Operation Research VTU CBCS Question Paper Set 2018

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10EE661

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

Operation Research

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Solve the given LPP, using graphical method.

Maximize $z = 3x_1 + 5x_2$

Subject to $x_1 + 2x_2 \le 2000$

$x_1 + x_2 \le 1500$

$x_2 \le 600$

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

b. A firm manufactures two types of products P_1 and P_2 and sells them at a profit of Rs 2 on product P_1 and Rs 3 on product P_2. Each product is processed on two machines M_1 and M_2 product p_1 requires one minute of processing time on M_1 and two minutes of processing time on M_2. Product P_2 requires one minute on M_1 and one minute on M_2. Machine M_1 is available for not more than 6 hours 40 minutes while machine M_2 is available for 10 hours during any day. Formulate the problem as a LPP. **(04 Marks)**

c. Use two phase simplex method to

Minimize $z = x_1 + x_2 + x_3$

Subject to $x_1 - 3x_2 + 4x_3 = 5$

$x_1 - 2x_2 \le 3$

$2x_2 + x_3 \ge 4$

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

2 a. Solve using simplex method

Maximize $z = 3x_1 + 9x_2$

Subject to $x_1 + 4x_2 \le 8$

$x_1 + 2x_2 \le 4$

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

b. Solve using Big M method and read the solution for dual from primal optimal solution

Maximize $z = 5x_1 + 12x_2 + 4x_3$

Subject to $x_1 + 2x_2 + x_3 \ge 5$

$2x_1 - x_2 + 3x_3 = 2$

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

3 a. Define dual problem. find the dual of the following LP problem.

Maximize $z = 2x_1 + 3x_2 + x_3$

Subject to $4x_1 + 3x_2 + x_3 = 6$

$x_1 + 2x_2 + 5x_3 = 4$

$x_1, x_2, x_3 \ge 0$ **(06 Marks)**

b. Define (i) Feasible solution (ii) Optimal solution in a linear programming problem. **(04 Marks)**

c. Solve using simplex method.

Maximize $z = 3x_1 + 2x_2 + 5x_3$

Subject to $x_1 + 2x_2 + x_3 \leq 430$

$3x_1 + 2x_3 \leq 460$

$x_1 + 4x_2 \leq 420$

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

4 a. Five employees are available to do five different jobs. From the past records the time in hrs that each employee takes to do each job is known and given in the table below. How should the jobs be allotted one per person so as to minimize the total man hours? **(10 Marks)**

Employees

Jobs	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

b. Solve the travelling sales man problem given by the following data:
$C_{12} = 20$, $C_{13} = 4$, $C_{14} = 20$, $C_{23} = 5$, $C_{34} = 6$,
$C_{25} = 10$, $C_{35} = 6$, $C_{45} = 10$ where $C_{ij} = C_{ji}$
And there is no route between cities i and j if the value of C_{ij} is not given. **(10 Marks)**

PART – B

5 a. Obtain an initial basic feasible solution for the following transportation problem using
i) North – west corner rule ii) Vogels Approximation method

	1	2	3	4	5	Supply
A	2	11	10	3	7	4
B	1	4	7	2	1	8
C	3	9	4	8	12	9
Demand	3	3	4	5	6	

(10 Marks)

b. Find the optimum solution for the transportation problem using MODI method.

	W_1	W_2	W_3	W_4	Factory capacity
F_1	19	30	50	10	7
F_2	70	30	40	60	9
F_3	40	8	70	20	18
Ware house requirement	5	8	7	14	

(10 Marks)

6 a. Solve the following game graphically and find the value of the game

Player b

Player a	b_1	b_2	b_3	b_4
a_1	8	5	-7	9
a_2	-6	6	4	-2

(10 Marks)

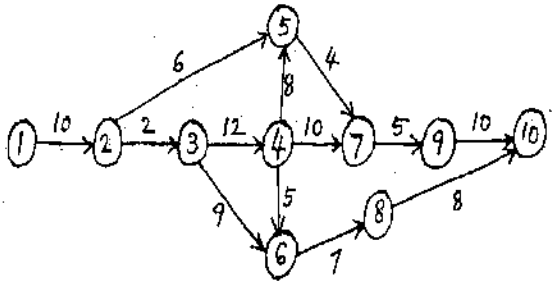
b. Determine the best sequencing of 6 jobs on 4 machines from the given table of processing time. The sequence of operation to be considered is $M_1 \rightarrow M_2 \rightarrow M_3 \rightarrow M_4$

