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10CS/IS661

Sixth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Operations Research

Time: 3 hrs. Max. Marks:100

Note: *Answer FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. What is operations research? Briefly explain the various phases of operations research study. **(08 Marks)**

b. A person requires minimum 10, 12 and 12 units of chemicals for A, B and C respectively for his garden. A liquid product contains 5, 2 and 1 units of A, B and C respectively per jar. A dry product contains 1, 2 and 4 units of A, B and C per jar. If the liquid product sells for Rs.3 per jar and dry product sells for Rs.2 per jar, how many of each should be purchased in order to minimize the cost and meet requirement. **(06 Marks)**

c. Use graphical method to solve the following :

$$\text{Max } z = 100x_1 + 40x_2$$

Subjected to $5x_1 + 2x_2 \le 1000$

$3x_1 + 2x_2 \le 900$

$x_1 + 2x_2 \le 500$

$x_1, x_2 \ge 0$ **(06 Marks)**

2 a. Solve the following LPP by using simplex method

$$\text{Max } z = 3x_1 + 2x_2 + 5x_3$$

Subjected to $x_1 + 2x_2 + x_3 \le 430$

$3x_1 + 2x_2 \le 460$

$x_1 + 4x_2 \le 420$

$x_1, x_2, x_3 \ge 0$ **(10 Marks)**

b. Explain the steps involved in setting up of a simplex method. **(10 Marks)**

3 a. Solve the following LPP by using Big M method:

$$\text{Max } z = -2x_1 - x_2$$

Subjected to $3x_1 + x_2 = 3$

$4x_1 + 3x_2 \ge 6$

$x_1 + 2x_2 \le 4$

$x_1, x_2 \ge 0$ **(10 Marks)**

b. Solve the following LPP by using two-phase method:

$$\text{Max } z = 5x_1 + 8x_2$$

Subjected to $3x_1 + 2x_2 \ge 3$

$x_1 + 4x_2 \ge 4$

$x_1 + x_2 \le 5$

$x_1, x_2 \ge 0$ **(10 Marks)**

4 a. Explain the steps involved in revised simplex method. (10 Marks)

b. Use revised simplex method to solve the following LPP: (10 Marks)

Min $z = x_1 + x_2$

Subjected to $x_1 + 2x_2 \geq 7$

$4x_1 + x_2 \geq 6$

$x_1, x_2 \geq 0$

PART – B

5 a. Explain the role of duality theory in sensitivity analysis. (10 Marks)

b. Write the dual of the following LPP:

i) Max $z = 3x_1 - x_2 + x_3$

Subjected to $4x_1 - x_2 \leq 8$

$8x_1 + x_2 + 3x_3 \geq 12$

$5x_1 - 6x_3 \leq 13$

$x_1, x_2, x_3 \geq 0$

ii) Min $z = 2x_2 + 8x_3$

Subjected to $3x_1 + x_2 \geq 12$

$2x_1 + x_2 + 6x_3 \leq 6$

$5x_1 - x_2 + 3x_3 = 4$

$x_1, x_2, x_3 \geq 0$ (10 Marks)

6 a. Find the initial solution to the following transportation problem using VAM: (10 Marks)

		Destination				
		D_1	D_2	D_3	D_4	Supply
Factory	F_1	3	3	4	1	100
	F_2	4	2	4	2	125
	F_3	1	5	3	2	75
	Demand	120	80	75	25	300

b. Explain Hungarian algorithm with example. (10 Marks)

7 a. Define the following with respect to games: (03 Marks)

i) Pay off ii) Strategy iii) Saddle point.

b. Solve the following game by graphical method: (07 Marks)

$$\text{Player A} \begin{bmatrix} 3 & -3 & 4 \\ -1 & 1 & -3 \end{bmatrix} \quad \text{Player B}$$

c. Solve the following game by dominance property: (10 Marks)

$$\text{Player A} \begin{bmatrix} 2 & -2 & 4 & 1 \\ 6 & 1 & 12 & 3 \\ -3 & 2 & 0 & 6 \\ 2 & -3 & 7 & 7 \end{bmatrix} \quad \text{Player B}$$

8 Write short notes on: (20 Marks)

a. Genetic algorithm.

b. Metaheuristics.

c. Tabu search algorithm.

d. Simulated annealing algorithm.

