No. of Printed Pages : 7 **MSTE-002**

POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)

Term-End Examination

December, 2022

MSTE-002 : INDUSTRIAL STATISTICS—II

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* ***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 answers : $5 \times 2 = 10$

   (a) In the regression model $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$, the interpretation for β_2 is : amount of change in X_2 for a unit change in Y.

(b) The regression model

$$Y = \beta_0 + \beta_1 X_1^2 + \beta_2 X_2^3 + e$$

is not a multiple linear regression model.

(c) In time series, a random process is said to be stationary, if the joint distribution of $Y_{t_1}, Y_{t_2}, Y_{t_3}, ..., Y_{t_k}$ depends on the shifting of the origin of time by an amount J (> 0).

(d) Suppose region R is convex and (1, 2), (4, 5) $\in R$, then $\frac{1}{4}(1, 2) + \frac{3}{4}(4, 5) \in R$.

(e) If a fair die is thrown and X_n denotes outcome of the nth throw, $n \geq 1$, then $\{X_n : n \geq 1\}$ is a Bernoulli process.

2. (a) A firm plans to purchase at least 200 quintals of scrap containing high quality metal X and low quality metal Y. It decides that the scrap to be purchased must contain at least 100 quintals of X-metal and not more than 35 quintals of Y-metal. The firm can purchase the scrap from two suppliers (A and B) in unlimited

quantities. The percentage of X and Y metals in terms of weight in the scrap supplied in A and B is given as follows :

Metals	**Supplier A**	**Supplier B**
X	25%	75%
Y	10%	20%

The price of A's scrap is ` 200 per quintal and that of B is ` 400 per quintal. What quantity of scrap should the firm buy from each supplier so that the total cost is minimised ? 6

(b) Let $S = \{(x, y, z) : z \geq x^2 + y^2\}$. Check whether S is convex set or not. If it is convex, prove it, and if it is not convex, also explain it. 4

3. Use the Simplex method to solve the LLP given as follows : 10

Maximize :

$$Z = 3x_1 + 5x_2 + 4x_3$$

Subject to the constraints :

$$2x_1 + 3x_2 \leq 8$$

$$2x_2 + 5x_3 \leq 10$$

$$3x_1 + 2x_2 + 4x_3 \leq 15$$

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

4. (a) An airline company has drawn up a new flight schedule involving five flights. To assist in allocating five pilots to the flights, it has asked them to state their preference scores by giving each flight a number out of 10. The higher the number, the greater is the preference. Of these, certain flights are unsuitable to some pilots owing to domestic reasons. These have been marked with X.

What should be the allocation of the pilots to flights in order to meet as many preferences as possible ? 5

Flight Number

		1	2	3	4	5
	A	8	2	X	5	4
	B	10	9	2	8	4
Pilot	C	5	4	9	6	X
	D	3	6	2	8	7
	E	5	6	10	4	3

(b) Explain travelling salesman problem in general and with the help of an example. 5

5. The data related to the stock index price (the dependent variable) of a fictitious economy based on two independent variables : Interest rate and unemployment rate are given below :

Stock Index Price	**Interest Rate**	**Unemployment Rate**
800	1.8	6.2
1,100	2.1	5.1
1,200	2.2	5.5
1,300	2.6	5.2

Fit a multiple regression model and interpret each coefficient including intercept. Also show that the sum of the residuals is equal to zero. 10

6. Define each of the following with at least ***one*** example : 1+1+1+2+3+2

(i) Residual

(ii) Multicollinearity

(iii) Overfitting

(iv) Autoregressive process

(v) Autoregressive integrated moving average model

(vi) Strict stationary process

7. (a) Consider an autoregressive AR (2) model :

$$X_t = 0.80\, X_{t-1} - 0.70\, X_{t-2} + a_t$$

Verify whether the series is stationary or not. 5

(i) Obtain P_k for $k = 1, 2, 3, 4, 5$ and

(ii) Plot the correlogram.

(b) Determine the monthly seasonal indices for the data given as follows regarding production of a commodity for the years 2018, 2019, 2020 using the method of simple averages : 5

Months \ Years	Production (in Tonnes)		
	2018	**2019**	**2020**
January	140	170	180
February	120	160	170
March	125	150	160

April	160	180	180
May	170	180	170
June	170	170	190
July	170	190	180
August	140	140	160
September	130	1390	120
October	120	150	120
November	140	150	130
December	160	170	180