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MSTE-002

POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)

Term-End Examination

01111

December, 2017

MSTE-002 : INDUSTRIAL STATISTICS-II

Time : 3 hours *Maximum Marks : 50*

Note :

(i) *Attempt **all** questions. Questions no. 2 to 5 have internal choices.*

(ii) *Use of scientific calculator is allowed.*

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

(iv) *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. *5×2=10*

   (a) In Simplex method of an LPP, if any of the non-basic variables has 0 value in the net-evaluation row, the LPP has unbounded solution.

(b) If there are 3 equations having 4 variables in an LPP, then the maximum number of possible basic solutions is 4.

(c) In a regression model

$$Y = B_0 + B_1X_1 + e,$$

if $H_0 : B_1 = 0$ is not rejected, then the variable X_1 will remain in the model.

(d) The autocovariance and autocorrelation function of a moving average process is zero when lag 'k' is equal to order 'q' of the process.

(e) Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minutes between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minutes. The probability that a person arriving at the booth will have to wait is $\frac{2}{5}$.

2. (a) Find all the basic solutions and basic feasible solutions of the equations : 4

$$2x_1 + 3x_2 + 4x_3 = 5$$

$$3x_1 + 4x_2 + 5x_3 = 6$$

(b) An advertising agency wishes to reach two types of audiences : customers with annual income greater than one lakh rupees and customers with annual income of less than one lakh rupees. The total advertising budget is ₹ 2,00,000. One programme of TV advertising costs ₹ 50,000; one programme of radio advertising costs ₹ 20,000. For contract reasons, at least three programmes ought to be on TV and the number of radio programmes must be maximum 5. Surveys indicate that a single TV programme reaches 4,50,000 prospective customers in target audience A and 50,000 in target audience B. One radio programme reaches 20,000 prospective customers in target audience A and 80,000 in target audience B. Determine the media mix to maximise the total reach by graphical method. 6

OR

A dairy firm has three plants located in a State and the firm must fulfil the needs of its four distribution centres. Cost in hundreds of rupees of shipping one million litres from each plant to each distribution centre is given in the following table :

Distribution Centre / Plant	D_1	D_2	D_3	D_4	Supply
P_1	2	3	11	7	6
P_2	1	2	6	4	1
P_3	5	8	15	9	10
Demand	7	5	3	2	17

(a) Find initial basic feasible solution by Vogel's approximation method.

(b) Determine optimal solution by MODI method. *4+6*

3. A department has five employees with five jobs to be performed. The time (in hours) each employee will take to perform each job is given in the effectiveness matrix :

		Employee				
		I	II	III	IV	V
Job	A	10	5	13	15	16
	B	3	9	18	13	6
	C	10	7	2	2	2
	D	7	11	9	7	12
	E	7	9	10	4	12

How should the jobs be allocated, one per employee, so as to minimise the total employee hours ? *10*

OR

(a) Customers arrive at a window in a bank according to Poisson distribution with an average rate of 10 customers per hour. Service time per customer is exponential distribution with mean 5 minutes.

(i) What is the probability that an arriving customer will have to wait ?

(ii) What is the average length of the queue that is formed from time to time ?

(iii) How long is an arriving customer expected to wait before service ? *2+1+1*

(b) A ready-made garments manufacturer has to process five items through two stages of production (cutting and sewing). The time (in hours) taken for each of these items at different stages is given below :

Item	Processing time (in hours)	
	Cutting	Sewing
1	5	2
2	7	8
3	3	7
4	4	8
5	6	7

Find an order in which these items should be processed so as to minimise the total processing time. Also calculate various idle times. *6*

4. After investigation, it has been found that the demand for automobiles in a city depends mainly upon the number of families residing in that city. The sales of automobiles in the five cities for the year 2015 and the number of families in those cities are given below :

City	No. of Families (in lakhs)	Sale of Automobiles (in 000's)
A	70	25·2
B	75	28·6
C	80	30·2
D	60	20·3
E	90	35·4

(a) Fit a regression line taking sale of automobiles as the dependent variable and number of families as the independent variable.

(b) Comment on the goodness of fit of the regression line after calculating the coefficient of determination.

(c) Test whether the sale of automobiles is influenced by the number of families in that city. *5+2+3*

OR

A researcher is interested in developing a linear model for the electricity consumption of a household having one AC (1·5 ton) so that he can predict the electricity consumption. For this purpose, he selects 25 houses and records the electricity consumption (in kWh), size of house (in square feet) and AC hours for one month during summers. The results obtained are

$\hat{B}_0 = 22{\cdot}38$, $\hat{B}_1 = 1{\cdot}6161$, $\hat{B}_2 = 0{\cdot}0144$,

$SS(B_0) = 12526{\cdot}08$, $SS(B_0, B_1) = 17908{\cdot}47$,

$SS(B_0, B_2) = 17125{\cdot}23$, $SS(B_0, B_1, B_2) = 18079{\cdot}0$

$\hat{\sigma}^2 = 10{\cdot}53$, $SE(\hat{B}_1) = 0{\cdot}17$ and $SE(\hat{B}_2) = 0{\cdot}0035$

Build a regression model by selecting appropriate regressors in the model using Forward selection method. *10*

5. The following table gives the sales (in thousands) of washing machines for 16 quarters over four years :

Year \ Quarter	Q_1	Q_2	Q_3	Q_4
2011	48	40	60	65
2012	58	54	68	76
2013	60	58	75	78
2014	63	59	80	84

(a) Calculate the four quarters centred moving average values.

(b) Compute the seasonal indices for the four quarters. *5+5*

OR

Suppose a stationary time-series has 8 successive observations as follows :

14, 12, 13, 15, 10, 12, 15, 13

Calculate : *5+2+3*

(a) Autocovariances C_0, C_1 and C_2

(b) Autocorrelation coefficients r_1 and r_2

(c) Partial autocorrelation functions (pacf), pacf (1) and pacf (2)