Jobs	Processing Time on Machines			
	M_1	M_2	M_3	M_4
A	6	5	3	4
B	7	2	5	5
C	9	6	3	3
D	8	5	5	4
E	8	3	4	3
F	9	5	5	4

(10 Marks)

7 a. Obtain the critical path and project duration for the following PERT network **(10 Marks)**

Fig. Q7 (a)



b. Explain the following terms in PERT/CPM
i) Earliest time
ii) Latest time
iii) Total activity slack
iv) Event slack
v) Critical path **(10 Marks)**

8 a. In a plant we have 105 machines operating. The average preventive maintenance cost for a machine has been worked out to be Rs 35. The breakdown cost is Rs 500 and the breakdown history of the machines is given below. Decide an appropriate maintenance policy?

Month of the year	1	2	3	4	5	6	7	8	9	10	11	12
Break down Frequency	2	3	4	5	5	6	9	12	12	14	15	15

(10 Marks)

b. We have the lots of 1000 bulbs, supplied to shop cost of individual replacement is Rs 10 and the bulk replacement cost is Rs 2.50 per bulb. The failure pattern noticed is as follows :

Period in months	1	2	3	4	5
Failure rate %	0.10	0.15	0.25	0.30	0.20

Work out the optimum replacement policy. **(10 Marks)**

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Sixth Semester B.E. Degree Examination, June/July 2016
Operation Research

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Normal distribution table is permitted.***

PART – A

1 a. Define Operation Research. List the applications of LPP. **(05 Marks)**

b. Using Graphical method find, $Z_{max} = 3x_1 + 4x_2$

Subject to $5x_1 + 4x_2 \le 200$

$3x_1 + 5x_2 \le 150$

$8x_1 + 4x_2 \ge 80$

$5x_1 + 4x_2 \ge 100$

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

c. Solve the following LPP by Simplex method

$Z_{min} = x_1 - 3x_2 - 2x_3$

Subject to $3x_1 - x_2 + 2x_3 \le 7$

$-2x_1 + 4x_2 \le 12$

$-4x_1 + 3x_2 + 8x_3 \le 10$. **(07 Marks)**

2 a. Explain degeneracy in LPP and also explain the procedure to resolve degeneracy. **(08 Marks)**

b. Write the dual for the following LPP

$Z_{max} = 3x_1 + 5x_2 + 7x_3$.

Subject to the constraints $x_1 + x_2 + 3x_3 \le 10$

$4x_1 - x_2 + 2x_3 \ge 15$

$x_1, x_2 \ge 0$

x_3 is unrestricted variable. **(12 Marks)**

3 a. Solve the LPP by dual Simplex method.

Max $Z = -3x_1 - 2x_2$

Subject to $x_1 + x_2 \ge 1$

$x_1 + x_2 \le 7$

$x_1 + 2x_2 \ge 10$

$x_2 \le 3$; $x_1, x_3 \ge 0$. **(10 Marks)**

b. Solve the LPP by using revised Simplex method.

Max. $Z = x_1 + x_2 + 3x_3$

Subject to constraints $3x_1 + 2x_2 + x_3 \le 3$

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

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

4 a. A company has 5 tasks and 5 persons to perform the same. The matrix shows the returns (profit) in hundreds of Rupees, for assigning jobs to the persons. Assign 5 tasks to 5 persons to maximize the total returns. **(08 Marks)**

		PERSONS				
		P_1	P_2	P_3	P_4	P_5
TASK	J_1	5	11	10	12	4
	J_2	2	4	6	3	5
	J_3	3	12	5	14	6
	J_4	6	14	4	11	7
	J_5	7	9	8	12	5

b. Solve the traveling salesman problem given by the following data : $C_{12} = 20$; $C_{13} = 4$; $C_{14} = 10$; $C_{23} = 5$; $C_{34} = 6$; $C_{25} = 10$; $C_{35} = 6$; $C_{45} = 20$, where $C_{ij} = C_{ji}$. There is no route between i and j, if the value of C_{ij} is not shown. **(12 Marks)**

PART – B

5 a. List the difference between transportation and assignment problems. **(06 Marks)**

b. A product is produced by 4 factories A, B, C and D. The unit production costs in them are Rs 2, Rs 3, Rs 1 and Rs 5 respectively. Their production capacities are factory A = 50 units and B = 70 units , C = 30 units and D = 50 units. These factories supply the product to 4 stores, demands of which are 25, 35, 105 and 20 units respectively. Unit transport cost in rupees from each factory to each store is given in the table.