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10CS/IS661

Sixth Semester B.E. Degree Examination, June/July 2015
Operations Research

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define : i) Feasible solution ii) Feasible region iii) Optimal solution. **(06 Marks)**

b. A manufacturer produces three models I, II, III of certain product using raw materials A and B. The following table gives the data for the problem.

Raw material	Requirement per unit			Availability
	I	II	III	
A	2	3	5	4000
B	4	2	7	6000
Minimum Demand	200	200	150	-
Profit per unit (Rs)	30	20	50	-

Formulate the problem as a linear program model. **(07 Marks)**

c. Using graphical method solve the LPP

Maximize $Z = 5x_1 + 4x_2$

Subject to $6x_1 + 4x_2 \le 24$

$x_1 + 2x_2 \le 6$

$-x_1 + x_2 \le 1$

$x_2 \le 2,\ x_1, x_2 \ge 0$ **(07 Marks)**

2 a. Define slack variable and surplus variable. **(04 Marks)**

b. Solve the following LPP by simplex method :

Maximize $z = 6x_1 + 8x_2$

Subject to $2x_1 + 8x_2 \le 16$

$2x_1 + 4x_2 \le 8$

$x_1, x_2 \ge 0$ **(10 Marks)**

c. Explain the following :

i) A standard form of the LPP

ii) Basic solution of a LPP

iii) Degeneracy and un bounded solution with respect to simplex methods. **(06 Marks)**

3 a. Solve the following LPP by Charne's big M method

Maximize $z = 20x_1 + 10x_2$

Subject to : $x_1 + x_2 = 150$

$x_1 \le 40$

$x_2 \ge 20$

where $x_1, x_2 \ge 0$ **(15 Marks)**

b. Write procedure to solve LPP of two phase simplex method. **(05 Marks)**

4 a. Explain the computational procedure of revised simplex method in standard form. **(10 Marks)**

b. Explain the following:

i) Weak duality property ii) Strong duality property

iii) Complementary solutions property iv) Complementary optimal solution property. **(10 Marks)**

PART – B

5 a. User dual simplex method and solve the following LPP:

Maximize $z = 3x_1 + x_2$

Subject to : $x_1 + x_2 \geq 1$

$2x_1 + 3x_2 \geq 2$

$x_1, x_2 \geq 0$ **(10 Marks)**

b. Explain the role of duality theory in sensitivity analysis. **(05 Marks)**

c. Write any five key relationships between the primal and the dual problems. **(05 Marks)**

6 a. Find an initial solution to the following transportation problem using VAM

Destination

Origin	D_1	D_2	D_3	D_4	D_5	Supply
O_1	7	6	4	5	9	40
O_2	8	5	6	7	8	30
O_3	6	8	9	6	5	20
O_4	5	2	7	8	6	10
Demand	30	30	15	20	5	

(10 Marks)

b. Solve the following assignment problem

Jobs

Machine	J_1	J_2	J_3	J_4	J_5
M_1	11	17	8	16	20
M_2	9	7	12	6	15
M_3	13	16	15	12	16
M_4	21	24	17	28	26
M_5	14	10	12	11	15

(10 Marks)

7 a. Define the following with respect to games

i) Pay – off ii) Zero – sum game iii) Saddle point **(03 Marks)**

b. Solve the following game graphically

Player B

Player A	B_1	B_2	B_3
A_1	2	6	22
A_2	16	10	24

(07 Marks)

c. Solve the following game:

		B			
		I	II	III	IV
A	1	20	15	12	35
	2	25	14	8	10
	3	40	2	19	5
	4	5	4	11	0

(10 Marks)

8 a. Write the outline of a basic table search algorithm. Explain it with the help of a minimum spanning tree problem with constraints. **(10 Marks)**

b. Write short notes on : i) simulated annealing ii) Genetic algorithms. **(10 Marks)**

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10CS/IS661

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Operations Research

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART - A

1 a. Define Operation Research. List and briefly explain the phases of Operations Research. **(08 Marks)**

b. Solve the following LPP by graphical method.

