B.TECH/ME/7TH SEM/MECH 4143/2021

OPERATIONS RESEARCH
(MECH 4143)

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) Every mathematical model in Operations Research [(CO1) (Remember/LOCQ)]
(a) Must be deterministic
(b) Requires computer aid for its solution
(c) Represents data in numerical form
(d) All of the above.

(ii) The decision maker has a knowledge about the states of nature that may happen, but lacks the knowledge about their probability of occurrences. This type of decision making is called [(CO2) (Understand/LOCQ)]
(a) Decision making under certainty
(b) Decision making under uncertainty
(c) Decision making under risk
(d) Decision making under conditions of conflict

(iii) Find the correct statement [(CO3) (Remember/LOCQ)]
(a) Critical path is the largest path in the network diagram
(b) In critical path, all the activity having total float equals to zero
(c) To find critical path of a network, the completion time or expected completion time should be known for all the activities in the network
(d) All of the above.

(iv) An activity which does not consume neither any resource nor time, is known as [(CO3) (Remember/LOCQ)]
(a) Null activity (b) Dummy activity
(c) Predecessor activity (d) special activity.

(v) To find an optimum solution in transportation problem _____ method is used. [(CO4) (Remember/LOCQ)]
(a) Simplex (b) Big-M (c) MODI (d) Hungarian.

(vi) An assignment problem is considered as a particular case of a [(CO4) (Remember/LOCQ)]
(a) Transportation problem (b) Sequencing problem
(c) Queuing problem (d) Game theory.

(vii) The number of basic feasible solutions of a set of m equations in n unknowns (n > m) is: [(CO5) (Remember/LOCQ)]
(a) n (b) m (c) nm (d) ${}^{n}C_{m}$.

(viii) If at-least one of the basic variables is zero in Linear Programming Problem, then solution is said to be: [(CO5) (Remember/LOCQ)]
(a) Feasible solution (b) Basic Solution
(c) Degenerate basic solution (d) Non degenerate basic solution.

(ix) Customer behaviour in which the customer moves from one queue to another in a multiple channel situation is [(CO6) (Remember/LOCQ)]
(a) Balking (b) Reneging (c) Jockeying (d) Alternating.

(x) In queuing theory, the ratio of mean arrival rate and the mean service rate is called [(CO6) (Remember/LOCQ)]
(a) Work factor (b) Utilization factor
(c) Slack constant (d) Production rate.

Group – B

2. A dairy firm wants to determine the quantity of butter it should produce to meet the demand. Past records have shown the following data patterns:

Quantity Required (Kg)	15	20	25	30	35	40	50
No. of days demand occurred	6	14	20	80	40	30	10

The stock levels are restricted to the range 15 to 50 kg due to inadequate storing facilities. Butter costs Rs.40 per kg and sold at Rs. 50 per kg.
(i) Construct conditional profit table and find out how much quantity of butter to be produced by EMV approach. [(CO2) (Create/HOCQ)]
(ii) Determine EVPI. [(CO2) (Analyse/IOCQ)]

[(3 + 3) + 6] = 12

3. (a) A maintenance project consist of following jobs, whose precedence relationships are given below.

Job	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (Days)	15	15	3	5	8	12	1	14	3	14

Draw the network and mark the critical path. Also find the minimum total project duration. [(CO3)(Analyse/IOCQ)]

(b) A project consists of seven activities, whose time estimates are listed in the table as follows

Activity	Estimated duration (weeks)		
	Optimistic (a)	Most likely(m)	Pessimistic (b)
1-2	1	1	7
1-3	1	4	7

2-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-6	2	5	8
5-6	3	6	15

Draw the network and select the critical path. Find the probability that the project will be completed within 19 weeks. [(CO3) (Analyse/IOCQ)]