Factory	1	2	3	4
A	2	4	6	11
B	10	8	7	5
C	13	3	9	12
D	4	6	8	3

Determine the extent of deliveries from each of the factories to each of the stores so that the total production and transportation cost is minimum. **(14 Marks)**

6 a. Define Optimal strategy. Using 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 **(12 Marks)**

	I	II	III	IV
I	3	2	4	0
II	3	4	2	4
III	4	2	4	0
IV	0	4	0	8

b. Use graphical method to solve the following sequencing problem, also calculate the total time required to complete both the jobs. **(08 Marks)**

JOB 1	Sequencing order and time	A	B	C	D	E
		2	3	4	6	2
JOB 2	Sequencing order and time	C	A	D	E	B
		4	5	3	2	6

7 a. The following table shows the jobs of a network along with their time estimation in days.

JOB	1-2	1-3	1-4	2-5	3-5	4-6	5-6
T_o	1	1	2	1	2	2	3
T_m	1	4	2	1	5	5	6
t_p	7	7	8	1	14	8	15

i) Draw the project network.
ii) Compute the expected duration and variance, also critical path.
iii) Calculate standard deviation.
iv) What is the probability of completion of project :
a) 4 days earlier than expected.
b) Not more than 4 days later than expected. **(12 Marks)**

b. Determine the optimum project duration (days) and cost (Rs) for the following data :

Activities	Normal		Crash	
	Time	Cost	Time	Cost
1-2	8	100	6	200
1-3	4	150	2	350
2-4	2	50	1	90
2-5	10	100	5	400
3-4	5	100	1	200
4-5	3	80	1	100

Indirect cost is Rs 70 per day. **(08 Marks)**

8 a. Explain Economic life of an equipment by illustrating chart. **(08 Marks)**

b. Below table gives the operation cost, maintenance cost and salvage value at the end of every year of a machine whose purchase value is Rs 12,000. Find the economic life of the machine assuming.
i) The interest rate is 0%.
ii) The interest rate as 15%. **(12 Marks)**

End of year (n)	Operation cost at the end of year (Rs)	Maintenance cost at the end of year (Rs)	Salvage value at the end of year (Rs)
1	2000	2500	8000
2	3000	3000	7000
3	4000	3500	6000
4	5000	4000	5000
5	6000	4500	4000
6	7000	5000	3000
7	8000	5500	2000
8	9000	6000	1000

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

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Normal distribution tables are permitted.***

PART – A

1 a. Briefly explain the engineering applications and limitations of Operation Research. **(10 Marks)**

b. The XYZ electric appliance Company produces two types of products : Refrigeration and televisions. The Company's two product are produced and sold on a weekly basis. The weekly production cannot exceed 25 refrigerators and 35 televisions. The Company regularly employs a total of 60 workers. A refrigerator requires 2 – man – weeks of labour, while TV requires 1 – man – week of labour. A refrigerator contributes a profit of Rs 60 and TV contributes a profit of Rs 40. How many units of refrigerators and TV's should the company produce to realize maximum profit? Formulate LPP and solve it by graphical method. **(10 Marks)**

2 a. Solve the following LPP using Simplex method and comment on the results.

Maximize $Z = 3x_1 + 2x_2$

Subject to $x_1 - x_2 \leq 1$

$3x_1 - 2x_2 \leq 6$

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

b. Solve the following LPP using two – phase Simplex method.

Maximize $Z = 8x_2$

Subject to $x_1 - x_2 \geq 0$

$1 + 3x_2 \leq -6$

x_1 and x_2 are unrestricted. **(12 Marks)**

3 a. Construct the dual for the following LPP : **(10 Marks)**

i) Maximize $Z = 5x_1 + 12x_2 + 4x_3$

Subject to $x_1 + 2x_2 + x_3 \leq 10$

$2x_1 - x_2 + 3x_3 = 8$

x_1, x_2 and $x_3 \geq 0.$

ii) Minimize $Z = x_2 + 3x_3$

Subject to $2x_1 + x_2 \leq 3$

$x_1 + 2x_2 + 6x_3 \geq 5$

$-x_1 + x_2 + 2x_3 = 2$

x_1, x_2 & $x_3 \geq 0.$

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

Minimize $Z = 2x_1 + x_2$

Subject to $3x_1 + x_2 \geq 3$

$4x_1 + 3x_2 \geq 6$

$x_1 + 2x_2 \leq 3$

x_1, & $x_2 \geq 0.$

4 a. Four different jobs can be done on four different machines. The matrix below gives the cost in rupees of producing job 'i' and on machines 'j'.

