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MSTE-002

POST GRADUATE DIPLOMA IN APPLIED STATISTICS (PGDAST)

Term-End Examination

00317

June, 2016

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 meaning.

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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) If there are 2 equations having 3 variables in an LPP, then the maximum number of possible basic solutions is 3.

(b) If the arrival rate is 6 per hour and service rate is 2 per hour, then the probability of no customer in queue is 0·7.

(c) The estimated value of 'b' in the regression line $Y = a + bX + e$ in terms of variance-covariance is $[\text{cov}(X, Y)/\sigma_X^2 \cdot \sigma_Y^2]$.

(d) Ratio to trend method is used to estimate the trend values in a time series.

(e) Given the trend equation, $\hat{Y} = 108 + 2{\cdot}88X$ with 1980 as origin and yearly data from 1980 to 1982, the estimated value for 1985 is 119·52.

2. A manufacturer produces two types of models M_1 and M_2. Each M_1 model requires 4 hours of grinding and 2 hours of polishing; whereas each M_2 model requires 2 hours of grinding and 5 hours of polishing. The manufacturer has 2 grinders and 3 polishers. Each grinder works for 40 hours a week and each polisher works for 60 hours a week. Profit on M_1 model is ₹ 3 and on M_2 model, it is ₹ 4. Whatever is produced in a week is sold in the market.

(a) Formulate the problem mathematically to maximise the profit; and

(b) Using the graphical method, determine how the manufacturer should allocate his production capacity to the two types of models so that he may make the maximum profit in a week. *3+7*

OR

Use Big-M method to solve the following LPP : *10*

Maximise $4x_1 + 3x_2$

subject to the constraints :

$$2x_1 + x_2 \geq 10$$

$$-3x_1 + 2x_2 \leq 6$$

$$x_1 + x_2 \geq 6$$

$$x_1 \geq 0 \text{ and } x_2 \geq 0$$

3. A departmental head has four subordinates and four tasks to be performed. The subordinates differ in efficiency and the tasks differ in their intrinsic difficulties. His estimate of time for each man to perform each task, is given in the table below :

	Men			
Tasks	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

How should the tasks be allocated to each subordinate so as to minimise the total man-hours ? *10*

OR

(a) A book binder has one printing press, one binding machine and the manuscripts of a number of different books. The time required to perform the printing and binding operations for each book are given below :

Book	Printing time (in hours)	Binding time (in hours)
1	30	80
2	120	100
3	50	90
4	20	60
5	90	30
6	110	10

Determine the order in which the books should be produced, in order to minimise the total time. *5*

(b) In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter-arrival time follows an exponential distribution and the service time distribution is also exponential with an average of 36 minutes, calculate (i) the mean queue size; and (ii) the probability that the queue size exceeds 10. If the input of the train increases to an average of 33 per day, what will the change in (i) and (ii) be ? *5*

4. A study was conducted on the effect of temperature (X) on the yield of a chemical process (Y). The following data (in coded form) were collected :

X	Y
– 5	– 1
– 4	5
– 3	4
– 2	7
– 1	10
0	8
1	9
2	13
3	14
4	13
5	18

(a) Assuming a model Y = a + bX + e, what are the least square estimates of a and b ? *4*

(b) Calculate the variances of the estimated regression coefficients. *3*

(c) Test the hypothesis that the temperature (X) has no effect on the yield (Y) of the chemical process, i.e., $H_0 : b = 0$; against $H_1 : b \neq 0$ at $\alpha = 0{\cdot}05$. *3*

OR

A statistician collected data of 78 values with two independent variables X_1 and X_2. The four models considered are

(a) $Y = B_0 + e$,

(b) $Y = B_0 + B_1X_1 + e$,

(c) $Y = B_0 + B_1X_1 + B_2X_2 + e$, and

(d) $Y = B_0 + B_2X_2 + e$.

The results are $SS(B_0) = 652{\cdot}42$, $SS(B_0,B_1) = 679{\cdot}34$, $SS(B_0,B_2) = 654{\cdot}00$, $SS(B_0,B_1,B_2) = 687{\cdot}79$ and $\hat{\sigma}^2 = 0{\cdot}91$. Find the additional contribution of (i) X_2 over X_1, and (ii) X_1 over X_2. Test whether their inclusion in the model is justified. *5+5*

5. Determine the seasonal indices for the data given below for the average quarterly prices of a commodity for four years : *10*

Years	Quarter I	Quarter II	Quarter III	Quarter IV
2009	554	590	616	653
2010	472	501	521	552
2011	501	531	553	595
2012	403	448	460	480

OR

(a) Fifteen successive observations on a stationary time series are as follows :

34, 24, 23, 31, 38, 34, 35, 31, 29, 28, 25, 27, 32, 33, 30

Calculate r_1, r_2, ..., r_5 and plot the correlogram. *6*

(b) For the model

$$(1 - 0{\cdot}2B)(1 - B) X_t = (1 - 0{\cdot}5B) a_t ,$$

find p, d, q, and express it as ARIMA (p, d, q). Determine whether the process is stationary. *4*