

**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) A city hospital has the following minimal daily requirement for nurses:

Period	Clock Time ( 24 hours day )	Minimum number of nurses required
10:00 a.m. – 2:00 p.m.	6:00 a.m. – 10:00 a.m.	3
32	2:00 p.m. – 6:00 p.m.	10
4	6:00 p.m. – 10:00 p.m.	6
5	10:00 p.m. – 2:00 a.m.	8
6	2:00 a.m. – 6:00 a.m.	6

- Nurses report to the hospital at the beginning of each period and work for 8 consecutive hours. The hospital wants to determine the minimal numbers of nurses to be employed so that there will be sufficient number of nurses available for each period. Formulate this as a linear programming problem by setting up appropriate constraints and objective function.
- b) There are seven jobs, each of which go first over machine 1 and then over machine 2 processing times in hours are given as follows:

Job	Machine 1	Machine 2
A	6	16
B	24	20
C	30	20
D	12	12
E	20	24
F	22	2
G	18	6

- Determine the optimum sequence in which job should be processed.
- c) The number of customers approaching a tailor appears to be Poisson distributed with a mean of 6 customers per hour. The tailor attends the customers at an average rate of 10 customers per hour with the service time exponentially distributed. Determine the probability that there is no customer in the queue. Also determine the expected number of customers waiting for tailor's services.
  - d) Draw a network for the following set of operation:
    - i) A is the initial activity and k is the end activity.
    - ii) A, C, D can start simultaneously
    - iii) B>A
    - iv) E> B , C
    - iv) F, G>D
    - vi) H, I>E, F
    - vii) J>I, G
    - viii) K>H

- e) What is simulation? Explain with the help of an example.  
 f) Solve the following game:

		B		
		I	II	III
A	I	6	8	6
	II	4	12	2

- g) Write the dual of the following:  
 Max.  $z = 5x_1 + 6x_2 + 7x_3$   
 s.t.  $x_1 + 2x_2 + x_3 = 10$   
 $2x_1 + 3x_2 + 5x_3 \leq 8$   
 $x_1, x_2, x_3 \geq 0$ .

**(7x4)**

**2.**

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

$$\begin{aligned} \text{Max. } z &= 3x_1 + 2x_2 + x_3 \\ \text{Subject to } &-3x_1 + 2x_2 + 2x_3 = 8 \\ &-3x_1 + 4x_2 + x_3 = 7 \\ &x_1, x_2, x_3 \geq 0. \end{aligned}$$

- b) A company has three factories at Amethi, Baghpat and Gwalior and four distribution centres at Allahabad, Bombay, Calcutta and Delhi. With identical cost of production at the three factories the only variable cost involved is transportation cost. The production at the three factories is 5,000 tones; 6,000 tones and 2,500 tones respectively. The demand at four distribution centres is 6,000 tones, 4,000 tones, 2,000 tones and 1,500 tones respectively. The transportation costs per tone from different factories to different centres are given below:

Factory	Distribution centre			
	Allahabad	Bombay	Calcutta	Delhi
Amethi	3	2	7	6
Baghpat	7	5	2	3
Gwalior	2	5	4	5

Find the optimum transportation schedule and find the minimum cost of transportation.

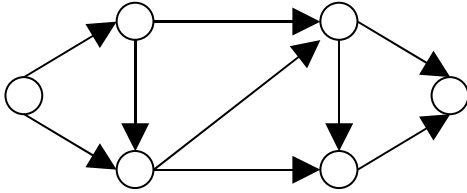
**(9+9)**

**3.**

- a) Determine sequences of seven jobs that will minimize the total elapsed time T. Processing time in hour are given as:

Job	:	1	2	3	4	5	6	7
Machine A	:	3	12	15	6	10	11	9
Machine B	:	8	10	10	6	12	1	3

- b) For the network shown in fig. below the scheduled completion time is 32 days determine the clock time for the events and identify the critical path.



(9+9)

4.

- a) A dentist scheduled all his patients for 30 minute appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following summary shows the various categories of work, their probabilities and the time actually needed to complete the work.

Category	Time required	Prob. of category
Filling	45 minutes	0.40
Crown	60 minutes	0.15
Cleaning	15 minutes	0.15
Extraction	45 minutes	0.10
Check up	15 minutes	0.20

Simulate the dentist clinic for four hours and determine the average waiting time for the patients as well as the idleness of the doctor. Assume that all the patients show up at the clinic at exactly their scheduled arrival time starting at 8 a.m. Use the following random numbers for handling the above problem.

40 82 11 34 25 66 17 79

- b) A and B play a game in which each has 3 coins; 5P, 10P and 20P. Each player selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount A wins B's coin; If the sum is even, B wins A's coin. Find the boot strategy for each player and the value of the game.

(9+9)

5.

- a) Solve the following using dynamic programming:

$\max Z = Y_1 Y_2 Y_3$  subject to the constraints

$$Y_1 + Y_2 + Y_3 = 5$$

$$Y_1, Y_2, Y_3 \geq 0.$$

- b) A particular item has a demand of 9,000 units/year. The cost of one procurement is Rs. 100 and the holding cost/unit is Rs 2.40 per year. The replacement is instantaneous and no shortages are allowed. Determine-
- the economic lot size,
  - the number of orders per year,
  - the time between orders,

(9+9)

6.

- a) There are five jobs to be assigned, one each to 5 machines and the associated cost matrix is given as.

		man				
		I	II	III	IV	V
Job	A	11	17	8	16	20
	B	9	7	12	6	15
	C	13	16	15	12	16
	D	21	25	17	28	26
	E	14	10	12	11	15

Find the optimal assignment that will minimize the total cost.

- b) An auto rickshaw driver finds from his previous record that the cost per year of running an auto rickshaw whose purchase price is Rs. 7,000 is given below:

Year	1	2	3	4	5	6	7	8
Running Cost (Rs.)	1,100	1,300	1,500	1,900	2,400	2,900	3,500	4,100
Price(Rs.)	3,100	1,600	850	475	300	300	300	300

At what age is the replacement due?

(9+9)

7.

- a) There are two market products of brand A & B respectively. Let each of these two brands has exactly 50% of the total market in same period and let the market be of a fixed size. The transition matrix is given by

		To	
		A	B
From	A	0.9	0.1
	B	0.5	0.5

If the initial market share break down is 50% for each brand, then determine their market share in the steady state.

- b) The cost and other factors for a production inventory system of automobile pistons are given below:

Demand per year	6,000 units
Unit cost	Rs. 40
Set up cost	Rs. 500
Production rate per year	36,000 unit
Holding cost per year	Rs. 8
Shortage cost per unit per year	Rs. 20

Find (i) optimum lot size (ii) number of shortages (iii) manufacturing time and time between setups.

(9+9)