Operations Research VTU Question Paper Set 2017

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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 2016
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 the following with reference to linear programming model.
   i) Unbounded solution
   ii) Feasible solution
   iii) Slack variable
   iv) Surplus variable
   v) Optimal Solution. **(10 Marks)**

b. The whit window company is a company with only 3 employees which makes two different kinds of handcrafted windows a wood framed and an aluminum framed window. They earn \$60 profit for each wood framed window and \$30 profit for each aluminum framed window. Doug makes the wood frames and can make 6 per day. Linda makes the aluminium frames and can make 4 per day. Bob forms and cuts the glass and can make 48 square feet of glass per day. Each wood framed window uses 6 square foot of glass and each aluminum framed windows used 8 square feet of glass. The company wishes to determine how many windows of each type to produce per day to it maximize total profit. Formulate it as LPP and solve graphically. **(10 Marks)**

2 a. Find all the basic solutions to the following systems of equations identifying in each case the basic and non basic variable and finally the optimal solution.

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

Subject to

$2x_1 + x_2 + x_3 \le 20$

$3x_1 + x_2 + 2x_3 \le 30$

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

b. Use the simplex method to solve the following problem.

Maximize $Z = x_1 + 2x_2 + 4x_3$

Subject to

$3x_1 + x_2 + 5x_3 \le 10$

$x_1 + 4x_2 + x_3 \le 8$

$2x_1 + 2x_3 \le 7$

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

3 a. Solve the following LPP using two phase method.

Minimize $Z = 2x_1 + 3x_2 + x_3$

Subject to

$x_1 + 4x_2 + 2x_3 \ge 8$

$3x_1 + 2x_2 \ge 6$

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

b. Use Big M method to solve the problem
Minimize $Z = 3x_1 + 2x_2 + 4x_3$
Subject to
$2x_1 + x_2 + 3x_3 = 60$
$3x_1 + 3x_2 + 5x_3 \geq 120$
$x_1, x_2, x_3 \geq 0.$ **(10 Marks)**

4 a. Solve by revised simplex method
Maximize $Z = 6x_1 - 2x_2 + 3x_3$
Subject to
$2x_1 - x_2 + 2x_3 \leq 2$
$x_1 + 4x_3 \leq 4$ and $x_1, x_2, x_3 \geq 0.$ **(10 Marks)**

b. Use duality to solve ;
Minimize $Z_x = 3x_1 + x_2$
Subject to
$x_1 + x_2 \geq 1$
$2x_1 + 3x_2 \geq 2, \ x_1, x_2, x_3 \geq 0.$ **(10 Marks)**

PART – B

5 a. Solve the following problem by dual simplex method.
Minimize $Z = 2x_1 + x_2$
Subject to
$3x_1 + x_2 \geq 3$
$4x_1 + 3x_2 \geq 6$
$x_1 + 2x_2 \geq 3$
$x_1, x_2 \geq 0.$ **(10 Marks)**

b. Solve the following problem by using lower bound technique.
Maximize $Z = 10x_1 + 15x_2 + 8x_3$
Subject to
$x_1 + 2x_2 + 2x_3 \leq 200$
$2x_1 + x_2 + x_3 \leq 220$
$3x_1 + x_2 + 2x_3 \leq 180$
$x_1 \geq 10, \ x_2 \geq 20, \ x_3 \geq 30.$ **(10 Marks)**

6 a. Hindustan construction company needs 3, 3, 4 and 5 million cubic feet of fill at four earthen dams-sites in Punjab. It can transfer the fill from three mounds A, B and C where 2, 6 and 7 million cubic feet of fill is available, cost of transporting one million cubic feet of fill from mounds to the four sites in lakhs are given in the table.
Find IBFs by using any method and check for optimality. **(10 Marks)**

		To				
From		I	II	III	IV	ai
	A	15	10	17	18	2
	B	16	13	12	13	6
	C	12	17	20	11	7
	bJ	3	3	4	5	

b. Five men are available to do five different jobs. From past records the time (in hrs) that each man takes to do each job is known and given in the following table ;

Man \ Job	I	II	III	IV	V
A	2	9	2	7	1
B	6	8	7	6	1
C	4	6	5	3	1
D	4	2	7	3	1
E	5	3	9	5	1

Find the assignment of men to jobs that will minimize the total time taken. **(10 Marks)**

7 a. Define the following with reference to game theory with an example :
   i) Pure strategy
   ii) Mixed strategy
   iii) Saddle point
   iv) Pay off matrix
   v) 2 person zero sum games. **(10 Marks)**

b. In a game of matching coins with two players, suppose one player wins Rs 2 when there are two heads and wins nothing when there are two tails and loses Rs 1 when there are one head and one tail. Determine the payoff matrix, the best strategies for each player and the value of the game. **(10 Marks)**

