NEW SCHEME **IP61**

USN

Sixth Semester B.E. Degree Examination, July/August 2005

ME/IM/IP/MA/AU/CC/MI

Operations Research

Time: 3 hrs.] [Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Use of statistical tables permitted.

1. (a) What are the various phases of O.R. problems? Explain them briefly. **(5 Marks)**

(b) Explain the applications of O.R. in industry. **(5 Marks)**

(c) A toy company manufactures two types of dolls, a basic version doll A and a deluxe version doll B. Each doll of type B takes twice as long to produce as one of type A and the company would have time to make a maximum of 2000 per day. The supply of plastic is sufficient to produce 1500 dolls per day (both A and B combined). The deluxe version requires a fancy dress of which there are only 600 per day available. If the company makes a profit of Rs.3/- and Rs.5/- per doll respectively on doll A and B, then how many of each doll should be produced per day in order to maximize the total profit. Formulate this problem and solve it graphically. **(10 Marks)**

2. (a) Define the following :

i) Unbounded solution

ii) Slack & surplus variable

iii) Basic feasible solution. **(6 Marks)**

(b) Maximize $Z = 5x_1 - 2x_2 + 3x_3$

Subject to

$$2x_1 + 2x_2 - x_3 \geq 2$$

$$3x_1 - 4x_2 \leq 3$$

$$x_2 + 3x_3 \leq 5$$

and $x_1, x_2, x_3 \geq 0$ **(14 Marks)**

3. (a) Use M-technique and solve the following:

Minimize $Z = 4x_1 + x_2$

Subject to

$$3x_1 + x_2 = 3$$

$$4x_1 + 3x_2 \geq 6$$

$$x_1 + 2x_2 \leq 3$$

$$x_1, x_2 \geq 0$$

(10 Marks)

Contd.... 2

(b) The rate of arrival of customers at a public telephone booth follows poisson distribution, with an average time of 10 minutes between one customer and the next. The duration of a phone call is assumed to follow exponential distribution, with mean time of 3 minutes

i) What is the probability that a person arriving at the booth will have to wait?

ii) What is the average length of the non-empty queues that form from time to time?

iii) The telephone department will install a second booth when it is convinced that the customers would expect waiting for atleast 3 minutes for their turn to make a call. By how much time should the flow of customers increase in order to justify a second booth?

iv) Estimate the fraction of a day that the phone will be in use. **(10 Marks)**

4. (a) Explain how to solve the degeneracy in transportation problems. **(4 Marks)**

(b) Solve the following transportation problem to maximise profit and give criteria for optimality.

Profit (Rs.) / Unit

Origin \ destination	1	2	3	4	supply
A	42	27	24	35	200
B	46	37	32	32	60
C	40	40	30	32	140
Demand	80	40	120	60	

(16 Marks)

5. Explain the steps involved in solving assignment problem using Hungarian method. **(6 Marks)**

(b) A salesman has to visit five cities A,B,C,D and E. The distance (in hundred km) between the five cities are as follows.

From \ To	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	-

If the salesman starts from city A and has to come back to city A, which route shoud he select so that the total distance travelled is minimum? **(14 Marks)**

6. (a) Define the following terms with reference to PERT. **(6 Marks)**

i) Total float ii) Free float iii) Independent float

Contd.... 3

(b) A project has the following characteristics :

Task	1-2	1-3	2-3	1-4	3-5	4-5	4-6	5-7	5-6	6-8	7-8
Least time	4	5	8	2	4	6	8	5	3	5	6
Greatest time	8	10	12	7	10	15	16	9	7	11	13
Most likely time	5	7	11	3	7	9	12	6	5	8	9

Find the earliest and latest expected times for each event. Also find critical path and variance for each event. (14 Marks)

7. Explain the Fulkerson's rule of numbering the nodes. (6 Marks)

(b) A small project is having seven activities. The relevant data about these activities is given below. Indirect cost per day is Rs. 100/-

Activity	Dependence	Normal duration (days)	Crash duration (days)	Normal cost (Rs.)	Crash cost (Rs.)
A	-	7	5	500	900
B	A	4	2	400	600
C	A	5	5	500	500
D	A	6	4	800	1000
E	B,C	7	4	700	1000
F	C,D	5	2	800	1400
G	E,F	6	4	800	1600

i) Find out the normal duration and the cost.

ii) Crash the network to complete in 21 days. What is the percentage increase in cost to complete in 21 days? (14 Marks)

8. (a) Define :

i) pay off matrix ii) saddle point iii) pure & mixed strategies. (4 Marks)

(b) Solve the following game by dominance method

		B			
		I	II	III	IV
A	I	6	8	3	13
	II	4	1	5	3
	III	8	10	4	12
	IV	3	6	7	12

(8 Marks)

Contd.... 4

(c) Solve the game graphically whose pay off matrix for the player A is given below.