Min $Z = 20x_1 + 10x_2$

Constraints $x_1 + 2x_2 \leq 40$

$3x_1 + x_2 \geq 30$

$4x_1 + 3x_2 \geq 60$

$x_1, x_2 \geq 0$ **(06 Marks)**

c. A farmer has 100 acres of form. He can sell all tomatoes, lettuce or radishes and can raise the price to obtain Re 1.00 per kg for tomatoes, Rs 0.75 ahead for lettuce and Rs 2.00 per kg for radishes. The average yield per acre is 2000kg of tomatoes, 3000 heads of lettuce, and 1000 kgs of radishes. Fertilizers are available at Rs 0.50 per kg and the amount required per acre is 100 kgs each for tomatoes and lettuce and 50 kgs for radishes. Labour required for sowing, cultivating and harvesting per acre is 5 man – days for tomatoes and radishes and 6 man – days for lettuce. A total of 400 man – days of labour are available at Rs 20.00 per man – day. Formulate this problem as a linear programming model to maximize the farmer's total profit. **(06 Marks)**

2 a. Explain 6 basic assumptions of Simplex method. **(06 Marks)**

b. Solve the following LPP using Simplex method. **(10 Marks)**

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

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

$3x_1 + 2x_3 \leq 460$

$x_1 + 4x_2 \leq 420$

$x_1, x_2, x_3 \geq 0.$

c. Write a brief note on 'Unbounded solution' and 'Infeasible solution' of Simplex method. **(04 Marks)**

3 a. Solve using 'Big – M' method.

Min $Z = 12x_1 + 20x_2$

Constraints $6x_1 + 8x_2 + \geq 100$

$7x_1 + 12x_2 \geq 120$

$x_1, x_2 \geq 0.$ **(10 Marks)**

b. Solve using '2 – Phase' method.

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

Constraints $2x_1 + x_2 - 6x_3 = 20$

$6x_1 + 5x_2 + 10x_3 \leq 76$

$8x_1 - 3x_2 + 6x_3 \leq 50$

$x_1, x_2, x_3 \geq 0.$ **(10 Marks)**

4 a. List any 5 differences between Simplex (Primal) and Dual Simplex method. **(05 Marks)**

b. Give the dual of the following problem

Max $Z = x + 2y$

Constraints $2x + 3y \geq 4$

$3x + 4y = 5$; $x \geq 0$, y is unrestricted. **(05 Marks)**

c. Use 'Revised Simplex method' to solve the following LPP.

Max $Z = x_1 + 2x_2$

Constraints $x_1 + x_2 \leq 3$

$x_1 + 2x_2 \leq 5$

$3x_1 + x_2 \leq 6$; $x_1, x_2 \geq 0$. **(10 Marks)**

PART - B

5 a. Use 'Dual Simplex method' to solve the following LPP

Min $Z = 5x_1 + 6x_2$

Constraints $x_1 + x_2 \geq 2$

$4x_1 + x_2 \geq 4$

$x_1, x_2 \geq 0$. **(10 Marks)**

b. Solve the following LPP using 'Branch and Bound' technique.