8 Explain briefly the following
a. Tabu search
b. Genetic Algorithm
c. Simulated annealing technique
d. Meta heuristics. **(20 Marks)**

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

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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

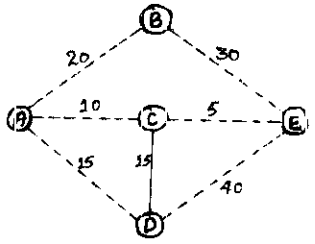
7 a. Use graphical method to solve the following game **(10 Marks)**

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

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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Sixth Semester B.E. Degree Examination, June / July 2014
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 operations research. Explain the six phases of OR study. **(10 Marks)**

b. A firm manufactures two types of products A & B and sells them at a profit of Rs.2 on type A and Rs.3 on type B. Each product is processed on two machines G and H. Type A requires one minute of processing time on G and two minutes on H. Type B requires one minute on G and one minute on H. The machine G is available for not more than 6 hours 40 minutes while H is available for 10 hours during any working day. How many items of type A and type B should be produced so that the total profit is maximum?

i) Use mathematical formulation to the LPP.

ii) Use graphical method to solve the problem. **(10 Marks)**

2 a. Discuss the various aspects of the concept tie breaking in simplex method. **(10 Marks)**

b. Solve the following LPP by simplex method.

Maximize $z = 5x_1 + 3x_2$

Subjected to $3x_1 + 5x_2 \le 15$

$5x_1 + 2x_2 \le 10$

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

3 a. Solve the following LPP using two phase method:

Minimize $z = 4x_1 + x_2$

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 Big-M method:

Minimize $z = +2x_1 + x_2$

Subjected to the constraints

$x_1 + 2x_2 \le 4$

$4x_1 + 3x_2 \ge 6$

$3x_1 + x_2 = 3$

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

4 a. Use Revised simplex method to solve LPP,

Maximize $z = x_1 + 2x_2$

Subject to $x_1 + x_2 \le 3$

$x_1 + 2x_2 \le 5$

$3x_1 + x_2 \le 6,$

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

4 b. Explain the following:
i) The essence of duality theory.
ii) Primal dual relationship. **(08 Marks)**

PART – B

5 a. Use dual simplex method to solve LPP,
Minimize $z = 2x_1 + x_2$
Subjected to the constraints

$$3x_1 + x_2 \geq 3$$
$$4x_1 + 3x_2 \geq 6$$
$$x_1 + 2x_2 \leq 3$$
$$x_1, x_2 \geq 0$$ **(10 Marks)**

b. Briefly discuss about sensitivity analysis. **(10 Marks)**

6 a. Explain various steps involved in Hungarian algorithm with an example. **(10 Marks)**

b. A product is produced by 4 factories F_1, F_2, F_3 and F_4. Their unit production costs are Rs 2, 3, 1 and 5 respectively. Production capacity of the factories are 50, 70, 30 and 50 units respectively. The product is supplied to 4 stores S_1, S_2, S_3 and S_4. The requirements of which are 25, 35, 105 and 20 respectively. Unit costs of transportation are given below.

Factories \ Stores	S_1	S_2	S_3	S_4
F_1	2	4	6	11
F_2	10	8	7	5
F_3	13	3	9	12
F_4	4	6	8	3

Find the transportation plan such that the total production and transportation cost is minimum. **(10 Marks)**

7 a. Two players A and B are playing a game of tossing a coin simultaneously: Player A wins 1 unit of value when there are two heads, wins nothing when there are two tails and looses $\frac{1}{2}$ unit of value when there is one head and one tail. Determine the pay off matrix, the best strategies for each player and the value of the game. **(10 Marks)**

b. Define the following with reference to game theory, with an example:
i) Pure strategy ii) Mixed strategy iii) Saddle point
iv) Pay off matrix v) Two person-zero-sum-game **(10 Marks)**

8 Explain briefly the following:
a. Tabu search algorithm.
b. Genetic algorithm.
c. Metaheuristics.
d. Simulated annealing algorithm. **(20 Marks)**

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

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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:

Min $z = x_1 + x_2$

Subjected to $x_1 + 2x_2 \geq 7$

$4x_1 + x_2 \geq 6$

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

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:

i) Pay off ii) Strategy iii) Saddle point. **(03 Marks)**

b. Solve the following game by graphical method:

$$\text{Player A} \begin{bmatrix} 3 & -3 & 4 \\ -1 & 1 & -3 \end{bmatrix} \quad \text{Player B}$$ **(07 Marks)**

c. Solve the following game by dominance property:

$$\text{Player A} \begin{bmatrix} 2 & -2 & 4 & 1 \\ 6 & 1 & 12 & 3 \\ -3 & 2 & 0 & 6 \\ 2 & -3 & 7 & 7 \end{bmatrix} \quad \text{Player B}$$ **(10 Marks)**

8 Write short notes on:

a. Genetic algorithm.

b. Metaheuristics.

c. Tabu search algorithm.

d. Simulated annealing algorithm. **(20 Marks)**

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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

A	I	II	III	IV
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.2013/Jan.2014
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. Explain the six phases of OR study. **(12 Marks)**

b. A retailer deals in two items only, item A and item B. He has ` 50,000 to invest and a space to store at most 60 pieces. An item 'A' costs him ` 2,500 and 'B' costs ` 500. A net profit to him on item 'A' is ` 500, and item 'B' is ` 150. If he can sell all the items he purchases, how should he invest his amount to have maximum profit?
(i) Give mathematical formulation to the LPP
(ii) Use graphical method to solve the problem. **(08 Marks)**

2 a. Explain the concept of Tie breaking in simplex method. **(10 Marks)**

b. Solve the following LPP by simplex method:
Maximize $Z = 2x_1 + 2x_2$
Subject to $5x_1 + 3x_2 \le 8$
$2x_1 + 4x_2 \le 8$ and $x_1, x_2 \ge 0$ **(10 Marks)**

3 a. Explain the post optimality analysis of linear programming. **(10 Marks)**

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

4 a. Apply revised simplex method to solve the following problem:
Maximize $Z = 6x_1 - 2x_2 + 3x_3$
Subject to $2x_1 - x_2 + 2x_3 \le 2$
$x_1 + 4x_3 \le 4$ and $x_1, x_2, x_3 \ge 0$ **(10 Marks)**

b. Explain the following:
(i) The essence of duality theory (ii) Primal dual relationship **(10 Marks)**

PART – B

5 a. Solve the following LPP by using dual simplex method:
Minimize $Z = 10x_1 + 6x_2 + 2x_3$
Subject to $-x_1 + x_2 + x_3 \ge 1$
$3x_1 + x_2 - x_3 \ge 2$ and $x_1, x_2, x_3 \ge 0$ **(10 Marks)**

b. Explain general procedure for sensitivity analysis. **(10 Marks)**

6 a. Explain Hungarian algorithm with example. **(10 Marks)**

b. The transportation costs per truck load of cement (in hundred of rupees) from each plant to each project site are as follows:

	Project Site				
	2	3	11	7	6
Factories	1	0	6	1	1 Supply
	5	8	15	9	10
	7	5	3	2	17

Determine the optimal distribution for the company so as to maximize the total transportation cost. **(10 Marks)**

7 a. Two players 'A' and 'B' throw 2 coins on a table 'A' wins ` 8 when both coins show heads and ` 1 when both are tail. 'B' wins ` 3 when coin does not match. Prepare the payoff matrix and determine optimal strategies for each player. **(10 Marks)**

b. With reference to game theory define the following, with an example:
(i) Pure strategy (ii) Mixed strategy (iii) Saddle point
(iv) Payoff matrix (v) Two-person-zero-sum- game **(10 Marks)**

8 Explain briefly the following :
a. Tabu search algorithm
b. Genetic algorithm
c. Metaheuristics
d. Simulated Annealing algorithm **(20 Marks)**

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10CS/IS661

Sixth Semester B.E. Degree Examination, June/July 2013
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 operations research. List and explain the various phases of an operations research study. **(08 Marks)**

b. A farmer has to plant two kinds of trees P and Q in a land of $400m^2$ area. Each P tree requires at least $25m^2$ and Q tree requires $40m^2$ of land. The annual water requirement of P tree is 30 units and of Q tree is 15 units per tree, while at most 3000 units of water is available. It is also estimated that the ratio of the number of Q trees to the number of P trees should not be less than 6/19 and should not be more than 17/8. The return per tree from P is expected to be one and half times as much as from Q tree. Formulate the problem as an LPP model. **(06 Marks)**

c. Use the graphical method to solve the following LPP.
Minimize $Z = 1.5x_1 + 2.5x_2$
Subject to the constraints $x_1 + 3x_2 \geq 3$,
$x_1 + x_2 \geq 2$
And $x_1, x_2 \geq 0$. **(06 Marks)**