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

(8 Marks)

** * **

NEW SCHEME

IP61

Reg. No.

Sixth Semester B.E. Degree Examination, January/February 2006

IP/ME/IM/MA/AU/CC/MI
Operations Research

(Max.Marks : 100

Time: 3 hrs.)

Note: *1) Answer any FIVE full questions.*
2) use of statistical data book is permitted.

1. (a) What are the steps involved in operations research? Explain in brief. **(5 Marks)**

   (b) What are the limitations of operations research? **(5 Marks)**

   (c) Consider the following constraints

   $x_1 + 2x_2 \geq 10$; $-x_1 + x_2 \leq 10$ *and* $x_2 \geq 0$

   Represent the constraints graphically and clearly show the feasible region. Draw two iso-Z lines if $Z = x_1 + x_2$. Show the direction of improvement of Z if Z is to be minimized. Find the minimum value of Z. What can be the maximum value of Z? **(10 Marks)**

2. (a) Define 'Basic feasible solution'. Find all basic solutions for the following problem and group them into basic feasible solution and basic infeasible solution.

   Maximise $Z = x_1 + x_2 + 7x_3$

   Subject to $x_1 + x_2 - 2x_3 \leq 10$ *and*

   $x_1, x_2, x_3 \geq 0$ **(6 Marks)**

   (b) Solve the following problem either by Big M method or by dual Simplex method. **(10 Marks)**

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

   Subject to $2x_1 + 3x_2 + 5x_2 \geq 2$

   $3x_1 + x_2 + 7x_3 \leq 3$

   $x_1 + 4x_2 + 6x_3 \leq 5$

   (c) With reference to the solution of LPP by Simplex method/table, when one can conclude as the problem has

   i) unbounded solution and ii) no feasible solution. **(4 Marks)**

3. (a) Write the dual for the following primal :

   Minimise $Z = 3x_1 + x_2 - 7x_3$

   Subject to $x_1 - 2x_2 + 3x_3 \leq 10$

   $3x_1 + 5x_2 - x_3 \geq 9$

   $-x_1 - 4x_2 + x_3 = 6$

   x_1 unrestricted ; $x_2, x_3 \geq 0$ **(6 Marks)**

   (b) Explain in brief the term 'Artificial variable' used in Big-M method. **(4 Marks)**

Contd.... 2

(c) A machine operator processes five types of items on his machine each week and must choose a sequence for them. The setup cost per change depends on the item presently on the machine and the setup to be made according to the following table :

		To Items				
		A	B	C	D	E
From item	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 item once and only once each week, how should he sequence the items on his machine in order to minimize the total setup cost?

(10 Marks)

4. A company manufacturing air-coolers has two plants located at Bombay and Calcutta with a capacity of 200 units and 100 units per week respectively. The company supplies the air-coolers to its four show rooms situated at Ranchi, Delhi, Lucknow and Kanpur which have a maximum demand of 75, 100, 100 and 30 units respectively. Due to variation in raw material cost and transportation cost, the profit per unit in rupees differs with places which is shown below :

	Ranchi	Delhi	Lucknow	Kanpur
Bombay	90	90	100	110
Calcutta	50	70	130	85

Due to contractual obligation a minimum of 10 aircoolers produced in Calcutta should be supplied to Ranchi. Find the optimum production supply schedule to maximize the profit.

(20 Marks)

5. (a) The owner of a small machine shop has four machinists available to assign to jobs for the day. Five jobs are offered with the expected profit in rupees for each machinist on each job as shown below :

		Job				
		A	B	C	D	E
Machinist	1	6.20	7.80	5.00	10.10	8.20
	2	7.10	8.40	6.10	7.30	5.90
	3	8.70	9.20	11.10	7.10	8.10
	4	4.80	6.40	8.70	7.70	8.00

Find the assignment of machinists to jobs that will result in a maximum profit. Which job should be declined?

(10 Marks)

(b) State the basic elementis of a queuing model. **(4 Marks)**

(c) In a railway marshalling yard, goods train arrive at a rate of 30 trains per day. Assuming arrival and service as per Poisson and exponential distributions and mean service time of 36 minutes, calculate

i) the mean queue size (including train being served)

ii) the probability that the queue size exceeds 10. **(6 Marks)**

6. (a) The Fig.Q6(a) shown below indicates the project network alongwith three time estimates for each activity.

