

- (b) A T.V. mechanic finds that the time spent on his jobs has an exponential distribution with mean 30 minutes, if he repairs sets in order in which they came in. If the arrival of sets is approximately Poisson with an average rate of 10 per eight-hour day, what is the mechanic's expected idle time each day? How many jobs are ahead of the average set just brought in?

**6 + 6 = 12**

7. (a) At a telephone booth, arrivals are considered to be Poisson with an average inter-arrival time of 12 minutes. The length of the phone call may be assumed to be distributed exponentially with an average of 4 minutes. Calculate the following:
- The probability that a fresh arrival will not have to wait for the phone.
  - The probability that an arrival will have to wait for more than 10 minutes before the phone is free.
  - The average length of queues formed from time to time.
- (b) The milk plant at a city distributes its products by trucks, loaded at the loading dock. It has its own fleet of trucks plus trucks of a private transport company. This transport company has complained that some time its trucks have to wait in line and thus the company loses money paid for a truck and driver that is only waiting. The company has asked the milk plant management either to go for a second loading dock or discount prices equivalent to the waiting time. The following data are available.  
Average arrival rate (all trucks) = 3 per hour.  
Average loading rate = 4 per hour.  
The transport company provided 40% of the total number of trucks. Assuming that these rates are random according to Poisson distribution. Determine
- The probability that a truck has to wait.
  - The waiting time of a truck that waits before start of loading.
  - The total expected waiting time of company trucks in queue per day.

**6 + 6 = 12**

### Group - E

8. (a) Solve the following NLPP with Graphical method:  
Maximize  $z = 2x_1 + 3x_2$   
Subject to:  $x_1^2 + x_2^2 \leq 20$   
 $x_1, x_2 \leq 8$   
 $x_1, x_2 \geq 0$ .
- (b) Find the maximum and/or minimum value of the function  $f(x) = 3x^5 - 5x^3$ .

**6 + 6 = 12**

9. (a) Explain Extreme Points, Global Maximum and Global Minimum with a curve.
- (b) Examine the following function for extreme points  $f(x_1) = 4x_1^4 + x_1^2 + 5$ .

**6 + 6 = 12**

## OPERATIONS RESEARCH (MECH 4103)

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

### Group - A (Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- The common errors that occur in a network construction is/are  
(a) looping (cycling) (b) dangling  
(c) redundancy (d) all of these.
  - Which of the following statements is not correct?  
(a) PERT is probabilistic in nature  
(b) CPM is probabilistic in nature  
(c) CPM and PERT use similar terminology but were developed independently  
(d) All of these statements are correct.
  - A situation in which a decision maker knows all of the possible outcomes of a decision and also knows the probability associated with each outcome is referred to as  
(a) certainty (b) risk (c) uncertainty (d) strategy.
  - The solution to a transportation problem with 'm' rows (supplies) and 'n' columns (destination) is feasible if number of positive allocations are  
(a) m+n (b) m\*n (c) m+n-1 (d) m+n+1.
  - In Hurwicz alpha criteria the degree of optimism  $\alpha$  varies between  
(a) 1 and 2 (b) 0 and 1 (c) 0 and 0.5 (d) 0 and 2.
  - The basic characteristics of a queuing system are  
(a) arrival pattern and service pattern  
(b) arrival pattern and queue discipline  
(c) arrival pattern and customer behaviour  
(d) arrival pattern, service pattern, queue discipline.
  - Expected waiting time a customer spends in the queuing systems is  $w_s =$   
(a)  $\frac{1}{(\mu-\lambda)}$  (b)  $\frac{\mu}{\mu(\mu-\lambda)}$  (c)  $\frac{\lambda}{(\mu-\lambda)}$  (d)  $\frac{\mu}{(\mu-\lambda)}$ .
  - In a M/M/1 queue, the service rate is  
(a) poisson (b) linear (c) exponential (d) none of these.

