BE10-R3: APPLIED OPERATIONS RESEARCH

NOTE:

1. **Answer question 1 and any FOUR questions from 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Time: 3 Hours **Total Marks: 100**

1.

a) In Operations Research (OR) there are two distinct types of computations: those involving simulation and those dealing with mathematical models. Discuss them briefly. Why are computations in OR mathematical models typically iterative?

b) A paper mill produce two grades of paper namely X and Y. Because of raw material restrictions, it cannot produce more than 400 tons of grade X and 300 tons of grade Y in a week. There are 160 production hours in a week. It requires 0.2 and 0.4 hours to produce a ton of products X and Y respectively with corresponding profits of Rs. 200 and Rs. 500 per ton. Formulate the above as a linear programming problem to maximize profit.

c) Consider the following problem:

minimize $z = 3x_1+4x_2-5x_3$

subject to

$2x_1+3x_2-5x_3 \geq 10$

$x_1-2x_2-3x_3 \leq 8$

$x_1,x_2,x_3 \geq 0$

Define the dual problem.

d) What is Critical Path Method (CPM)? What are its main objectives?

e) Arrivals at a telephone both are considered to be following Poisson process with an average time of 10 minute between one arrival and the next. Length of a phone call is assumed to be distributed exponentially with mean 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 queue?

f) Determine the optimal sequence of jobs, which minimizes the total elapsed time based on the following information.

Processing times on the machines A, B, C

Job	A	B	C
1	3	3	5
2	8	4	8
3	7	2	10
4	5	1	7
5	2	5	6

g) The demand rate for an item in a company is 18000 units per year. The company can produce at the rate of 3000 per month. The set-up-cost is Rs. 500 per order and the holding cost is Rs. 0.15 per unit per month. Calculate:

i) optimum manufacturing quantity

ii) maximum inventory.

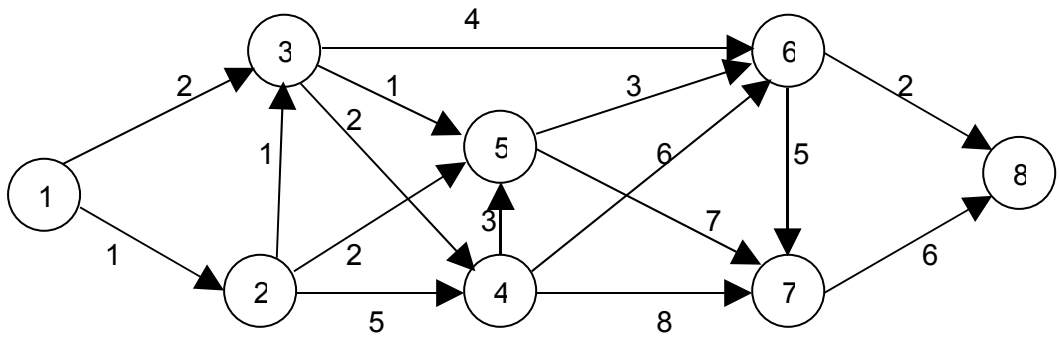
(7x4)

2.

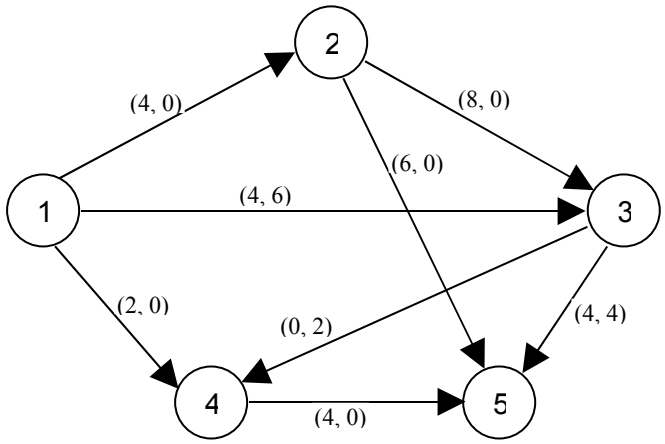
a) The network in the following figure represents the distances in miles between various cities i, i =1, 2, …., 8. Find the shortest routes between the following pairs of cities:

i) City 1 and city 8.