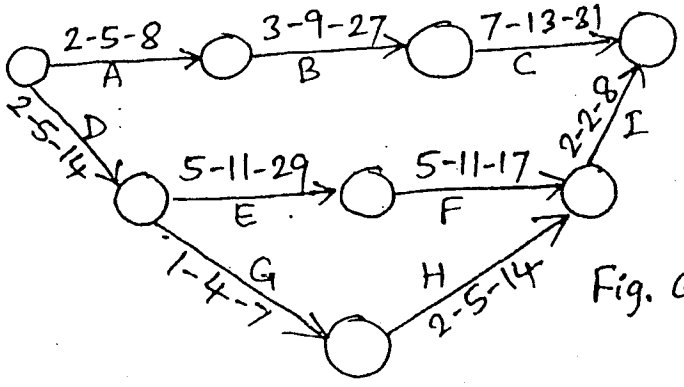

Fig. Q 6 (a)

i) Number the nodes as per Fulkerson's rule.

ii) Value of expected time, standard deviation and variance of each activity.

iii) Critical path.

iv) Variance of critical path.

v) Probability of completion of project in 38 days. **(12 Marks)**

(b) What is the shortest route from plant to site for the network shown in fig.Q6(b).

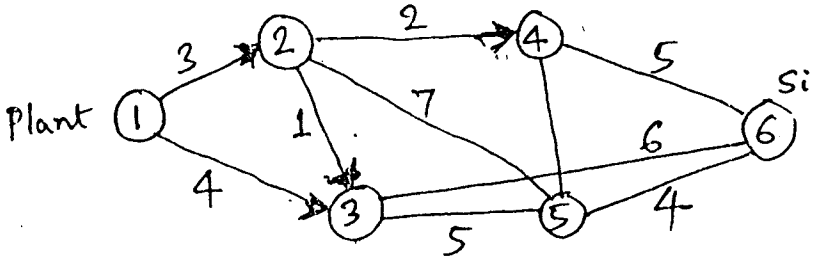

Fig. Q 6 (b).

(8 Marks)

7. (a) The information regarding a project is summarised in the table below. Find out the optimum project duration and the corresponding cost.

Activity	Preceding activity	Normal time (weeks)	Crash time(weeks)	Normal cost(Rs.)	Crash Cost (Rs.)
A	-	5	4	600	800
B	-	3	1	400	600
C	-	8	5	900	1200
D	A	4	2	600	1200
E	B	4	3	500	700

Contd.... 4

(20 Marks)

8. (a) Define saddle point. Is it necessary that a game should always possess a saddle point? (4 Marks)

(b) For what value of λ, the game with the following payoff matrix has a saddle point?

$$\begin{array}{cc} & B \\ & \begin{matrix} B_1 & B_2 & B_3 \end{matrix} \\ A \begin{matrix} A_1 \\ A_2 \\ A_3 \end{matrix} & \begin{bmatrix} \lambda & 6 & 2 \\ -1 & \lambda & -7 \\ -2 & 4 & \lambda \end{bmatrix} \end{array}$$

(6 Marks)

(c) Solve graphically

$$\begin{array}{cc} & B \\ & \begin{matrix} 1 & 2 & 3 & 4 \end{matrix} \\ A \begin{matrix} 1 \\ 2 \end{matrix} & \begin{bmatrix} -6 & 0 & 6 & -15 \\ 7 & -3 & -8 & 2 \end{bmatrix} \end{array}$$

(10 Marks)

** * **

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006
IP/ME/IM/MA/AU/CC/MI
Operations Research

Time: 3 hrs.] [Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***

1 a. Discuss the areas of management where operation research techniques are applied. **(06 Marks)**

b. A manufacturer of a line of patent medicines is preparing a production plan on medicines A and B. There are sufficient ingredients available to make 20,000 bottles of A and 40,000 bottles of B, but there are only 45,000 bottles into which either of the medicines can be put. Further more, it takes 3 hours to prepare enough material to fill 1,000 bottles of A, it takes one hour to prepare enough material to fill 41,000 bottles of B and there are 66 hours available for this operation. The profit is Rs.8 per bottle of A and Rs.7 per bottle of B.

i) Formulate this problem as an L.P.P to maximize the profit.

ii) Solve it graphically. **(14 Marks)**

2 a. Define : i) Basic solution ii) Surplus variable. **(04 Marks)**

b. Solve the following L.P.P using simplex method.