Max $Z = 7x_1 + 9x_2$

Constraints $-x_1 + 3x_2 \leq 6$

$7x_1 + x_2 \leq 35$

$x_2 \leq 7$

$x_1, x_2 \geq 0$. **(10 Marks)**

6 a. Find an optimal solution after obtaining the IBFS using 'Vogels Approximation method'. **(10 Marks)**

	W_1	W_2	W_3	W_4	Capacity
F_1	19	30	50	10	07
F_2	70	30	40	60	09
F_3	40	08	70	20	18
Demand	05	08	07	14	34

b. Solve the given Assignment problem, so that the total cost is minimized. **(10 Marks)**

	M_1	M_2	M_3	M_4
J_1	05	07	11	06
J_2	08	05	09	06
J_3	04	07	10	07
J_4	10	04	08	03

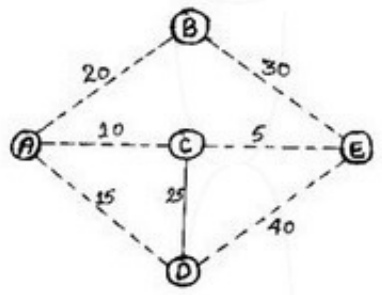
7 a. Use graphical method to solve the following game **(10 Marks)**

$$\begin{array}{c} \\ A \\ \\ \end{array} \begin{array}{c} B \\ \begin{bmatrix} 1 & 3 & 11 \\ 8 & 5 & 2 \end{bmatrix} \end{array}$$

b. A firm owner is seriously considering of drilling a farm well in the past, only 70% of wells drilled were successful at 200 Feet of depth. Moreover on finding no water at 200 Ft., some persons drilled it further upto 250 Ft but only 20% struck water at 250 Ft. The prevailing cost of drilling is Rs 50/Foot. The farm owner estimated that in case he does not get his own wells he will have to pay Rs 15,000 over the next 10 years in PV term, to buy water from the neighbor. The following decisions can be optimal : i) Do not drill any well ii) Drill upto 200 Ft and iii) If no water is found at 200 Ft, drill further upto 250 Ft.

Draw an appropriate decision tree and determine the farm owner's strategy under Expected Monetary Value (EMV) approach. **(10 Marks)**

8 a. Use Tabu search algorithm to find an optimal solution of the following illustration.
Constraint 1 : Link AD can be included only if link DE also included.
Constraint 2 : At most one of the three links AD, CD and AB can be included. Charge a penalty of Rs 100 if Constraint 1 is violated. Charge a penalty of Rs 100 if two of the three links specified in constraints 2 are included. Increase this penalty to Rs 200 if all the three of links are included. **(10 Marks)**



b. Write a brief note on :
i) Simuted Annealing ii) Genetic Algorithm. **(10 Marks)**

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10CS/IS661

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Operations Research

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. What are different phases of operation research? Briefly explain phases of operations research study. **(08 Marks)**

b. Old hens can be brought at ₹50/each but young ones cost ₹100/- each. The old hens lay 3 eggs/week and young ones lay 5 eggs/week. Each egg sold at ₹2/-. A hen costs ₹5/week to feed. If a person has only ₹3000/- to spend for hens. Formulate the problem to decide how many of each kind of hen should he buy? Assume that he cannot house more than 50 hens. **(06 Marks)**

c. Define the following with respect to a LPP. Give example for each :
(i) Feasible solution
(ii) Feasible region
(iii) Infeasible solution **(06 Marks)**

2 a. Solve the following LPP by using graphical method:
Maximize $Z = 5x_1 + 4x_2$
Subject to $6x_1 + 4x_2 \le 24$
$x_1 + 2x_2 \le 6$
$-x_1 + x_2 \le 1$
$x_2 \le 2$
where $x_1, x_2 \ge 0$ **(08 Marks)**

b. What are methods of post optimality analysis of LPP? **(02 Marks)**

c. Solve the following LPP by using Simplex method.
Maximize $Z = 5x_1 + 3x_2$
Subject to $x_1 + x_2 \le 2$
$5x_1 + 2x_2 \le 10$
$3x_1 + 8x_2 \le 12$
where $x_1, x_2 \ge 0$ **(10 Marks)**

