

## BE10-R4: APPLIED OPERATIONS RESEARCH

**NOTE:**

1. Answer question 1 and any FOUR from questions 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) Find the sequence that minimizes the total elapsed time required to complete the following tasks on two machines.

Task	A	B	C	D	E
Machine 1	2	5	4	9	6
Machine 2	6	8	7	4	3

- b) Solve the following matrix game?

$$\begin{pmatrix} 2 & 5 & 4 & 1 \\ 3 & 4 & 5 & 6 \end{pmatrix}$$

- c) Write the dual of the following linear program:

$$\begin{aligned} \text{Max } z &= x_1 - x_2 + x_3 \\ \text{subject to } &x_1 + x_2 + x_3 \leq 100 \\ &x_1 - x_3 \leq 20 \\ &2x_1 - x_2 \leq 6 \\ &x_1, x_2, x_3 \geq 0. \end{aligned}$$

- d) Customers arrive at the ticket counter of a theatre at a rate of 15 per hour. There is one clerk serving the customers at a rate of 30 per hour. Assuming the conditions for use of single channel queuing model, evaluate the probability that there is no customer at a counter.
- e) The production company requires 2400 Kg. of raw material for manufacturing a particular item per year. The price of the item is Rs. 10 per Kg. The cost of placing the order is Rs. 24 and the cost carrying inventory is 20% of the investments in the inventories. Find the economic order quantity.
- f) Find the initial basic feasible solution for the following transportation problem, using Vogel's method:

	1	2	3	4	Supply
1	4	6	9	9	55
2	6	9	6	8	50
3	5	7	6	9	45
Demand	20	30	40	60	

g)

For the function

$$f(x, y) = x^2 - 2xy + y^2 - 3x + 4y$$

find the steepest descent direction at the point (2, -2)

**(7x4)**

2.

a) Solve the following linear program by the simplex method

$$\begin{aligned} \text{Min } z &= 3x_1 + 8x_2 \\ \text{subject to } 5x_1 + 4x_2 &= 14 \\ 2x_1 - x_2 &\leq 4 \\ x_1, x_2 &\geq 0. \end{aligned}$$

b) A child care shop dealing with kids requirements has one cashier who handles all payments. He takes an average 5 minutes per customer. Customers arrive to the cashier randomly but an average of 10 people per hour. What is the average length of waiting line? What is the time for which cashier is idle?

(10+8)

3.

a) Solve the following assignment problem.

		MACHINES				
		1	2	3	4	5
J O B S	1	14	16	18	13	20
	2	21	15	16	27	14
	3	12	14	18	15	21
	4	11	18	19	10	21
	5	16	14	17	12	22

b) Solve the following matrix game whose pay-off matrix is given below.

		Player B			
		I	II	III	IV
Player A	I	30	65	25	5
	II	30	20	15	0
	III	40	50	0	10
	IV	55	60	10	15

(9+9)

4.

a) Find the optimum transportation schedule and minimum cost of transportation for the following data:

	Dest 1	Dest 2	Dest 3	Dest 4	Available
Source 1	19	30	50	10	7
Source 2	70	30	40	60	9
Source 3	40	8	70	20	18
Demand	5	8	7	14	34

b) Suppose two repairers have the responsibility of keeping 5 machines running. Each machine breaks down at the average rate of once every five hour. In addition, both repairers can repair the machines at the average rate of 3/Hour.

- Find the average number of machines waiting to be repaired?
- What is the effective break down rate when considering all five machines?

(9+9)

5.

- a) Suppose several types of furniture must pass through three pre-finishing stages in the same order. Because of the size and complexity of each type of furniture, the processing time at each stage varies considerably.

Type	Stage 1	Stage 2	Stage 3
Chair	7	2	5
Desk	20	3	8
Lamp	6	4	4
End Table	7	3	2
Coffee Table	8	5	2

- i) Determine optimal sequence for processing the five types of furniture through the three stages in order to minimize the total elapsed time.  
 ii) What is the total elapsed time for an optimal sequence?  
 iii) What is the total idle time at Stage1, Stage 2 and Stage 3?
- b) Find the optimal solution of the following integer programming problem using branch and bound method

$$\begin{aligned} \text{Max } z &= 6x_1 + 8x_2 \\ \text{subject to } x_1 + 4x_2 &\leq 8 \\ 7x_1 + 2x_2 &\leq 14 \\ x_1, x_2 &\geq 0 \\ x_1, x_2 &\text{ are integers.} \end{aligned}$$

(9+9)

6.

- a) A company placed 6 orders each of size 200 in an year for a particular item. Given ordering cost is Rs. 600, holding cost is 20%, cost per unit is Rs. 50. Find the loss to the company if it does not adopt any good inventory policy.
- b) A project has the following time schedule.

Task	Predecessors	Time (in days)
A	-	23
B	-	8
C	-	20
D	A	16
E	A	24
F	B, D	18
G	C	19
H	B	4
I	F, G	10

Construct the network diagram. Find the critical path in the network.

(9+9)

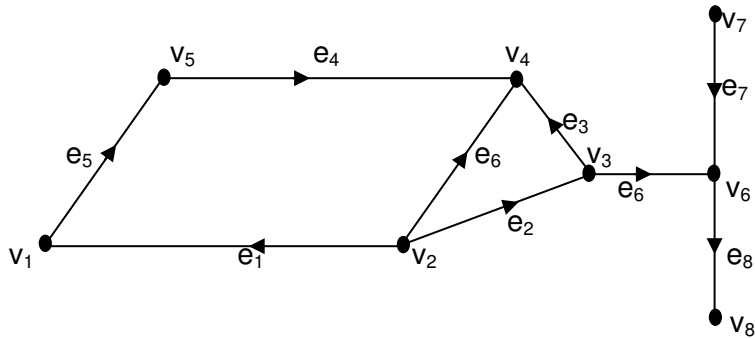
7.

- a) Find all the basic solutions of the following system and classify them as degenerate and non-degenerate ones.

$$2x_1 + 3x_2 - x_3 + x_4 = 4$$

$$x_1 - 2x_2 + x_3 - 2x_4 = 8$$

- b) Consider the following directed graph.



Write the adjacency matrix and incidence matrix of it.

(10+8)