		Machines			
		M_1	M_2	M_3	M_4
Jobs	J_1	5	7	11	6
	J_2	8	5	9	6
	J_3	4	7	10	7
	J_4	10	4	8	3

Represent the problem as an LP problem and how should the jobs be assigned to the various machines, so that the total cost is minimized. **(08 Marks)**

b. An electrical service engineer has to visit five places A, B, C, D and E. The cost of going from one place to another are given below. Determine the optimal route and cost. **(08 Marks)**

	A	B	C	D	E
A	∞	7	6	8	4
B	7	∞	8	5	6
C	6	8	∞	9	7
D	8	5	9	∞	8
E	4	6	7	8	∞

c. Write the algorithm for revised Simplex method. **(04 Marks)**

PART – B

5 a. The power company has three power plants that supply the needs of four cities. The cost of sending 1 million kWh of electricity from plant to city is given in the following table : Solve the following transportation problem to minimize the cost of meeting each city peak power demand. (Use North – west corner method and UV method). **(12 Marks)**

	City - 1	City - 2	City - 3	City - 4	Supply (million)
Plant - 1	8	6	10	9	35
Plant - 2	9	12	13	7	50
Plant - 3	14	9	16	5	40
Demand (in million)	45	20	30	30	

b. Obtain the initial basic feasible solution (IBFS) to the following TP using Vogel's Approximation method.

		Destinations				
		D_1	D_2	D_3	D_4	Supply
Sources	S_1	5	1	3	3	34
	S_2	3	3	5	4	15
	S_3	6	4	4	3	12
	S_4	4	1	4	2	19
Demand		21	25	17	17	

The unit transportation costs are represented in the TP table. **(08 Marks)**

6 a. Briefly explain the Maxmin and Minmax principle. **(05 Marks)**

b. Solve the following game graphically whose payoff matrix for the player – A is given in the following table : **(10 Marks)**

		Player A			
		I	II	III	IV
Player B	I	2	2	3	-2
	II	4	3	2	6

c. Using dominance property, obtain the optimal strategies for both the players and determine the value of game. The Payoff matrix for Player 'A' is given by **(05 Marks)**

		Player B				
		I	II	III	IV	V
Player 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

7 a. Draw the PERT network for the following project and number the events. **(06 Marks)**

Event Number	A	B	C	D	E	F	G	H	J	K	L
Preceded by :	Start event	A	B	B	D	B	E	G,E	D,F,H	C,J	K

b. Define the following :
i) Optimistic time estimate ii) Pessimistic time estimates iii) Most likely time estimate iv) Average time. **(04 Marks)**

c. For the network shown in fig. Q7(c), calculate the probability of finishing the project within 22 days. **(10 Marks)**

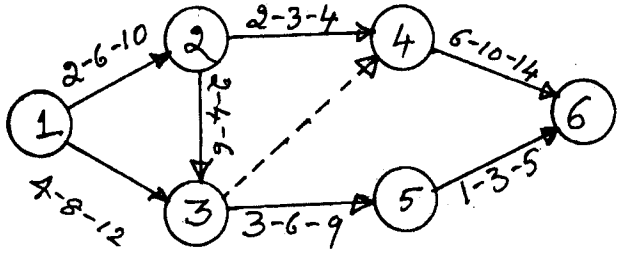

Fig.Q7(c)

8 a. The cost of a electric machine is Rs 6100 and its scrap value is Rs 100. The maintenance costs found from the experience are as follows : **(10 Marks)**

Year	1	2	3	4	5	6	7	8
Maintenance cost (in Rs)	100	250	400	600	900	1200	1600	2000

When should the machine be replaced?

b. A computer contains 10,000 resistors. The cost of replacing a single resistor is Re 1 only. If all the resistors are replaced at the same time, the cost per resistor would be reduced to 35 paise. The percent surviving by the end of month 't' is given by :

Month (t)	0	1	2	3	4	5	6
Percent surviving by the end of month	100	97	90	70	30	15	0

What is the Optimum plan? **(10 Marks)**

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10EE661

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.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. What is operations Research? Explain linear programming problems. **(04 Marks)**

b. The owner of metro sports wishes to determine how many advertisements to place in the selected three monthly magazines A, B and C. His objective is to advertise in such a way that total exposure to principal buyers of expensive sports goods in maximized. Percentages of readers for each magazine are known. Exposure in any particular magazine is the number of advertisements placed multiplied by the number of principal buyers. The following data is available.