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

Subject to : $x_1 + 4x_2 + 2x_3 \geq 8$

$3x_1 + 2x_2 \geq 6$

$x_1, x_2 \geq 0$ **(16 Marks)**

3 a. Solve the following L.P.P by dual simplex method:

Minimize $Z = 2x_1 + x_2$

Subject to: $3x_1 + x_2 \geq 3$

$4x_1 + 2x_2 \geq 6$

$x_1 + 2x_2 \geq 3$

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

b. A box office ticket window is being manned by a single server. Customers arrive to purchase tickets according to a Poisson input process with a mean rate of 30 per hour. The time required to serve a customer has an exponential distribution with a mean of 90 seconds. Calculate,

i) Mean queue length, L.

ii) Mean line length, Lq.

iii) Mean waiting time in the system, W.

iv) Mean waiting time in the line, Wq. **(08 Marks)**

4 a. With respect to transportation problems, what is degeneracy and how is it tackled? **(05 Marks)**

Contd....2

4 b. A company has factories at A, B and C, which supply warehouses at D, E, F and G. Monthly factory capacities are 160, 150 and 190 units respectively. Monthly warehouse requirements are 80, 90, 110 and 160 units respectively. Unit shipping costs (in Rs.) are as follows:

TO

FROM	D	E	F	G
A	42	48	38	37
B	40	49	52	51
C	39	38	40	43

Determine the optimum distribution for this company to minimize shipping costs. Also find the minimum cost. **(15 Marks)**

5 a. Distinguish clearly between assignment problem and transportation problem. **(04 Marks)**

b. Find the optimal assignment plan and optimal cost for the following problem: **(08 Marks)**

	1	2	3	4	5	6
A	12	10	15	22	18	8
B	10	18	25	15	16	12
C	11	10	3	8	5	9
D	6	14	10	13	13	12
E	8	12	11	7	13	10

c. Given the matrix of set up costs below, show how to sequence the production, so as to minimize the set up cost. **(08 Marks)**

	A_1	A_2	A_3	A_4	A_5
A_1	∞	2	5	7	1
A_2	6	∞	3	8	2
A_3	8	7	∞	4	7
A_4	12	4	6	∞	5
A_5	1	3	2	8	∞

6 a. Differentiate between event and activity with examples. **(04 Marks)**

b. The table below gives the list of jobs and their duration in days:.

JOBS	DURATION
1-2	5
1-3	4
1-4	2
2-4	1
4-5	4
3-5	6
4-6	2
6-7	5
2-7	2
5-7	4
3-4	0
2-6	2

i) Draw the network.
ii) Determine EST, EFT, LST, LFT and Total Float.
iii) Find the critical path. **(16 Marks)**

Contd....3

7 a. Distinguish clearly between PERT and CPM. (05 Marks)

b. Given below is the list of Jobs, and their duration and cost:

JOBS	NORMAL		CRASH	
	DURATION (DAYS)	COST (RS.)	DURATION (DAYS)	COST (RS.)
1-2	3	50	2	100
1-4	6	140	2	260
1-3	2	50	1	80
2-4	5	100	3	180
3-5	2	50	2	50
2-5	7	120	5	180
4-5	4	100	2	240

The indirect cost of the project is Rs.50 per day.
Determine the optimum duration and cost of the project. (15 Marks)

8 a. Explain the terms : i) Saddle point ii) Pay-off matrix (04 Marks)

b. Use dominance to solve the following game: (08 Marks)

		PLAYER B			
		I	II	III	IV
PLAYER A	1	6	2	4	8
	2	2	-1	1	12
	3	2	3	3	9
	4	5	2	6	10

c. Solve the following game graphically : (08 Marks)

		A			
		1	2	3	4
B	I	1	4	-2	-3
	II	2	1	4	5

*****

IP61

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2007
IP/IM/ME/MA/CC/MI/AU
Operations Research

Time: 3 hrs.] [Max. Marks:100

Note :1. ***Answer any FIVE full questions.***
2. ***Use of statistical tables permitted.***

1 a. List and explain briefly the phases of operation research. **(05 Marks)**

b. A company has two grades of inspectors A and B. It is required that atleast 1800 pieces to be inspected per day of 8 hours. Grade A inspector can check at the rate of 25 pieces per hour with an accuracy of 98%. Grade B inspector can check at the rate of 15 pieces per hour with 95% accuracy. The wage rate for grade A inspector is Rs.20/hr and that of Grade B inspector is Rs.15/hr. Each time an error is made by an inspector the cost to company is Rs.10. There are 8 grade 'A' inspectors and 10 grade B inspectors available for service. Determine the optimal assignment of inspectors that will optimize the total cost of inspection. Solve graphically the above LPP. **(15 Marks)**

2 a. Find the optimal value Z of the following LPP by inspecting its dual only (Do not solve it).