ii) City 2 and City 6.



b) Determine the maximum flow between nodes 1 and 5 for the network given below:



(9+9)

3. Consider the integer linear programming problem:

maximize $Z = 7x_1+9x_2$

subject to

$-x_1+3x_2 \leq 6$

$7x_1+x_2 \leq 35$

x_1, x_2 nonnegative integers.

a) Using branch-and-bound algorithm (B&B), obtain the optimal solution.

b) Outline briefly the steps of B&B algorithm

c) How will you modify B&B algorithm to fit minimization problem?

(8+6+4)

4.

a) Solve the following linear programming problem by simplex method.

Maximize $z = x_1 + x_2 + 3x_3 - x_4$

subject to

$x_1 + 2x_2 + 3x_3 = 15,$

$2x_1 + x_2 + 5x_3 = 20,$

$x_1 + 2x_2 + x_3 + x_4 = 10$ where $x_1, x_2, x_3, x_4 > 0$

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

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

Find the allocation so that the total transportation cost is minimum.

(9+9)

5.

a) A shipping company has single unloading berth with ships arriving in a Poisson fashion at an average rate of there per days. The unloading time distribution of a ship with n unloading crews is found to be exponential with average unloading time 1/2n days. The company has large labour supply without regular working hours, and to avoid long waiting lines, the company has a policy of using as many unloading crew on a ship as there are ships waiting in line or being unloaded.

i) Under these conditions what will be the average number of unloading crew working at any time?

ii) What is the probability that more than 4-crew will be needed?

b) A manufacturing company purchases 9,000 parts of a machine for its annual requirements ordering 1-month usage at a time. Each part cost Rs. 20. The ordering cost per order is Rs. 15 and the carrying charges are 15% of the average inventory per year. You have been asked to suggest a more economical purchasing policy for the company. What advice would you offer? And how much would it save the company per year?

(9+9)

6.

a) The activities for buying a new car are summarized below. Draw the network model and carry out the computations.

Activity	**Description**	**Immediate predecessor(s)**	**Duration (days)**
A	Conduct feasibility study	-	3
B	Find potential customer for present car	A	14
C	List possible models	A	1
D	Research all possible models	C	3
E	Conduct interviews with machines	C	1
F	Collect dealer propaganda	C	2
G	Compile and organize all pertinent information	D, E, F	1
H	Choose top all three choices	G	1
I	Test drive all three choices	H	3
J	Gather warranty and financing information	H	2
K	Chosen one car	I, J	2
L	Compare dealer and chosen dealer	K	2
M	Search for desired color and options	L	4
N	Test drive chosen model once again	L	1
O	Purchase new car	B, M, N	3

b) Discuss the problem of n jobs and m machines and obtains the sequence that minimizes the elapsed time required to complete the following tasks. The processing time is given in hours. Calculate also the idle time.

Job	1	2	3	4	5	6	7	8	9	10
M1	2	3	4	15	3	6	10	15	2	8
M2	6	2	4	10	6	9	15	3	1	0

(9+9)

7.

a) Solve the following problem using dynamic programming.

Minimize $z = \sum_{j=1}^{n} y_j^2$

subject to the constraints

$\prod_{j=1}^{n} y_j = b$, $y_j \geq 0$ for all j .

b) For a game with the following payoff matrix, determine the optimal strategy and the value of the game.

$$\begin{array}{c} \\ A \end{array} \begin{array}{c} \begin{array}{cc} B & \end{array} \\ \begin{pmatrix} 6 & -3 \\ -3 & 0 \end{pmatrix} \end{array}$$

(12+6)