	Magazine		
	A	B	C
Readers	1 lakh	0.6 Lakh	0.4 Lakh
Principal buyers	20%	15%	8%
cost per advertisement (RS)	8000/-	6000/-	5000/-

The budgeted amount is at most Rs 1 lakh for advertisements. The owner has already decided that magazine A should have no more than 15 advertisements and that B and C each have at least 50 advertisements. Formulate an LP model for this problem. **(06 Marks)**

c. Solve the LPP :

Max $Z = 3x_1 + 2x_2$

Subject to : $4x_1 + 3x_2 \leq 12$

$4x_1 + x_2 \leq 8$

$x_2 - 4x_1 \geq -8$ and $x_1, x_2 \geq 0$. **(10 Marks)**

2 a. Solve the following LPP graphically and comment on the result.

Maximize $Z = x_1 + x_2$

Subject to : $x_1 + x_2 \leq 1$

$-3x_1 + x_2 \geq 3$

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

b. Use Big M method to solve the following LPP.

Minimize $Z = 5x_1 + 3x_2$

Subject to constraints $2x_1 + 4x_2 \leq 12$

$2x_1 + 2x_2 = 10$

$5x_1 + 2x_2 \geq 10$ and $x_1, x_2 \geq 0$. **(14 Marks)**

3 a. Write the Dual of the following primal problem.

Maximize $Z = 2x_1 + 3x_2$

Subject to $5x_1 + 2x_2 \le 40$

$6x_1 + 12x_2 \le 80$ where x_1 and x_2 are unrestricted in sign. **(06 Marks)**

b. Use Revised simplex method to solve the following LPP.

Maximize $Z = x_1 + x_2$

Subject to $2x_1 + 5x_2 \le 6$

$x_1 + x_2 \ge 2$ and

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

c. Solve the given LPP using dual simplex method.

Minimize $Z = 2x_1 + 4x_2$

Subject to constraints $2x_1 + x_2 \ge 4$

$x_1 + 2x_2 \ge 3$

$2x_1 + 2x_2 \le 12$

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

4 a. Alpha construction company has five crews. The skills of the crews differ from one another. The company has five different projects on hand. The times (in days) taken by different crews to complete different projects are summarized in Table Q4(a). Find the best assignment of the crews to different project such that the total time taken to complete all the projects is minimized

Table Q4 (a)

Crew	Project				
	A	B	C	D	E
1	20	30	25	15	35
2	25	10	40	12	28
3	15	18	22	32	24
4	29	8	34	10	40
5	35	23	17	26	45

Project execution time in days

(10 Marks)

b. A machine operator processes five types of items on his machine each week and must choose a sequence for them. The set up cost per change depends on the items presently on the machine and set up to be made, according to the following table

From items \ To items	A	B	C	D	E
A	∞	4	7	3	4
B	4	∞	6	3	4
C	7	6	∞	7	5
D	3	3	7	∞	7
E	4	4	5	7	∞

If he processes each type of them only once in each week, how should he sequence the items on his machine in order to minimize the total set up cost? **(10 Marks)**

PART – B

5 a. What is degeneracy in transportation problems? How to resolve it? **(04 Marks)**

b. Obtain the initial basic feasible solution to the given transportation problem using Vogel's Approximation method. **(06 Marks)**

Table Q 5 (b)

D / S	D_1	D_2	D_3	D_4	Supply
S_1	2	2	2	1	3
S_2	10	8	5	4	7
S_3	7	6	6	8	5
Demand	4	3	4	4	15

c. A company has three plants A, B and C, 3 ware houses X, Y and Z. The number of units available at the plants is 60, 70, 80 and the demand at X, Y, Z is 50, 80, 80 respectively. The unit cost of transportation is given in the following table.

	X	Y	Z
A	8	7	3
B	3	8	9
C	11	3	5

Find the optimum allocation, so that the total transportation cost is minimum. **(10 Marks)**

6 a. Define pure strategy, mixed strategy and Two – person zero sum game. **(06 Marks)**

b. Solve the game whose pay off matrix is given by

Player B

$$\text{Player A} \begin{bmatrix} 3 & 2 & 4 \\ 0 & -4 & 2 \\ 2 & -1 & 5 \end{bmatrix}$$

Comment on the result. **(06 Marks)**

c. In a game of matching coins with two players A and B, suppose A wins one unit of value when there are two heads, wins nothing when there are two tails and losses $\frac{1}{2}$ unit of value when there are one head and one tail. Determine the pay off matrix, the best strategies for each player and the value of the game to player A. **(08 Marks)**

7 a. A project consists of a series of tasks A, B ..... H, I with the following relationships, W < X, Y means X and Y can not start until W is completed. X, Y < W means, W can not start until both X and Y are completed. With this notation, construct the network diagram having the following constraints: A < D, E; B, D < F ; C < G ; B < H ; F, G < I. Find the critical path and minimum time of completion of project, when the time of completion of each task is given as below. Also find the float for each activity.