Minimize $Z = 4x_1 + 5x_2 + 3x_3 + 4x_4$

Subject to the

$2x_1 + 6x_2 + 3x_3 - 4x_4 \geq 50$

$x_1, x_2, x_3, x_4 \geq 0$ **(05 Marks)**

b. Solve the following LPP:

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

Subject to the

$-3x_1 + 2x_2 + 2x_3 = 8$

$-3x_1 + 4x_2 + x_3 = 7$

$x_1, x_2, x_3 \geq 0$ **(15 Marks)**

3 a. At what rate must the clerk of a super market work in order to ensure a probability of 0.9 that the customer will not have to wait longer than 12 minutes in the system? It is assumed that the arrivals follow Poisson distribution at an average rate of 15/hr. The length of service by the clerk has an exponential distribution. **(05 Marks)**

b. A mechanic is to be hired to repair machines which break down at an average rate of 3 /hour. Breakdowns are distributed in time in a manner that may be regarded as Poisson. The non-productive time on any machine is considered to cost the company Rs.5/hour. The company has narrowed the choice of two mechanics A and B. The mechanic A costs Rs. 3/hour and will service the machines exponentially at an average rate of 4/hour. The mechanic B cost Rs.5/hour and can repair machines exponentially at an average rate of 6/hour. Decide which mechanic should be hired. **(15 Marks)**

Contd....2

4 a. Differentiate between PERT and CPM. **(04 Marks)**

b. A project consists of the activities as given in the table below :

Job	A	B	C	D	E	F	G	H	J	K	L	M
Duration (days)	13	5	8	10	9	7	7	12	8	9	4	17

Constraints :

- A and B are starts.
- A controls C, D and E.
- B controls F and K.
- G depends on C.
- H depends on D.
- E and F control J and M.
- L depends on K.
- M is also controlled by L.

i) Draw the network of the above project. **(05 Marks)**

ii) Find the critical path and project duration. **(04 Marks)**

iii) Calculate the EST, EFT, LST, LFT, TF and FF for each activity. **(07 Marks)**

5 Table below shows the activities with their normal duration, normal cost, crash duration and crash cost. The overhead cost is Rs.300/day.

Activity	Normal duration in days	Normal cost in Rs.	Crash duration in days	Crash cost in Rs.
1 – 2	6	1400	4	1900
1 – 3	8	2000	5	2800
2 – 3	4	1100	2	1500
2 – 4	3	800	2	1400
3 – 4	-	-	-	-
3 – 5	6	900	3	1600
4 – 6	10	2500	6	3500
5 – 6	3	500	2	800

a. Draw the network and determine the normal length and its cost. **(06 Marks)**

b. Find the optimum duration and its cost. **(07 Marks)**

c. If all the activities are crashed to the maximum possible extent, what is the corresponding cost of the project? **(07 Marks)**

6 a. Differentiate between transportation problems and assignment problem. **(04 Marks)**

b. A Canning company operates 2 Canning plants. 3 growers are willing to supply fresh fruits in the following amounts:

Grower 1 – 200 quintals at Rs.100/quintal

Grower 2 – 300 quintals at Rs.90/quintal

Grower 3 – 400 quintals at Rs.80/quintal

The shipping cost in rupees per quintal are,

	A	B
G_1	20	25
G_2	10	15
G_3	50	30

Contd.....3

The plant A and B capacity and labor costs are
Plant A capacity – 450 quintals ; Labor cost – Rs. 250 / quintal
Plant B capacity – 350 quintals ; Labor cost – Rs. 200 / quintal
The Canned fruits are sold at Rs.500/quintal to the distributor.
How should the company plan its two plants so as to maximize its profit? **(16 Marks)**

7 a. Solve the following LPP using dual simplex method.

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

Subject to the

$2x_1 + 3x_2 + 5x_3 \geq 2$

$3x_1 + x_2 + 7x_3 \leq 3$

$x_1 + 4x_2 + 6x_3 \leq 5$

$x_1, x_2, x_3 \geq 0$ **(08 Marks)**

b. A college athletic conference has 6 basket ball officials. It must assign to 3 conference games. Two officials must be assigned to each game. The conference office desires to assign the officials such that the total distance traveled by all the six officials will be minimized. The distances each official would have to travel to each game are given below :

		Officials					
		1	2	3	4	5	6
Game	A	20	40	60	20	70	80
	B	45	90	70	60	15	25
	C	10	70	30	40	50	35

The conference office has decided not to assign the officials 4 to game A because of the previous conflicts with one of the coaches. Determine the optimal assignment. **(12 Marks)**

8 a. Deduce the following game by dominance and find the values of the game: **(16 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

b. Explain the following with respect to game theory:
i) Saddle point.
ii) Two person zero sum game.
iii) Mixed strategy.
iv) Pure strategy. **(04 Marks)**

