*Total number of printed pages–7*

**3 (Sem–5/CBCS) STA HE 1**

**2023**

# STATISTICS

( Honours Elective )

Paper : STA–HE–5016

***( Operations Research )***

*Full Marks : 60*

Time : Three hours

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

1. Answer the following as directed : 1×7=7

   *(a)* Operations research came into existence

   *(i)* in the year 1949

   *(ii)* in the military context

   *(iii)* during World War I

   *(iv)* during World War II

   *(Choose the correct option)*

*Contd.*

(b) 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)*

(c) The general LPP is said to be in standard form if

(i) the constraints are strict equations

(ii) the constraints are inequalities of $\leq$ type

(iii) the constraints are inequalities of $\geq$ type

(iv) the decision variables are unrestricted in sign

*(Choose the correct option)*

(d) The number of non-negative variables in a basic feasible solution to a transportation problem with $m$ sources and $n$ destinations is

(i) $mn$

(ii) $m + n$

(iii) $m + n - 1$

(iv) $m - n + 1$

*(Choose the correct option)*

(e) A game is said to be fair, if

(i) both upper and lower values of the game are same and zero

(ii) upper and lower values of the game are not equal

(iii) upper value is more than lower value of the game

(iv) None of the above

*(Choose the correct option)*

(f) When maximin and minimax values of the game are same then

(i) there is a saddle point

(ii) solution does not exist

(iii) strategies are mixed

(iv) None of the above

*(Choose the correct option)*

(g) Define lead time.

2. Answer the following questions : 2×4=8

(a) For the system $AX = b$ of $m$ linear equations in $n$ unknowns $(n > m)$ with rank $(A) = m$, define a basic solution. Hence define basic feasible solution.

*Contd.*

(b) Define the following terms :

(i) Pure strategy

(ii) Mixed strategy

(c) Define Economic Lot Size Problem and Economic Order Quantity (EOQ).

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

3. Answer ***any three*** from the following questions : 5×3=15

(a) A manufacturer of furniture makes two products – chairs and tables. Processing of these product is done on two machines *A* and *B*. A chair requires 2 hours on machine *A* and 6 hours on machine *B*. A table requires 5 hours on machine *A* and no time on machine *B*. There are 16 hours of time per day available on machine *A* and 30 hours on machine *B*. Profit gained by manufacturer from a chair and a table is Re. 1 and Rs.5 respectively. Formulate the above problem as a LPP.

(b) Define inventory. What are the different types of inventory in industries ? State the various types of costs associated with inventory control. Explain *any one* of them. 1+1+1+2=5

(c) Explain North-West corner rule for finding an initial basic feasible solution for a transportation problem.

(d) Find all basic solutions of the following system of equations

$$2x_1 + x_2 + 4x_3 = 11,\ 3x_1 + x_2 + 5x_3 = 14$$

Are they degenerate ? Also find the basic feasible solutions.

(e) Explain the maximin and minimax strategies used in game theory.

*Answer the following :* 10×3=30

4. Answer **either** *(a)* **or** *(b)* from the following :

(a) Solve the following LPP by simplex method : 10

Maximize $Z = 5x_1 + 3x_2$

subject to the constriants

$$\begin{aligned} x_1 + x_2 &\leq 2 \\ 5x_1 + 2x_2 &\leq 10 \\ 3x_1 + 8x_2 &\leq 12 \\ x_1, x_2 &\geq 0 \end{aligned}$$

(b) (i) State the general linear programming problem. 4

(ii) Solve the following LPP graphically :

Maximize $Z = x_1 + x_2$

subject to the constraints

$$\begin{aligned} -2x_1 + x_2 &\leq 1 \\ x_1 &\leq 2 \\ x_1 + x_2 &\leq 3 \\ x_1, x_2 &\geq 0 \end{aligned}$$

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5. Answer **either** *(a)* **or** *(b)* :

*(a)* *(i)* Explain Vogel's approximation method of finding an initial solution for a transportation problem. 5

*(ii)* Determine an initial basic feasible solution to the following transportation problem using North-West corner rule where $O_i$ and $D_j$ represent $i^{th}$ origin and $j^{th}$ destination respectively. 5

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $O_1$ | 6 | 4 | 1 | 5 | 14 |
| $O_2$ | 8 | 9 | 2 | 7 | 16 |
| $O_3$ | 4 | 3 | 6 | 2 | 5 |
| Demard | 6 | 10 | 15 | 4 | 35 |

(b) Obtain the EOQ of an inventory model where production is instantaneous, shortages are not allowed and rate of demand is different in different production cycles. 10

6. Answer **either** (a) **or** (b) :

(a) (i) What is saddle point ? Explain the method for detecting a saddle point. 5

(ii) Explain zero-sum two person game giving suitable example. 5

(b) (i) A manufacturer has to supply his customer with 600 units of his product per year. Shortages are not allowed and the storage cost amounts to Rs.0.60 per unit per year. The set up cost per run is Rs.80.00. Find the optimum run size and minimum average yearly cost. 4

(ii) Explain ABC analysis. 6

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