Task	A	B	C	D	E	F	G	H	I
Time Days	23	8	20	16	24	18	19	4	10

(08 Marks)

b. A project is composed of different activities whose time estimates are listed in the following table.

Activity	Estimated Duration		
	Optimistic to	Most likely tm	Pessimistic Tp
1 – 2	1	2	9
2 – 3	1	4	7
2 – 4	2	4	12
3 – 4	0	0	0
3 – 5	2	3	4
4 – 5	4	6	8
4 – 6	3	5	7
5 – 6	1	3	5
5 – 7	5	7	15
3 – 7	6	8	16
6 – 7	3	4	5

i) Draw the project network
ii) Find the expected duration and variance of each activity
iii) Determine the expected project completion time
iv) What is the probability of completing the project in 25 days?

(Given that for standard normal Z = 1.08, area under the standard normal curve from extreme left Z = -∞ to Z is 0.8599) **(12 Marks)**

8 a. A truck owner finds from his past records that the maintenance costs per year of a truck, whose purchase price is Rs. 8000, are as given in table Q8(a). Determine the time at which it is profitable to replace the truck.

Year	1	2	3	4	5	6	7	8
Maintenance Cost	1000	1300	1700	2200	2900	3800	4800	6000
Resale price	4000	2000	1200	600	500	400	400	400

(08 Marks)

b. The following mortality rates have been observed for a certain type of light bulbs.

Week	1	2	3	4	5
Percent failure of the end of week	10	25	45	75	100

There are 1000 bulbs in use and it costs Rs. 2 to replace an individual bulb, which has burnt out. If all the bulbs were replaced simultaneously, it would cost 50 paise per bulb. It is proposed to replace all bulbs at fixed intervals, whether or not they have burnt out and to continue replacing burnt out bulbs as they fail. Determine the optimum interval at which all the bulbs should be replaced. **(12 Marks)**

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10EE661

Sixth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Operation 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. Briefly explain the characteristics of operation research. **(05 Marks)**

b. A company manufactures two products A and B. Each unit of 'B' takes twice as long to produce as one unit of A. and if the company were to produce only A it would have time to produce 2000 units per day. The availability of raw – materials is sufficient to produce 1500 units per day of both A and B combined. Product B requiring a special ingredient only 600units can be made per day. If A fetches a profit of Rs. 2 per unit and B a profit of Rs.4 per unit. Find the optimum product mix by formulating LPP. **(07 Marks)**

c. Solve the following LPP by graphical method :

Max $z = 100x_1 + 40x_2$

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

$3x_1 + 2x_2 \le 900$

$x_1 + 2x_2 \le 500$

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

2 a. Solve the following LPP by Big – M method :

Maximize $z = -2x_1 - x_2$

Subject to $3x_1 + x_2 = 3$

$4x_1 + 3x_2 \ge 6$

$x_1 + 2x_2 \le 4$

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

b. Find the dual of the following LPP and solve it.

maximize $z = 5x_1 - 2x_2 + 3x_3$

subject to $2x_1 + 2x_2 - x_3 \ge 2$

$3x_1 - 4x_2 \le 3$

$x_2 + 3x_3 \le 5$

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

3 a. Use dual simplex method to solve the LPP :

Maximize $z = -2x_1 - x_3$

Subject to $x_1 + x_2 - x_3 \ge 5$

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

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

b. Use revised simplex method to solve the following LPP :

maximize $z = x_1 + x_2$

subject to $2x_1 + 5x_2 \le 6$

$x_1 + x_2 \ge 2$

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

4 a. Five men are available to do five different jobs. Form past records, the time (in hours) that each man takes to do each job is known and given in the following table. **(10 Marks)**

Man	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

b. Solve the travelling – salesman problem given by the following data :
$C_{12} = 20$ $C_{13} = 4$ $C_{14} = 10$ $C_{23} = 5$ $C_{34} = 6$ $C_{25} = 10$ $C_{35} = 6$ $C_{45} = 20$
Where $C_{ij} = C_{ji}$ and there is no route between cities i and j if the value for C_{ij} is not shown. **(10 Marks)**

PART – B

5 a. Explain stepping stone method in problems. **(05 Marks)**

b. Find the basic feasible solution of the following transportation problem by NWCR. Also find the optimal transportation plan.