*****

USN | | | | | | | | | | |

IP61

Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Operations Research

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. What are the features of OR approach to any decision problem? Explain in brief. **(06 Marks)**

b. State the limitations of OR. **(04 Marks)**

c. A factory has two bottling plants located at A and B. Each plant produces three drinks – P, Q and R. The number of bottles produced per day are as follows:

Product	Plant at	
	A	B
P	1500	1500
Q	3000	1000
R	2000	5000

In a particular month, there is a demand of 20,000, 40,000 and 44,000 for P, Q and R respectively. The operating cost per day at A and B are Rs.6000 and Rs.4000. For how many days each plant be run for meeting the market demand, to minimize the production cost? Solve graphically and state redundant constraint if there is any. **(10 Marks)**

2 a. Find all the basic solutions to the following problem:

Maximize, $Z = x_1 + 3x_2 + 3x_3$

Subject to $x_1 + 2x_2 + 3x_3 = 4$

$2x_1 + 3x_2 + 5x_3 = 7$

Also, classify them into basic feasible solution and basic infeasible solution. **(08 Marks)**

b. Obtain the dual problem of the following primal LPP:

Minimize, $Z = x_1 - 3x_2 - 2x_3$

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

$2x_1 - 4x_2 \ge 12$

$-4x_1 + 3x_2 + 8x_3 = 10$ **(08 Marks)**

$x_1, x_2 \ge 0$

c. Explain in brief the assumptions of LPP. **(04 Marks)**

3 a. Use Big-M method to

Minimize, $x_1 + 2x_2 + x_3$

Subject to $x_1 + \frac{1}{2}x_2 + \frac{1}{2}x_3 \le 1$

$\frac{3}{2}x_1 + 2x_2 + x_3 \ge 8$ **(10 Marks)**

$x_1, x_2, x_3 \ge 0$

b. Products 1, 2, 3, 4 and 5 are to be processed on a machine. The set-up costs in rupees per change depend upon the product presently on the machine and the set-up to be made and are given by the following data:

$C_{12} = 16$, $C_{13} = 4$, $C_{14} = 12$, $C_{23} = 6$, $C_{24} = 5$, $C_{25} = 8$, $C_{35} = 6$, $C_{45} = 20$, $Cij = Cji$, $Cij = \infty$ for $i = j$ and for all values of i and j not given. Find the optimum sequence of products in order to minimize the total set-up cost. **(10 Marks)**

4 A problem of scheduling the weekly production of certain items for the next four weeks is to be solved. The production cost of the item is Rs.10 for the first two weeks and Rs.15 for the last two weeks. The weekly demands are 500, 800, 1000 and 900, which must be met. The plant can produce a maximum of 700 units per week. In addition, the company can use overtime during second and third week. This increases the weekly production by an additional 200 units, but the production cost increases by Rs.5. Excess production can be stored at a unit cost of Rs.3 per week. How should the production be scheduled so as to minimize the total cost? **(20 Marks)**

5 a. An airline company has drawn up a new flight schedule involving five flights. To assist in allocating five pilots to the flights, it has asked them to state their preference scores by giving each flight a number out of 10. The higher the number, the greater is the preference. Certain of these flights are unsuitable to some pilots owing to domestic reasons. These have been marked with a 'X'. What should be the allocation in order to meet as many preferences as possible? **(10 Marks)**

Pilot \ Flight Number	1	2	3	4	5
1	8	2	X	5	4
2	10	9	2	8	4
3	5	4	9	6	X
4	3	6	2	8	7
5	5	6	10	4	3

b. A super market has two girls running up sales at the counters. If the service time for each customer is exponential with mean of 4 minutes and if people arrive in a Poisson fashion at the rate of 10 an hour.

i) What is the probability of having to wait for service?
ii) What is the expected percentage of idle time for each girl?
iii) If a customer has to wait, what is the expected waiting time? **(10 Marks)**

6 Consider a project having the following activities and their time estimates:

Activity	Immediate predecessor	Activity Time (Weeks)		
		Most Optimistic	Most Likely	Most Pessimistic
A	-	5	4	6
B	-	12	8	16
C	A	5	4	12
D	B	3	1	5
E	D, A	2	2	2
F	B	5	4	6
G	C, E, F	14	10	18
H	G	20	18	34

a. Draw the project network and number the nodes as per Fulkerson's rule.
b. Find the expected duration and variance for each activity.
c. Determine the critical path and the mean project completion time.
d. Calculate the variance and standard deviation of the project length.
e. Find he probability that the project is completed in 36 weeks.
f. If the project manager wishes to be 99% sure that the project is completed on June 30, 2007, when should he start project work? **(20 Marks)**

7 a. Explain reasons for incorporating dummy activities in a network diagram. In what way do these differ from the normal activities? **(06 Marks)**

b. The following tables gives the activities in a construction project and other relevant information:

