

**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**
- (i) OR approach is typically based on the use of
(a) physical model (b) mathematical model
(c) iconic model (d) descriptive model.
- (ii) In an LP graphical method, if two constraints do not intersect in the positive quadrant of the graph, then
(a) the problem is infeasible
(b) the solution is unbounded
(c) one of the constraints is redundant
(d) the constraint which coincides is redundant.
- (iii) EOL is
(a) Extra opportunity loss (b) Extreme opportunity loss
(c) Existing opportunity loss (d) Expected opportunity loss.
- (iv) If dual has an unbounded solution, primal has
(a) no feasible solution (b) unbounded solution
(c) feasible solution (d) none of the above.
- (v) The north-west corner rule
(a) is used to find an initial feasible solution
(b) is used to find an optimal solution
(c) is based on the concept of minimizing opportunity cost
(d) none of the above.
- (vi) In a transportation problem, if the number of non negative allocation is equal to $m+n-1$, where m is number of rows and n is number of column, the problem is called as
(a) Feasible solution (b) Initial solution
(c) Basic feasible solution (d) Optimal solution.

- (vii) The region which satisfies all the constraints in NLPP is called as
 - (a) Phisible region
 - (b) Feasible region
 - (c) Convex region
 - (d) Concave region.
- (viii) Queue can form only when
 - (a) arrivals exceed service capacity
 - (b) arrivals equals service capacity
 - (c) service facility is capable to serve all the arrivals at a time
 - (d) there are more than one service facilities.
- (ix) In critical path analysis, CPM is
 - (a) event oriented
 - (b) probabilistic in nature
 - (c) deterministic in nature
 - (d) dynamic in nature.
- (x) A solution which optimises the objective function is called as
 - (a) Solution
 - (b) Basic solution
 - (c) Feasible solution
 - (d) Optimal solution.

Group - B

- 2. (a) Describe the meaning of EMV and EOL.
- (b) The following matrix gives payoff of different strategies (alternatives) S_1, S_2, S_3 against conditions (events) N_1, N_2 and N_3 :

	N_1	N_2	N_3	N_4
S_1	Rs.4000	Rs. -100	Rs.6000	Rs.1800
S_2	20,000	5,000	400	0
S_3	20,000	15,000	-2000	1000

Indicate the decision taken under the following approach:

- (a) Pessimistic (b) Optimistic (c) Regret (d) Equal Probability

4 + 8 = 12

- 3. (a) The following table lists all the activities which together constitute a small engineering project.

Activity	A	B	C	D	E	F	G	H	I	J
Immediate predecessor	-	A	B	B	B	C	C	F,G	D,E,H	I
Duration (Hours)	14	22	10	16	12	10	6	8	24	16

Draw the network, Calculate total float of each activity and determine the minimum duration of completion of the project.

- (b) The following table gives the data for the activities of a small project:

Job (i-j)	1-2	1-3	2-4	2-6	3-4	3-5	4-5	5-6
a (days)	1	5	3	1	8	2	5	2
m (days)	4	10	3	4	15	4	5	5
b (Days)	7	17	3	7	26	8	5	8

Draw the network and find the expected project completion time.

Find the project completion time which will have 95% confidence. Value of Z is 1.64 at 95% confidence level.

6 + 6 = 12

Group - C

4. (a) Solve the following LPP by Simplex method.
 Maximize, $Z = 10x_1 + 5x_2$
 Subject to the constraints,
 $4x_1 + 5x_2 \leq 100$
 $3x_1 + 2x_2 \leq 80$
 $x_1, x_2 \geq 0$
- (b) Solve the following LPP by graphical method.
 Maximize $Z = 5x_1 + 3x_2$
 Subject to,
 $x_1 + x_2 \leq 6$
 $0 \leq x_1 \leq 3$
 $0 \leq x_2 \leq 3$
 $2x_1 + 3x_2 \geq 3$

6 + 6 = 12

5. (a) Four different jobs are to be done on four different machines. The set up and production times are prohibitively high for changeover. The table below indicates the cost of producing job i on machine j , in rupees.

Jobs	Machines			
	1	2	3	4
1	5	7	11	6
2	8	5	9	6
3	4	7	10	7
4	10	4	8	3

Assign jobs to different machines so that the total cost is minimised.

- (b) Obtain an initial basic feasible solution to the following transportation problem by LCM. Figures in the cells represent transportation cost from factory to warehouse in rupees.

Warehouse/Factory	W ₁	W ₂	W ₃	W ₄	Supply
F ₁	21	16	25	13	11
F ₂	17	18	14	23	13
F ₃	32	27	18	41	19
Demand	06	10	12	15	43

6 + 6 = 12

Group - D

6. (a) Explain the various elements of a Queuing System.
- (b) Car arrive at a security checking gate according to Poisson distribution with mean 8/hour. Average time required to pass through the gate is 5 minutes. Calculate average queue length, average waiting time and idle time in 8-hour shift.

6 + 6 = 12

7. (a) Customers arrive at a sales counter manned by a single person according to a Poisson process with a mean rate of 20 per hour. The time required to serve a customer has an exponential distribution with a mean of 100 seconds. Find the average waiting time of a customer.
- (b) For a departmental store, mean arrival rate = 20 customer / hr, mean service rate 24 customer / hr. Calculate values of ρ , L_s and W_s . The symbols represent their usual meanings.

6 + 6 = 12**Group - E**

8. (a) Determine whether the following function is concave or convex or neither.
 $f(X) = 3x_1 + 2x_1^2 + 4x_2 + x_2^2 - 2x_1x_2$
- (b) If $f(X) = 5x_1 + 2x_2^2 + x_3^2 - 3x_3x_4 + 4x_4^2 + 2x_5^4 + x_5^2 + 3x_5x_6 + 6x_6^2 + 3x_6x_7 + x_7^2$, then show that $f(X)$ is convex by expressing it as a sum of functions of one or two variables and then proving that all the functions are convex.

6 + 6 = 12

9. (a) In the following NLPP, Minimize, $Z=2x_1^2-24x_1+ 2x_2^2-8x_2+ 2x_3^2-12x_3+200$, by separating this function into three one-variable functions, show that the function is convex. Solve each one-variable function by calculus.
- (b) Determine the extreme point in a NLPP , $f(x)=x_1+2x_3+x_2x_3-x_1^2-x_2^2-x_3^2$.

8 + 4 = 12

Department & Section	Submission link:
ME A	https://forms.gle/bhPoQuPiLTn6w9r69
ME B	https://forms.gle/JDtRdGbTd7EvUL2C7