	1	2	3	4	5	Available	
A	4	3	1	2	6	80	
B	5	2	3	4	5	60	
C	3	5	6	3	2	40	
D	2	4	4	5	3	20	
Required	60	60	30	40	10	200	Total

(15 Marks)

6 a. Explain the characteristics of game theory. **(05 Marks)**

b. Reduce the following game by dominance property and solve it. **(07 Marks)**

		Player B			
		I	II	III	IV
Player A	I	3	2	4	0
	II	3	4	2	4
	III	4	2	4	0
	IV	0	4	0	8

c. Solve the following game by graphical method.

		B		
		I y_1	II y_2	III y_3
A	x_1 I	1	3	11
	$1-x_1$ II	8	5	2

(08 Marks)

7 a. Explain the basic steps in PERT – CPM. **(06 Marks)**

b. A project has the following schedule.

Activity	Time in weeks	Activity	Time in weeks
(1 – 2)	4	5 – 7	8
(1 – 3)	1	6 – 8	1
(2 – 4)	1	7 – 8	2
(3 – 4)	1	8 – 9	1
(3 – 5)	6	8 – 10	8
(4 – 9)	5	9 – 10	7
(5 – 6)	4	–	–

Construct PERT network and compute :

i) T_E and T_L for each event

ii) Float for each activity

iii) Critical path and its duration. **(14 Marks)**

8 a. Mention the situations for the replacement of models **(04 Marks)**

b. The probability P_n of failure just before are n is shown below. If individual replacement cost is Rs. 12.50 and group replacement costs is Rs. 3.00 per item. Find the optimal replacement policy.

n	1	2	3	4	5
P_n	0.1	0.2	0.25	0.3	0.15

(16 Marks)

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10EE661

Sixth Semester B.E. Degree Examination, June / July 2014
Operations Research

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Quantitative / Statistical / Normal distribution Tables permitted.***

PART – A

1 a. Explain the following with respect to simplex method:
i) Dealing with unrestricted variables.
ii) Degeneracy and how it can be resolved. **(06 Marks)**

b. Explain the formulation of dual when primal problem contains constraints with,
i) Equal sign.
ii) Unrestricted variable. **(04 Marks)**

c. Solve the following linear programming problem using Charne's penalty method:
Maximize $z = -2x_1 - x_2$
Subjected to, $3x_1 + x_2 = 3$
$4x_1 + 3x_2 \geq 6$
$x_1 + 2x_2 \leq 4$
$x_1, x_2 \geq 0$ **(10 Marks)**

2 a. A farmer has 100 acre land. He can sell all tamotoes and radishes he can raise. The price he can obtain is Rs.1.0 per kg for tomotoes and Rs.2.0 per kg for radishes. The average yield per acre is 2000 kgs of tomotoes and 1000 kgs of radishes. Fertilizer is available at Rs.0.5 per kg and the amount required per acre is 100 kgs for tomotoes and 50 kgs for radishes. Labour required for sowing, cultivating and harvesting per acre is 5 man days for tomotoes and 6 man days for radishes. A total of 400 man days of labour are available at Rs.20 per man day. Formulate this problem as linear programming problem to maximize the farmers total profit. Also solve the problem using graphical method. **(10 Marks)**

b. Using two phase simplex method solve the following linear programming problem:
Maximize $z = 3x_1 - x_2$
Subjected to, $2x_1 + x_2 \geq 2$
$x_1 + x_2 \leq 2$
$x_2 \leq 4$
$x_1, x_2 \geq 0$ **(10 Marks)**

3 a. Solve the LPP given below using revised simplex method.
Maximize $z = 6x_1 - 2x_2 + 3x_3$
Subjected to, $2x_1 - x_2 + 2x_3 \leq 2$
$x_1 + 4x_3 \leq 4$
$x_1, x_2, x_3 \geq 0$ **(15 Marks)**

b. Explain in brief, the essence of parametric programming in operations research. **(05 Marks)**

4 a. Indian cricket team has five very good batsmen with five batting positions needs to be assigned. Following table gives batting averages of each of these batsmen in all five batting positions. How should the batting position be allocated so as to minimize match loosing percentage? **(10 Marks)**

