factory to each agency is as follows : 7

| Agency / Factory | $A_1$ | $A_2$ | $A_3$ | $A_4$ | Availability |
|---|---|---|---|---|---|
| A | 29 | 40 | 60 | 22 | 7 |
| B | 80 | 40 | 50 | 70 | 10 |
| C | 50 | 20 | 70 | 30 | 18 |
| Require-ment | 5 | 8 | 7 | 15 | 35 |

An analyst obtained a basic feasible solution as $x_{11} = 5$, $x_{14} = 2$, $x_{23} = 7$, $x_{24} = 3$, $x_{32} = 8$, $x_{34} = 10$. Check whether this solution is optimal using MODI method. If it is not optimal, then find the optimal solution and the corresponding optimal cost.

(b) In a departmental store, one cashier is there to serve the customers. The customers pick up their needs by themselves. The arrival rate is 9 customers for every 5 minutes and the cashier can serve 10 customers in

5 minutes. Assuming Poisson arrival rate and exponential service rate, find : 3

(i) average number of customers in the system.

(ii) average number of customers in the queue.

4. A manager has 4 jobs in hand to be assigned to 3 of his clerical staffs. Clerical staff differ in their efficiency. The efficiency is a measure of time taken by them to do various jobs. The manager wants to assign the duty to this staff so that the total time taken by the staff should be minimum. The time taken by each staff to do a particular job is as follows :

| **Job** | **Staff (Time taken in hours)** | | | | |
|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ |
| $J_1$ | 9 | 3 | 4 | 2 | 10 |
| $J_2$ | 12 | 10 | 8 | 11 | 9 |
| $J_3$ | 11 | 2 | 9 | 2 | 8 |
| $J_4$ | 8 | 2 | 10 | 3 | 7 |
| $J_5$ | 7 | 5 | 6 | 2 | 9 |

Assign the jobs to the clerical staffs using Hungarian method. 10

5. Apply the ratio to moving average method for calculating the seasonal indices for the time series data on production of a commodity (in hundred) of a firm given as follows : 10

| Year | $Q_1$ | $Q_2$ | $Q_3$ | $Q_4$ |
|---|---|---|---|---|
| 2019 | 480 | 410 | 600 | 650 |
| 2020 | 580 | 520 | 680 | 740 |
| 2021 | 600 | 560 | 750 | 780 |

Also find deseasonalised values.

6. (a) It is given that : 6

$\bar{X} = 6.97,\ SS_X = 6.40,\ n = 10,\ \sigma^2 = 5.42,$

$SS_{XY} = 61.81$

On the basis of the given information :

(i) Estimate regression coefficient $b$.

(ii) Find Var $(\hat{a})$ and Var $(\hat{b})$.

(iii) Test the hypothesis :

$H_0 : b = 8$ against $H_1 : b \neq 8$

at 5% level of significance.

(b) Consider an AR (2) process given as follows : 4

$$X_t = X_{t-1} - 0.5X_{t-2} + \in_t$$

Verify whether the series is stationary or not. Also find $\rho_1$ and $\rho_2$.

7. (a) The following data give the time needed to process Jobs A and B on five machines $M_1$, $M_2$, $M_3$, $M_4$ and $M_5$. Calculate the total time required to complete both jobs : 6

| | | | | | | |
|---|---|---|---|---|---|---|
| **Job A** | **Sequence** | $M_1$ | $M_2$ | $M_3$ | $M_4$ | $M_5$ |
| | **Time (in hours)** | 6 | 8 | 4 | 12 | 4 |
| **Job B** | **Sequence** | $M_2$ | $M_3$ | $M_1$ | $M_4$ | $M_5$ |
| | **Time (in hours)** | 10 | 8 | 6 | 4 | 12 |

(b) The production department of a company requires 3600 kg of raw material for manufacturing a particular

item per year. It has been estimated that the cost of carrying inventory is 25% of the investment cost in the inventories. The price of raw material is ₹ 10 per kg. Find the economic lot size to be ordered and the total minimum cost. 4

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