Bachelor of Engineering (Mechanical Engg.) Fifth Year (2nd Semester) Examination, 2019

Operations Research

Time: Three hours **Answer any five questions.** **Full Marks: 100**

1. (a) What is linear programming? Give some applications of linear programming. (b) Define optimal solution, basic feasible solution, and non-degenerate basic feasible solution in LP.
(c) Solve the following LPP using graphical method:

Minimize $Z = 2500x + 3000y$

Subject to: $x \geq 30$

$y \geq 20$

$x + y \geq 60$

and $x, y \geq 0$ [4 + 6 + 10]

2. (a) A project work consists of five major jobs for which an equal number of contractors have submitted tenders. The tender amount quoted (in lakhs of Rupees) is given in the matrix:

		Job				
		a	b	c	d	e
Contractor	1	9	5	13	15	16
	2	3	9	18	13	7
	3	10	7	2	2	2
	4	7	12	9	7	12
	5	7	9	10	4	11

Find the assignment that minimizes the total cost of the project, when each contractor has to be assigned at one job. Name the method you use to solve it.
(b) Compare between PERT and CPM in project management. [15 + 5]

3. (a) A company has three warehouses (W1, W2, W3) and four stores (S1, S2, S3, S4). The availability of a given commodity at three warehouses is as follows: W1 = 7, W2 = 6, W3 = 9. The demand at the four stores is: S1 = 6, S2 = 8, S3 = 5, and S4 = 3. The cost of shipping (Rs. '000) one unit of commodity from warehouse I to store j are given below.

	S1	S2	S3	S4
W1	9	12	9	6
W2	7	3	7	7
W3	6	4	6	11

Find out a shipping schedule and the corresponding total cost based on VAM. (b) What are the probability distributions used in estimating the activity time and the project duration in PERT analysis? [15 + 5]

4. The activities comprising a project have been identified as follows.

Activity	A	B	C	D	E	F	G	H
Immediate predecessor(s)	-----	----	-----	A	C	B,E	C	G,F
Time(weeks)	4	7	8	5	4	4	11	4
No. of men	1	1	2	3	1	2	2	1

Draw the network based on AOA. Determine the critical path and the project duration. How long would the project take if three men were available at any time? [20]

5. (a) State three major reasons for using simulation in optimization problems.
(b) For a company, the number of trucks arriving with the corresponding probability is given in the following table.

No. of trucks arriving	0	1	2	3	4	5
Probability	0.13	0.30	0.30	0.15	0.10	0.02

Using Monte Carlo simulation, simulate the waiting time process of 7 days with a known service rate (i) 2 per day, and (ii) 3 per day. Use the following random numbers for the above solution. 2,6,14,26,87,23,76,56,15,28,90,54,27,84. [5 +15]

6. Two manufacturers A and B are competing with each other in a restricted market. Over the year, A's customers have exhibited a high degree of loyalty as measured by the fact that customers are using A's product 70 percent of the time. In addition, former customers purchasing the product form B have switched back to A's product 40 percent of the time.

   Construct the state transition matrix. Calculate the probability of a customer purchasing A's product at the end of the second period. What will be the distribution of customers at equilibrium? [6 + 6 + 8]

7. Consider the following payoff matrix.

		States of Nature				
		S1	S2	S3	S4	S5
Strategy	A1	15	10	0	-6	17
	A2	3	14	8	9	2
	A3	1	5	14	20	-3
	A4	7	19	10	2	0

No probabilities are known for the occurrence of the nature of states. Compare the solutions obtained by each of the following criteria. (i) Laplace, (ii) pessimistic, (iii) optimistic, and (iv) Hurwicz (alpha = 0.6) [20]

8. A repair shop attended by a single mechanic has an average of four customers an hour who bring small appliances for repair. The mechanic inspects them for defects render a diagnosis. This takes him six minutes, on an average. Arrivals are Poisson and service time has the exponential distribution. Determine (i) the proportion of time during which the shop is empty, (ii) the probability of finding at least one customer in the shop, and (iii) the average number of customers in the system. [5 + 10 + 5]

9. (a) In an election campaign, the strategies adopted by the ruling party and the opposition party along with payoffs (ruling party's per cent share in votes polled) are given below.

Ruling party's strategies	Opposition party's strategies		
	A	B	C
A	55	40	35
B	70	70	55
C	75	55	65

Assuming a zero-sum game, find the optimum strategies for both parties and expected payoff to the ruling party.

(b) Solve the following game.

$$\begin{array}{c} \\ A \\ \\ \end{array} \begin{array}{c} B \\ \begin{bmatrix} 1 & 7 & 2 \\ 6 & 2 & 7 \\ 5 & 2 & 6 \end{bmatrix} \end{array}$$

10. In a flowshop scheduling environment, each of eight jobs is to be processed on two machines A and B. The processing times for each job on these two machines are given below.

Jobs	1	2	3	4	5	6	7	8
Processing time on Machine A (in mins)	30	45	15	20	80	120	65	10
Processing time on Machine B (in mins)	20	30	50	35	36	40	50	20

Determine the optimum sequence of jobs, the corresponding makespan or the total completion time, and the idle times on these two machines.