Standard Normal Distribution Table

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189

(3 + 2 + 1) + (3 + 1 + 2) = 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 four facilities. The capacities of the four facilities *A*, *B*, *C*, and *D* are limited and the available capacities in hours are 200 Hrs, 150 Hrs, 100 Hrs. and 80 hours respectively. Product *X* requires 5, 3, 5 and 8 hours of facilities *A*, *B*, *C* and *D* respectively. Similarly, the requirement of product *Y* is 4, 5, 5, and 4 hours respectively on *A*, *B*, *C* and *D*. Find the optimal product mix to maximize the profit.[Use Graphical method to solve] [(CO5) (Apply/IOCQ)]

(b) Also construct the dual of the Problem no. 4(a). [(CO5) (Apply/IOCQ)]

8 + 4 = 12

5. (a) Use Simplex Method to solve the following problem:

Maximize $Z = 5x + 2y + 3z$

Subject to –

$x + 2y + 2z \leq 8$

$3x + 4y + z \leq 7$

$x, y, z \geq 0$ [(CO5) (Apply/IOCQ)]

(b) Determine the initial basic feasible solution of the following transportation problem by Vogel's approximation method: [(CO4)(Apply/IOCQ)]

FACTORY	WAREHOUSE				CAPACITY
	W1	**W2**	**W3**	**W4**	
F1	19	30	50	10	**7**
F2	70	30	40	60	**9**

	F3	40	8	70	20	**18**
REQUIREMENT		**5**	**8**	**7**	**14**	**34 (Total)**

6 + 6 = 12

Group – D

6. (a) Consider the following cost matrix of assigning four jobs to four persons:

PERSONS	**JOBS**			
	J1	**J2**	**J3**	**J4**
P1	5	8	6	10
P2	2	5	4	8
P3	6	7	6	9
P4	6	9	8	10

Find the minimum cost of the assignment problem subject to the constraint that job J4 is assigned to person P2. [(CO4) (Apply/IOCQ)]

(b) Solve the following assignment problem. Assign one machine to one worker so that time in hours is minimized. [(CO4) (Apply/IOCQ)]

	M1	**M2**	**M3**	**M4**	**M5**
A	3	2	7	4	8
B	5	4	3	8	5
C	3	7	9	1	2
D	4	2	6	5	7
E	2	8	4	6	6

6 + 6 = 12

7. (a) Test the following function whether it is convex, concave or neither.
$f(X)=x_1^2 + 3x_1x_2 + 2x_2^2$ [(CO5) (Analyse/IOCQ)]

(b) Examine whether the following function is concave or convex or neither. If it can be determined, then also find the maximum or minimum value of the function.
$f(X)= x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$ [(CO5)(Analyse/IOCQ)]

6 + (4 + 2) = 12

Group – E

8. (a) Identify four different type of customer behaviour. [(CO6) (Understand/LOCQ)]

(b) In a shop the average arrival rate of customer is 10 in every 30 minutes, following Poisson process. The average time taken by a cashier to service every customer is 2.5 minutes following exponential distribution. Find the probability that the queue length exceeds seven. Also find the expected time spent by a customer in the system? [(CO6) (Evaluate/HOCQ)]

(4 × 1.5) + (3 + 3) = 12

9. (a) A person repairing radios, finds the time spent on the radio sets has exponential distribution with mean 20 minutes. If the radios are repaired in the order in which they come in and their arrival is approximately Poisson with an average rate of 15 per 8-hour day, find out what is the repairman's expected idle time each day. How many radios are waiting in queue to be repaired?

[(CO6)(Evaluate/HOCQ)]

(b) Explain Jockeying and traffic intensity. [(CO6) (Understand/LOCQ)]

(3 + 3) + (3 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	20.75%	62.26%	16.98%

Course Outcome (CO):

After the completion of the course students will be able to

CO 1	Interpret the basic idea, history and different applications of operations research in engineering as well as managerial fields.
CO 2	Formulate different decision making problems and argue for solving them with different techniques.
CO 3	Illustrate different network models and estimate about project scheduling and completions.
CO 4	Solve different transportation and assignment problems.
CO 5	Distinguish between LPP and NLPP problems and apply different techniques for developing their solutions.
CO 6	Analyzesingle channel waiting line problems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	**Submission link:**
ME	https://classroom.google.com/c/NDA5MjI1NDk1MDAx/a/NDY0MDIyNTkxNDk0/details