Activity	Immediate Predecessor	Time (months)		Direct cost (Rs.'000)	
		Normal	Crash	Normal	Crash
A	-	4	3	60	90
B	-	6	4	150	250
C	-	2	1	38	60
D	A	5	3	150	250
E	C	2	2	100	100
F	A	7	5	115	175
G	D, B, E	4	2	100	240

Indirect costs vary as follows:

Months	15	14	13	12	11	10	9	8	7	6
Costs (Rs.'000)	600	500	400	250	175	100	75	50	35	25

Determine the project duration, which will result in minimum total project cost by crashing systematically. **(14 Marks)**

8 a. Define: i) Payoff matrix, ii) Pure and mixed strategies, iii) Saddle point, iv) Rectangular game, v) Game value. **(10 Marks)**

b. Consider the following game:

		B			
		B_1	B_2	B_3	B_4
A	A_1	19	6	7	5
	A_2	7	3	14	6
	A_3	12	8	18	4
	A_4	8	7	13	-1

i) Find maximin and minmax values.

ii) Use dominance rule to reduce the game to either (2 × n) or (m × 2) game and then solve graphically. **(10 Marks)**

*****

USN

06CS661

Sixth Semester B.E. Degree Examination, June-July 2009
Operations Research

Time: 3 hrs. Max. Marks:100

Note: *Answer any 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	Requirements 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 $6x_1 + 4x_2 \leq 24$

$x_1 + 2x_2 \leq 6$

$-x_1 + x_2 \leq 1$

$x_2 \leq 2$, $x_1, x_2 \geq 0$ **(07 Marks)**

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

b. Find all the basic solutions of the following system of equations identifying in each case the basic and non basic variables.

$2x_1 + x_2 + 4x_3 = 11$, $3x_1 + x_2 + 5x_3 = 14$ **(06 Marks)**

c. Using simplex method of tabular form solve the LPP.

Maximize $Z = 4x_1 + 3x_2 + 6x_3$

Subject to $2x_1 + 3x_2 + 2x_3 \leq 440$

$4x_1 + 3x_3 \leq 470$

$2x_1 + 5x_2 \leq 430$

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

3 a. Using two-phase method solve the LPP.

Minimize $Z = 7.5x_1 - 3x_2$

Subject to $3x_1 - x_2 - x_3 \geq 3$

$x_1 - x_2 + x_3 \geq 2$

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

b. Using Big-M method solve the CPP.

Maximize $Z = 2x_1 + x_2$

Subject to $3x_1 + x_2 = 3$

$4x_1 + 3x_2 \geq 6$

$x_1 + 2x_2 \leq 3$

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

4 a. Use Revised Simplex Method to solve the LPP.

Maximize $Z = 3x_1 + 5x_2$

Subject to $2x_1 \leq 4$

$2x_2 \leq 12$

$3x_1 + 2x_2 \leq 18$

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

b. Explain : i) Weak duality property ii) Strong duality property

iii) Complementary solutions property **(06 Marks)**

c. Write the dual of the following :

i) Maximize $Z = 6x_1 + 10x_2$

Subject to $x_1 \leq 14$

$x_2 \leq 16$

$3x_1 + 2x_2 \leq 18$

$x_1, x_2 \geq 0$

ii) Maximize $Z = \begin{pmatrix} 5 & 8 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$

Subject to $\begin{pmatrix} 1 & 2 \\ 1 & 3 \\ 3 & 5 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 5 \\ 10 \\ 20 \end{pmatrix}$

$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} \geq \begin{pmatrix} 0 \\ 0 \end{pmatrix}$ **(04 Marks)**

PART – B

5 a. In Parametric Linear Programming explain about :

i) Systematic changes in the Cj parameters.

ii) Systematic changes in the bj parameters. **(08 Marks)**

b. Using dual simplex method solve the LPP.

Maximize $Z = -3x_1 - 2x_2$

Subject to $x_1 + x_2 \geq 1$

$x_1 + x_2 \geq 7$

$x_1 + 2x_2 \geq 10$

$x_2 \geq 3$

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

6 a. The transporation costs per truck load of cement (in hundreds of rupees) from each plant to each project site are as follows :

		Project sites				
		1	2	3	4	
Factories	1	2	3	11	7	6 Supply
	2	1	0	6	1	1
	3	5	8	15	9	10
		7	5	3	2	17

Demand

Determine the optimal distribution for the company so as to minimize the total transportation cost. **(12 Marks)**

b. Four jobs are to be done on four different machines. The cost (in rupees) of producing i^{th} job on the j^{th} machine is given below :

		Machines			
		M_1	M_2	M_3	M_4
Jobs	J_1	15	11	13	15
	J_2	17	12	12	13
	J_3	14	15	10	14
	J_4	16	13	11	17

Assign the jobs to different machines so as to minimize the total cost. **(08 Marks)**

7 a. Solve the game whose payoff matrix to the player A is given below :

		B		
		I	II	III
A	I	1	7	2
	II	6	2	7
	III	5	2	6

(10 Marks)

b. Solve the following (2 x 3) game graphically.