- (ix) A transportation problem deals with the transportation of a
  - (a) multi-product from several sources to several destinations
  - (b) single product from several sources to a destination
  - (c) single product from several sources to several destinations
  - (d) single product from a source to several destinations.
- (x) What is the method used to solve an LPP involving artificial variables?
  - (a) Simplex method
  - (b) Big-M Method
  - (c) VAM
  - (d) Hungarian method.

**Group - B**

- 2. (a) Mr. Nishok has Rs. 10,000 to invest in one of three options. A, B or C. The return on his investment depends on whether the economy experiences inflation recession, or no change at all. His possible returns under each economic condition are given below.

Strategy	States of nature		
	Inflation	Recession	No change
A	2000	1200	1500
B	3000	800	1000
C	2500	1000	1800

What should he decide using the pessimistic criterion and optimistic criterion?

- (b) The following table shows the jobs of a project with their duration in days. Draw the network and determine the critical path by calculating total float. Also calculate earliest, latest, start and finish times of each activity.

Jobs	1-2	1-3	1-4	2-5	3-7	4-6	5-7	5-8	6-7	6-9	7-10	8-10	9-10	10-11	11-12
Duration	10	8	9	8	16	7	7	7	8	5	12	10	15	8	5

**6 + 6 = 12**

- 3. (a) The following table shows the jobs of a network along with their time estimates.

Job	1-2	1-6	2-3	2-4	3-5	4-5	6-7	5-8	7-8
Compl. time									
Optimistic	1	2	2	2	7	5	5	3	8
Most likely	7	5	14	5	10	5	8	3	17
Pessimistic	13	14	26	8	19	17	29	9	32

Draw the project network, calculate expected time and standard deviation for each activity.

- (b) A newspaper agent's experience shows that the daily demand of the newspapers in his area has the following probability distribution.

Daily Demand	300	400	500	600	700
Probability	0.1	0.3	0.4	0.1	0.1

He sells the newspapers for Rs. 5 each, while he buys each at Rs. 4. Unsold copies are traded as scrap and each such copy fetches 10 paise. Assuming that he stocks the newspapers in multiples of 100 only, how many should he stock so that his expected profit is maximum?

**6 + 6 = 12**

**Group - C**

- 4. (a) Transportation costs (in Rs.) of products from origin to destinations are provided along with number of supply and demand in the table given below. Find the optimum cost by NWCR.

	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	Supply
O <sub>1</sub>	6	4	1	5	14
O <sub>2</sub>	8	9	2	7	16
O <sub>3</sub>	4	3	6	2	5
Required	6	10	15	4	35

- (b) Use graphical method to solve the LPP.

Maximize  $Z = 6x_1 + 4x_2$

subject to,

$-2x_1 + x_2 \leq 2$

$x_1 - x_2 \leq 2$

$3x_1 + 2x_2 \leq 9$

$x_1, x_2 \geq 0$ .

**6 + 6 = 12**

- 5. (a) Solve the following assignment problem in order to minimize the total cost. The cost matrix given below gives the assignment cost when different operators are assigned to various machines.

Operator \ Machine	I	II	III	IV	V
A	30	25	33	35	36
B	23	29	38	23	26
C	30	27	22	22	22
D	25	31	29	27	32
E	27	29	30	24	32

- (b) Using simplex method solve the LPP

Maximize  $Z = x_1 + x_2 + 3x_3$

subject to,

$3x_1 + 2x_2 + x_3 \leq 3$

$2x_1 + x_2 + 2x_3 \leq 2$

$x_1, x_2, x_3 \geq 0$ .

**5 + 7 = 12**

**Group - D**

- 6. (a) In a super market, the average arrival rate of customer is 10 in every 30 minutes, following Poisson process. The average time taken by the cashier to list and calculate the customer's purchase is 2.5 minutes, following exponential distribution.

(i) What is the probability that the queue length exceeds six?

(ii) What is the expected time spent by a customer in the system?