OPERATIONS RESEARCH
(MECH 4143)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Event indicates _____ of activity.
(a) Starting (b) Ending (c) Both (a) & (b) (d) None of these

(ii) Simplex method of solving linear programming problem uses
(a) all the points in the feasible region
(b) only the corner points of the feasible region
(c) intermediate points within the infeasible region
(d) only the interior points in the feasible region.

(iii) A feasible solution to the linear programming problem should
(a) Satisfy the problem constraints
(b) Optimize the objective function
(c) Satisfy the problem constraints and non-negativity restrictions
(d) Satisfy the non-negativity restrictions.

(iv) The maximum value of Z of the following LPP is Max Z = 4x + 6y
Subject to $3x + 2y \leq 12$
$x + y \geq 2$
$x, y \geq 0$
(a) 24 at (6,0) (b) 36 at (0,6)
(c) 24 at (0,4) (d) 16 at (4,0).

(v) In an assignment problem having n facilities and n jobs, what is the number of possible ways of making assignments?
(a) n! (b) n^2 (c) 2n (d) 2^n.

(vi) Hungarian algorithm is used to solve
(a) transportation problem
(b) assignment problem
(c) unconstrained nonlinear programming problem
(d) constrained nonlinear programming problem.

(vii) An assignment problem is considered as a particular case of a
(a) transportation problem (b) sequencing problem
(c) queuing problem (d) game theory.

(viii) The queue discipline in stack of plates is
(a) LIFO (b) SIRO (c) Non-Pre-Emptive (d) FIFO.

(ix) Customer behavior in which the customer moves from one the queue to another in a multiple channel situation is
(a) Balking (b) Reneging (c) Jockeying (d) Alternating.

(x) Essential characteristics of a decision model are
(a) States of nature (b) Decision alternatives
(c) Payoff (d) All of these.

Fill in the blanks with the correct word

(xi) A mathematical technique for finding the optimal use to an organization's scarce resources is called _____

(xii) Service mechanism in a queuing system is characterized by _____ behaviours.

(xiii) The objective of network analysis is to_____ the total project duration.

(xiv) A queuing system is said to be a _____ state when its operating characteristic are independent upon time.

(xv) An activity which does not consume neither any resource nor time is known as _____ activity.

Group - B

2. (a) The following matrix gives the payoff of different strategies (decision alternatives) S_1, S_2, S_3 against conditions (Events) N_1, N_2, N_3, N_4. Indicate the decision to be taken under the following approaches:
(i) Optimistic (ii) Pessimistic (iii) Regret (iv) Criterion of Realism (v) Equal probability.

	N_1	N_2	N_3	N_4
S_1	4000	-100	6000	18000
S_2	20000	5000	400	0
S_3	20000	15000	-2000	1000

[(CO1)(Analyse/IOCQ)]

(b) Name four Decision making Environments. *[(CO1)(Remember/LOCQ)]*

10 + 2 = 12

3. (a) A newspaper boy has the following probabilities of selling a magazine:

No. Copies Sold	10	11	12	13	14
Probability	0.10	0.15	0.20	0.25	0.30

Cost of a copy is 30 rupees and the sale price is 50 rupees. He cannot return the unsold copies. Determine how many copies should he order by following expected value criterion? *[(CO1)(Analyse/IOCQ)]*

(b) Explain EVPI. *[(CO1)(Remember/LOCQ)]*

8 + 4 = 12

Group - C

4. (a) A company manufactures two products X and Y. The profit contribution of X and Y are Rs. 3/- and Rs. 4/- respectively. The products X and Y require the services of three facilities. The capacities of the three facilities A, B, and C are limited and the available capacities in hours are 200 hrs, 150 hrs and 120 hrs. respectively. Product X requires 5, 3 and 4 hours of facilities A, B and C respectively. Similarly, the requirement of product Y is 4, 5 and 3 hours respectively on A, B and C. Find the optimal product mix to maximize the profit. [Use Graphical method to solve]. *[(CO4)(Apply/IOCQ)]*

(b) A simple table for a linear programming problem is given below:

	5	2	3	0	0	0	
Basic Variables	x_1	x_2	x_3	x_4	x_5	x_6	RHS
x_4	1	2	2	1	0	0	8
x_5	3	4	1	0	1	0	7
x_6	2	3	4	0	0	1	10

Find the leaving and entering variables in the next iteration of the simplex table *[(CO4)(Apply/IOCQ)]*

8 + 4 = 12

5. Find the optimal solution to the following transportation problem using the Stepping Stone Method.

Factory	Warehouse				Capacit
	W_1	W_2	W_3	W_4	
F_1	21	16	25	13	11
F_2	17	18	14	23	13
F_3	32	27	18	41	19
Requirement	6	10	12	15	43

[(CO5)(Apply/IOCQ)]

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Group - D

6. (a) Explain concave function and convex function. Also explain local maxima, local minima, global maxima and global minima. *[(CO4)(Remember/LOCQ)]*

(b) Determine if the following function is convex, concave or neither.
$f(X) = 3x_1 + 2x_1^2 + 4x_2 + x_2^2 - 2x_1x_2$ *[(CO4)(Analyse/IOCQ)]*

6 + 6 = 12

7. (a) Determine the relative maximum and minimum (if any) of the following function.

$f(x) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$ *[(CO4)(Analyse/IOCQ)]*

(b) Solve the NLPP utilizing Lagrange multiplier method.

Maximize $Z = 4x_1 - x_1^2 + 8x_2 - x_2^2$,

Subject to $x_1 + x_2 = 2$,

$x_1, x_2 \geq 0$. *[(CO4)(Evaluate/HOCQ)]*

6 + 6 = 12

Group - E

8. (a) A company has a truck loading unloading dock to operate with trucks. The average arrival rate of the trucks are 3 per hour following Poisson distribution and average service rate is 4 per hour following exponential distribution. If the waiting cost of each truck is Rs. 100 per hour, then what is the average cost for each truck due to waiting before it starts to get loaded? *[(CO6)(Analyse/IOCQ)]*

(b) Workers come to the tool room to collect or return specific tools in a workshop. The average time between two arrivals is 60 seconds following Poisson distribution and the average service time is 40 seconds following exponential distribution by a single tool room attendant. Determine:

1. Average queue length.
2. Mean waiting time of an arrival.
3. The idle time of the tool room attendant in an 8 hour day. *[(CO6)(Evaluate/HOCQ)]*

6 + 6 = 12

9. Customers arrive at a bank counter manned by a single cashier according to Poisson distribution with mean arrival rate 6 customers / hour. The cashier attends the customers on a first come, first serve basis at an average rate of 10 customers / hour with the service time exponential distribution. Find

1. The probability of the number of arrivals (0 to 5) during 15 minutes.
2. The probability that the queuing system is idle.
3. The probability associated with the number of customers (0 to 5) in the queuing system.
4. The time a customer should expect to spend in the queue.
5. The time a customer spends before leaving the bank counter. *[(CO6)(Evaluate/HOCQ)]*

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	12.5	62.5	25