3 a. Solve the following by using Big-M method.
Maximize $Z = 6x_1 + 4x_2$
Subject to $2x_1 + 3x_2 \le 30$
$3x_1 + 2x_2 \le 24$
$x_1 + x_2 \ge 3$
where $x_1, x_2 \ge 0$ **(10 Marks)**

b. Solve the following LPP by using Two-phase Simplex method.
Maximize $Z = 5x_1 + 3x_2$
Subject to $2x_1 + x_2 \le 1$
$x_1 + 4x_2 \ge 6$
where $x_1, x_2 \ge 0$ **(08 Marks)**

c. Mention software packages used to solve LPP. **(02 Marks)**

4 a. Solve the following LPP by using revised Simplex method.
Maximize $Z = 2x_1 + x_2$
Subject to $3x_1 + 4x_2 \leq 6$
$6x_1 + x_2 \leq 3$
where $x_1, x_2 \geq 0$ **(10 Marks)**

b. Explain the following terms :
(i) Weak duality property (ii) Strong duality property (iii) Complimentary solution property. **(06 Marks)**

c. Write the dual of the following :

(i) Maximize $Z = 4x_1 + 10x_2 + 25x_3$
Subject to $2x_1 + 4x_2 + 8x_3 \leq 25$
$4x_1 + 9x_2 + 8x_3 \leq 30$
$6x_1 + 2x_3 \leq 40$
where $x_1, x_2, x_3 \geq 0$

(ii) Minimize $Z = 20x_1 + 40x_2$
Subject to $2x_1 + 20x_2 \geq 40$
$20x_1 + 3x_2 \geq 20$
$4x_1 + 20x_2 \geq 30$
where $x_1, x_2 \geq 0$

(04 Marks)

PART – B

5 a. Briefly explain about sensitivity analysis. **(05 Marks)**

b. Explain primal-dual relationship with an example. **(05 Marks)**

c. Solve the following by using dual simplex method.
Minimize $Z = 2x_1 + 2x_2 + 4x_3$
Subject to $2x_1 + 3x_2 + 5x_3 \geq 2$
$3x_1 + x_2 + 7x_3 \leq 3$
$x_1 + 4x_2 + 6x_3 \leq 5$
where $x_1, x_2, x_3 \geq 0$ **(10 Marks)**

6 a. Solve the following transportation problem by using (i) North-West corner method (ii) Vogel's approximation method.

		Destination 1	2	3	4	Supply
Source	1	3	1	7	4	300
	2	2	6	5	9	400
	3	8	3	3	2	500
Demand		250	350	400	200	

(10 Marks)

b. Solve the following assignment problem.

		Subject S_1	S_2	S_3	S_4
Professor	P_1	2	10	9	7
	P_2	15	4	14	8
	P_3	13	14	16	11
	P_4	3	15	13	8

Find the schedule so as to minimize the total subject preparation time for all subjects.
(10 Marks)

7 a. Explain following terms with example :
(i) Saddle point (ii) Value of the game (iii) Payoff matrix **(06 Marks)**

b. Solve the following game by dominance principle :

		Player B				
		1	2	3	4	5
Player A	1	2	5	10	7	2
	2	3	3	6	6	4
	3	4	4	8	12	1

(07 Marks)

c. Solve optimally using graphical method by considering the payoff matrix of player A as shown below:

		Player B				
		1	2	3	4	5
Player A	1	3	6	8	4	4
	2	-7	4	2	10	2

(07 Marks)

8 Explain the following terms:
a. Metaheuristics, advantages and disadvantages
b. Tabu search algorithm
c. Genetic algorithm
d. Simulated annealing **(20 Marks)**

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10CS/IS661

Sixth Semester B.E. Degree Examination, June/July 2017
Operations Research

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions, selecting atleast TWO questions from each part.*

PART – A

1 a. Define operations research. Explain the phases of operations research. **(08 Marks)**

b. A firm can be produced 3 types of body sweaters say A, B and C. Three kinds of wool are required for it, say red wool, green wool and blue wool. One unit of type A sweater needs 2 yards of red wool and 3 yards of blue wool, one unit of type B sweater needs 3 yards red wool 2 yards of green wool and 2 yards of blue wool. One unit of type C sweater needs 5 yards of green wool and 4 yards of blue wool. The firm has only a stock of 80 yards of red wool, 100 yards of green wool and 150 yards of blue wool. It is assumed that the income obtained from each unit of type A sweater is Rs. 30, type B sweater is Rs. 50 and type C sweater is Rs. 40. Formulate this problem as LPP. **(05 Marks)**

c. Using graphical method solve the following :