Batting Positions / Batsman	I	II	III	IV	V
SACHIN	59.49	61.52	56.97	18.55	50.43
KOHLI	60.62	58.23	40.37	32.28	49.40
PUJARA	34.50	50.89	51.85	48.10	43.54
DHONI	45.54	58.05	54.12	36.41	44.83
SEHWAG	31.42	49.43	51.09	59.57	43.57

b. Solve the traveling salesman problem, given the cost matrix as shown below: **(10 Marks)**

		To City			
		A	B	C	D
From City	A	-	46	16	40
	B	41	-	50	40
	C	82	32	-	60
	D	40	40	36	-

PART – B

5 a. Karnataka power corporation has three electric power plants that supply the needs of five cities. Each power plant can supply the following numbers of kWh of electricity:
Sharavathi plant : 8 million units
Raichur plant : 12 million units
Varahi plant : 14 million units
The peak power demands of these five cities are as follows (in kWh):
Bangalore : 4 million units
Mysore : 4 million units
Mangalore : 6 million units
Tumkur : 8 million units
Davanagere : 8 million units
The cost of sending 1 million kWh of electricity from different plants to each city is given in table below. To minimize the cost of meeting each city's peak power demand, formulate a balanced transportation problem. Obtain initial basic feasible solution by VAM method and optimal solution by MODI method. **(14 Marks)**

	Bangalore	Mysore	Mangalore	Tumkur	Davangere
Sharavathi plant	4	2	3	2	6
Raichur plant	5	4	5	2	1
Varahi plant	6	5	4	7	3

b. i) List out the differences between transportation and assignment problem.
ii) Write any three differences between a balanced and an unbalanced transportation problem. **(06 Marks)**

6 a. What is a game strategy? Explain in brief, pure strategy and mixed strategy as applicable to game theory. **(05 Marks)**

b. Write any three properties of a competitive game. **(03 Marks)**

c. Define the following with respect to game theory:
i) Pay off matrix.
ii) Game of choice. **(02 Marks)**

6 d. Two players Prakruthi and Sudheeksha play a game in which each has thre coins: a 5 paise, a 10 paise and 20 paise. Each selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount Prakruthi wins Sudheeksha's coins. If the sum is even Sudheeksha wins Prakruthi's coins.

i) Develop a pay off matrix with respect to player Prakruthi.

ii) Find the optimal strategies for the players. What is the value of the game?

(10 Marks)

7 a. A project consists of a series of tasks labelled A, B, ...H, I with the following relationships.[w < x, y means x and y cannot start untill w is completed) with this notation, construct the network diagram having the following constraints:

A < D, E; B, D < F; C < G; B < H; F, G < I

Find also the minimum time of completion of the project when the time (in days) of completion of each task is as follows:

Task:	A	B	C	D	E	F	G	H	I
Time:	23	8	20	16	24	18	19	4	10

Further determine

i) Earliest start time [ES] ii) Earhest Finish time [EF]

iii) Latest start time [LS] iv) Latest finish time [LF]

v) Total Float time [TF]

(08 Marks)

b. A small project is composed of seven activities whose time estimates are listed in table below:

Activity		1 – 2	1 – 3	1 – 4	2 – 5	3 – 5	4 – 6	5 – 6
Estimated Duration in Weeks	Optimistic	1	1	2	1	2	2	3
	Most likely	1	4	2	1	5	5	6
	Pessimistic	7	7	8	1	14	8	15

i) Draw the project network.

ii) Find the expected duration and variance of each activity.

iii) Calculate early and late occurance times for each event, what is the expected project length?

iv) Calculate the variance and standard deviation of project length? What is the probability that the project will be completed?

- at least 4 weeks earlier than expected?
- Not more than 4 weeks earlier than expected.

v) If the project due date is 19 weeks, what is the probability of meeting the due date.

(12 Marks)

8 a. The data on running costs per year and resale price of equipment A whose purchase price is 2 lakhs are as follows:

Year	1	2	3	4	5	6	7
Running costs in Lakhs	0.30	0.38	0.46	0.58	0.72	0.90	1.10
Resale value in Lakhs	1	0.50	0.25	0.12	0.08	0.08	0.08

i) What is the optimum period of replacement?

ii) When equipment A is two years old, equipment B which is new model for the same usage is available. The optimum period for replacement is 4 years with an average cost of Rs.72000. Should equipment A be changed with equipment B? If so, when?

(12 Marks)

b. Why do we need to replace machines? List out different replacement strategies. Also explain in brief, various types of failures which are responsible for replacement of machines.

(08 Marks)

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