SPECIAL SUPPLE B.TECH/ME/7TH SEM/MECH 4103/2018

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) 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 facility.

(ii) Minimization of objective function in LPP means
(a) least value chosen among the allowable decisions
(b) greatest value chosen among the allowable decisions
(c) both (a) & (b)
(d) none of the above.

(iii) A constraint in an LPP restricts
(a) value of objective function (b) value of a decision variable
(c) use of available resource (d) uncertainty of optimum value.

(iv) If two constraints do not intersect in the positive quadrant of the graph, then
(a) one of the constraint is redundant (b) the solution is infeasible
(c) the solution is unbounded (d) none of these.

(v) For maximization LPP, the simplex method is terminated when all the net-evaluations are
(a) negative (b) non-negative
(c) zero (d) non-positive.

(vi) The value of the co-efficient of optimum "α" is needed, while using the criteria of
(a) equally likely (b) realism (c) maximin (d) minimax.

(vii) In critical path analysis, CPM is
(a) event oriented (b) probabilistic in nature
(c) deterministic in nature (d) dynamic in nature.

(viii) If there are n workers and n jobs, there would be
(a) n solutions (b) n! solutions
(c) (n-1)! solutions (d) $(n!)^n$ solutions.

(ix) The solution to a transportation problem with m-solutions and n-destinations is feasible, if the number of allocations are
(a) m + n - 1 (b) m + n + 1
(c) m + n (d) m × n

(x) In a non-linear programming problem,
(a) the objective function is non-linear
(b) one or more of the constraints have non-linear relationship
(c) both (a) and (b)
(d) none of the above.

Group – B

2. (a) A small industry finds from the past data that the cost of making an item is Rs.25, the selling price of the item is Rs.30 if it is sold within a week, and it could be disposed off at Rs.20, per item at the end of the week if unsold. Frequency of weekly sales is given below:

Weekly Sales :	< 3	4	5	6	7	>8
No. of weeks :	0	10	20	40	30	0

Find the optimum number of items per week the industry should make.

(b) Estimated times for the jobs of a project are given below:

Job	A	B	C	D	E	F	G	H	I	J	K	L
Time (weeks)	13	5	8	10	9	7	7	12	8	9	4	17

The constraints governing the jobs are as follows:
A and B are start jobs; A controls C, D and E; B controls F and J; G depends upon C; H Depends on D; E and F control I and L; K follows J; L is also controlled by K; G, H, I and L are the last jobs. Draw the network; determine project duration and the critical path.

6 + 6 = 12

3. (a) A mother notes that when her teenaged son uses the telephone, he takes no less than 10 minutes for a call and sometimes as much as one hour. Twenty-minute calls are more frequent than calls for any other duration. If son's phone call were an activity in a PERT project :

(i) What would be the phone call"s expected duration?
(ii) What would be its variance?
(iii) In scheduling the project, how much time would be allocated for the phone call?

(b) Obtain the dual problem of the following primal problem:
Minimize $Z = X_1 - 3X_2 - 2X_3$, subject to the constraints :
$3X_1 - X_2 + 2X_3 \leq 7$, $2X_1 - 4X_2 \geq 12$, $-4X_1 + 3X_2 + 8X_3 = 10$,
$X_1, X_2 \geq 0$, and X_3 is unrestricted.

6 + 6 = 12

Group – C

(a) Solve the following LPP by graphical method:
Maximize $Z = -X_1 + 2X_2$; subject to: $X_1 - X_2 \leq -1$, $-0.5X_1 + X_2 \leq 2$, $X_1, X_2 \geq 0$

(b) Solve the following LPP by simplex method:
$Z = 3X_1 + 4X_2$, subject to: $X_1 + X_2 \leq 450$, $2X_1 + X_2 \leq 600$, $X_1, X_2 \geq 0$

6 + 6 = 12

5. (a) Obtain an initial feasible solution of the following transportation problem using Vogel"s Approximation Method:

	D	E	F	G	AVAILABLE
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
REQUIREMENT	200	225	275	250	

(b) The Head of the department has five jobs A, B, C, D, E and five sub-ordinates V, W, X, Y, Z. The number of hours each man would take to perform each job is as follows:

	V	**W**	**X**	**Y**	**Z**
A	3	5	10	15	8
B	4	7	15	18	8
C	8	12	20	20	12
D	5	5	8	10	6
E	10	10	15	25	10

How would the jobs be allocated to minimize the total time?

6 + 6 = 12

Group – D

6. (a) Write short notes on:
   (i) Elements of a queuing system
   (ii) Operating characteristics of a queuing system.

   (b) On an average, 6 customers reach a telephone booth every hour to make calls. Determine the probability that exactly 4 customers will reach in 30-minute period, assuming that arrivals follow Poisson Distribution.

(4 + 2) + 6 = 12

7. Arrival rate of telephone calls at a telephone booth are according to Poisson Distribution, with an average time of 9 minutes between two consecutive arrivals. The length of telephone call is assumed to be exponentially distributed, with mean of 3 minutes.
   (i) determine the probability that a person arriving at the booth will have to wait.
   (ii) find the average queue length that is formed from time to time
   (iii) the telephone company will install a second booth when convinced that an arrival would expect to have to wait at least four minutes for the phone. Find the increase in flow rate of arrivals which will justify a second booth.
   (iv) find the fraction of a day that the phone will be in use.

12

Group – E

8. (a) Explain the canonical form of a non-linear programming problem.

   (b) In a NLPP, if $f(x, y) = x^2 - 2xy - 4x + 2y + 2y^2$, calculate the maxima or minima.

6 + 6 = 12

9. (a) The total profit (Z) of a firm depends upon the level of output (Q) and the advertising expenditure (A). Find the profit maximizing the values of Q and A, as given the following relationship:
   $Z = 800 – 3Q^2 - 4Q + 2QA - 5A^2 + 48 A$

   (b) Solve the following NLPP using the Lagrange Multipliers Method:
   Minimize $Z = 2X_1^2 – 24X_1 + 2X_2^2 - 8 X_2 + 2X_3 - 12 X_3 + 200$.

6 + 6 = 12