Maximize $Z = 3000x_1 + 2000x_2$

Subject to $x_1 + 2x_2 \le 6$

$2x_1 + x_2 \le 8$

$x_2 \le 2$

$-x_1 + x_2 \le 1$

and $x_1, x_2 \ge 0$. **(07 Marks)**

2 a. Explain the setting up of simplex method. **(04 Marks)**

b. Using Simplex method , solve the following LPP taking $x_1 = y_1 + 10$, $x_2 = y_2 + 20$ and $x_3 = y_3 + 30$, the LPP becomes.

Maximize $Z = 10y_1 + 15y_2 + 8y_3 + 640$

Subject to $y_1 + 2y_2 + 2y_3 \le 90$

$2y_1 + y_2 + y_3 \le 150$

$3y_1 + y_2 + 2y_3 \le 70$

and $y_1, y_2, y_3 \ge 0$. **(13 Marks)**

c. Why Simplex method is better than graphical method? **(03 Marks)**

3 a. Using Big-M method solve the following LPP :

Maximize $Z = 2x_1 + x_2$

Subject to $3x_1 + x_2 = 3$

$4x_1 + 3x_2 \ge 6$

$x_1 + 2x_2 \le 4$

$x_1, x_2 \ge 0$. **(08 Marks)**

b. Using Two-phase method solve the LPP :

Maximize $Z = -4x_1 - 3x_2 - 9x_3$

Subject to $2x_1 + 4x_2 + 6x_3 \ge 15$

$6x_1 + x_2 + 6x_3 \ge 12$

and $x_1, x_2 x_3 \ge 0$. **(12 Marks)**

4 a. Explain the computational procedure of revised Simplex method in standard form. **(08 Marks)**

b. Using revised Simplex method solve the following LPP :
Minimize $Z = x_1 + x_2$
Subject to $x_1 + 2x_2 \geq 7$
$4x_1 + x_2 \geq 6$
and $x_1, x_2 \geq 0$. **(12 Marks)**

PART – B

5 a. Explain the role of duality theory in sensitivity analysis. **(05 Marks)**

b. Explain the procedure of dual Simplex method. **(05 Marks)**

c. Use dual Simplex method and solve the following LPP and also find the solution to the primal.
Minimize $Z = 2x_1 + 9x_2 + x_3$
Subject to $x_1 + 4x_2 + 2x_3 \geq 5$
$3x_1 + x_2 + 2x_3 \geq 4$
and $x_1, x_2, x_3 \geq 0$. **(10 Marks)**

6 a. Find the initial basic feasible solution using North West corner rule and Vogel's approximation method for the following transportation problem : **(10 Marks)**

19	30	50	10	7
70	30	40	60	9
40	8	70	20	18
5	8	7	14	

b. Write the procedure of Hungarian method. **(05 Marks)**

c. Find the optimal solution to the following assignment problem showing the costs (Rs) for assigning workers to jobs. **(05 Marks)**

		Job		
	W_1	18	17	16
Workers	W_2	15	13	14
	W_3	19	20	21

7 a. Using the dominance concept, obtain the optimal strategies for both the players and determine the value of game. The pay off matrix for player A is given. **(10 Marks)**

		B				
		I	II	III	IV	V
A	I	2	4	3	8	4
	II	5	6	3	7	8
	III	6	7	9	8	7
	IV	4	2	8	4	3

b. Using Graphical method solve the following : **(10 Marks)**

		B		
		I	II	III
A	I	1	3	11
	II	8	5	2

8 Explain briefly :
a. Meta heuristics
b. Decision trees
c. Simulated annealing
d Genetic algorithm. **(20 Marks)**