			Y_1	Y_2	Y_3
			I	II	III
A	x_1	I	1	3	11
	$1-x_1$	II	8	5	2

(10 Marks)

8 a. Use Tabu Search algorithm to find the optimal solution of **(08 Marks)**

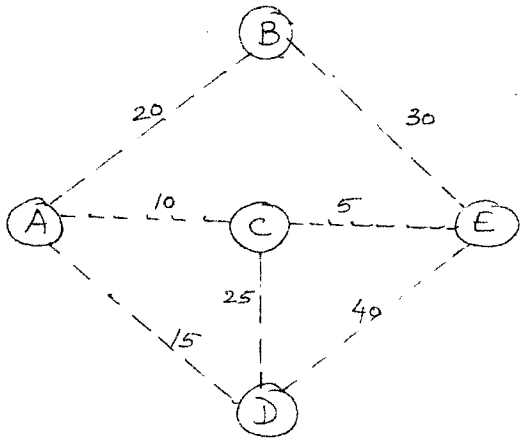

Fig. Q8 (a)

b. Give note on outline of a Basic Simulated Annealing Algorithm. **(06 Marks)**

c. Give note on outline of a Basic Genetic Algorithm. **(06 Marks)**

* * * * *

USN | | | | | | | | | | |

06CS/IS661

Sixth Semester B.E. Degree Examination, May/June 2010
Operations Research

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Explain the following :
   i) Origin, nature and impact of OR.
   ii) Defining the problem and gathering the data. **(10 Marks)**

b. A farmer has to plant two kinds of trees P and Q in a land of 4000 sq.m. area. Each P tree requires at least 25 sq.m and Q tree requires at least 40 sq.m. of land. The annual water requirements 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 Q trees to the number of P trees should not be less than $\frac{6}{19}$ and should not be more than $\frac{17}{8}$. The return per tree from P is expected to be one and half times as mush as from Q tree.
Formulate the problem as a LP model. **(10 Marks)**

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

b. Solve the following LPP by simplex method :
Maximize $Z = 6x_1 + 8x_2$
Subject to $2x_1 + 8x_2 \leq 16$
$2x_1 + 4x_2 \leq 8$
$x_1, x_2 \geq 0$ **(10 Marks)**

3 a. Explain in detail the computer implementation of simplex method and available software option for linear programming. **(10 Marks)**

b. Explain the postoptimality analysis of linear programming. **(05 Marks)**

c. Explain the two phase technique procedure of solve LPP in simplex method. **(05 Marks)**

4 a. Explain the relation between the solution of the primal and the dual. **(05 Marks)**

b. Find the dual of the following problem :
Minimize $Z = 2x_2 + 5x_3$
Subject to $x_1 + x_2 \geq 2$
$2x_1 + x_2 + 6x_3 \leq 6$
$x_1 - x_2 + 3x_3 = 4$
$x_1, x_2, x_3 \geq 0$ **(05 Marks)**

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

PART – B

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

Minimize $Z = 3x_1 + x_2$

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. Explain how sensitivity analysis has been applied. **(05 Marks)**

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

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. The owner of a small machine shop has four machines available to assign for the jobs. Five jobs are offered to assign, with the expected profits in hundreds of rupees for each machine on each job being as follows :

Job

Machines	1	2	3	4	5
A	6.2	7.8	*	10.1	8.2
B	7.0	8.4	6.5	7.5	6.0
C	8.7	9.2	11.1	7.0	8.2
D	*	6.4	8.7	7.7	8.0

* indicates that machine A and D cannot perform the jobs 3 and 1 respectively. Find the assignment of jobs to machinies that will result in the maximum profit. **(10 Marks)**

7 a. Solve the following game graphically : **(10 Marks)**

Player B

Player A	B_1	B_2	B_3
A_1	2	6	22
A_2	16	10	4

b. Explain in detail decision making without experimentation. **(05 Marks)**

c. Explain the details of solving simple games in game theory. **(05 Marks)**

8 a. Explain in detail, the minimum spanning tree problem with constraints. **(06 Marks)**

b. Outline the general procedure for generating a child from a pair of parents. **(06 Marks)**

c. Explain the number of details that need to be worked out to fit structure of the problem. **(08 Marks)**

* * * * *