2 a. Define basic solution and obtain all the basic solutions to the following system of linear equations:
$2x_1 + 3x_2 + 4x_3 = 10$,
$3x_1 + 4x_2 + x_3 = 12$
Also, classify the solutions into
i) Basic feasible solution
ii) Degenerate basic solution
iii) Non-degenerate basic feasible solution. **(07 Marks)**

b. Solve the following LPP using simplex method:
Maximize $Z = 10x_1 + 15x_2 + 8x_3$
Subject to the constraints
$x_1 + 2x_2 + 2x_3 \leq 200$,
$2x_1 + x_2 + x_3 \leq 220$,
$3x_1 + x_2 + 2x_3 \leq 180$,
$x_1 \geq 10$,
$x_2 \geq 20$,
$x_3 \geq 30$
and $x_1, x_2, x_3 \geq 0$. **(13 Marks)**

3 a. Solve the following LPP by two-phase simplex method:
Maximize $Z = 3x_1 - x_2$
Subject to the constraints
$2x_1 + x_2 \geq 2$,
$x_1 + 3x_2 \leq 2$,
$x_2 \leq 4$
and $x_1, x_2 \geq 0$. **(10 Marks)**

b. Solve the following LPP by Big-M method:
Maximize $Z = -2x_1 - x_2$
Subject to the constraints
$3x_1 + x_2 = 3,$
$4x_1 + 3x_2 \geq 6,$
$x_1 + 2x_2 \leq 4$
and $x_1, x_2 \geq 0.$ **(10 Marks)**

4 a. Solve the following LPP by revised simplex method:
Maximize $Z = 2x_1 + x_2$
Subject to the constraints
$3x_1 + 4x_2 \leq 6,$
$6x_1 + x_2 \leq 3$
And $x_1, x_2 \geq 0$ **(12 Marks)**

b. Explain the following:
i) Weak duality property
ii) Strong duality property
iii) Complementary solutions property
iv) Complementary optimal solutions property. **(08 Marks)**

PART – B

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

b. Write the duals of the following LPP's.
i) Maximize $Z = 7x_1 + 4x_2 + 5x_3$
Subject to the constraints
$2x_1 - 4x_2 + 3x_3 \leq 10,$
$x_1 + 3x_2 + x_3 \leq 6$
and $x_1, x_2, x_3 \geq 0.$
ii) Minimize $Z = 3x_1 + 2x_2 + x_3$
Subject to the constraints
$2x_1 - 3x_2 + x_3 \leq 5,$
$4x_1 - 2x_2 \geq 9,$
$-8x_1 + 4x_2 + 3x_3 = 8$
and $x_1, x_2 \geq 0$ and x_3 is unrestricted. **(07 Marks)**

c. Solve the following LPP by dual simplex method:
Minimize $Z = 2x_1 + 2x_2 + 4x_3$
Subject to the constraints
$2x_1 + 3x_2 + 5x_3 \geq 2,$
$3x_1 + x_2 + 7x_3 \leq 3,$
$x_1 + 4x_2 + 6x_3 \leq 5$
and $x_1, x_2, x_3 \geq 0.$ **(08 Marks)**

6 a. A company has 3 cement factories located in 3 cities X, Y and Z which supply cement to 4 project sites located in cities A, B, C and D. Each plant can supply 6, 1 and 10 truckloads of cement daily and the daily requirements of the projects are 7, 5, 3 and 2 truckloads respectively. The transportation cost (in thousands of rupees) per truck load of cement from each plant to each project site are shown below.

Plants	Projects A	B	C	D
X	2	3	11	7
Y	1	0	6	1
Z	5	8	15	9

Determine the optimal distribution of the company so as to minimize the total transportation cost. Use VAM method to find the initial BFS. **(12 Marks)**

b. Solve the following assignment problem:

Jobs	Machines M_1	M_2	M_3	M_4	M_5
J_1	11	17	8	16	20
J_2	9	7	12	6	15
J_3	13	16	15	12	16
J_4	21	24	17	28	26
J_5	14	19	12	11	13

(08 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 by Dominance principle:

Player A	Player B B_1	B_2	B_3	B_4
A_1	3	2	4	0
A_2	3	4	2	4
A_3	4	2	4	0
A_4	0	4	0	8

(06 Marks)

c. Solve the following game by graphical method:

Player A	Player B B_1	B_2	B_3	B_4
A_1	8	5	-7	9
A_2	-6	6	4	-2

(07 Marks)

d. Write a short note on decision trees. **(04 Marks)**

8 a. Write the outline of a basic tabu 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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