

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

**I SEMESTER M. TECH DEGREE EXAMINATION, APR 2021/SEPT 2021**

**Branch: MECHANICAL ENGINEERING**

**Stream(s): INDUSTRIAL ENGINEERING**

**Course Code & Name: 01 ME 6403 ADVANCED OPERATIONS RESEARCH**

Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60

Duration: 3 hours

**PART A**

1. A company manufactures three products: X, Y and Z by using three resources. Each unit of product X takes three man - hours and 10 hours of machine capacity and 1 cubic meter of storage place. Similarly, one unit of product Y takes 5 man-hours and 2 machine hours on 1cubic meter of storage place and that of each unit of products Z is 5 man-hours, 6 machine hours and 1 cubic meter of storage place. The profit contribution of products X, Y and Z are Rs. 4/-, Rs.5/- and Rs. 6/- respectively. A maximum of 900 man - hours, 1400 machine hours and 250 units of storage space is available. Formulate and solve the linear programming problem and conduct sensitivity analysis to identify the effect of increase of manhour availability by 100 on the optimal product mix. (9 Marks)
  
2. A repair shop attended by a single machine has average of four customers an hour who bring small appliances for repair. The mechanic inspects them for defects and quite often can fix them right away or otherwise render a diagnosis. This takes him six minutes, on the average. Arrivals are Poisson and service time has the exponential distribution.
  - (a) Find the proportion of time during which the shop is empty.
  - (b) Find the probability of finding at least one customer in the shop.
  - (c) What is the average number of customers in the system?
  - (d) Find the average time spent, including service. (9 Marks)

3. a. A furniture dealer deals in only two items: tables and chairs. He has Rs. 50,000 to invest and has storage space of at most 60 pieces. A table costs Rs. 2500 and a chair Rs. 500. He estimates that from the sale of one table, he can make a profit of Rs. 250 and that from the sale of one chair a profit of Rs. 75. Formulate an integer programming problem based on the above information to maximize his total profit, assuming that he can sell all the items which he buys. (4.5 Marks)

- b. Using dual simplex method to solve

$$\begin{array}{ll} \text{Minimize} & Z = 4X_1 + 8X_2 + 3X_3 \\ \text{Subject to} & X_1 + X_2 \geq 2 \\ & 2X_1 + X_3 \geq 5 \\ & X_1, X_2, X_3 \geq 0 \end{array} \quad (4.5 \text{ Marks})$$

**PART B**

4. a. Find the stationary points of the following functions and label them

$$\begin{array}{ll} \text{i.} & f(x) = x^3 - 3x + 2 \\ \text{ii.} & f = 2x^2 - 2xy - 16x + 5y^2 \end{array} \quad (4.5 \text{ Marks})$$

- b. Write notes on

- i. Separable programming
  - ii. Non - convex programming
- (4.5 Marks)

5. a. Minimize  $X_1^2 + 3X_2^2 - 2X_1 - 8X_2$  using the method of steepest descend (4.5 Marks)

- b. Minimize  $Z = 6X_1^2 + 5X_2^2$   
 Subject to  $X_1 + 5X_2 = 3$   $X_1, X_2 \geq 0$  using the method of Lagrangian multipliers (4.5 Marks)

6. Use Kuhn -Tucker conditions to solve

$$\begin{array}{ll} \text{Minimize} & Z = 8X_1 + 10X_2 - X_1^2 - X_2^2 \\ \text{Subject to} & 3X_1 + 2X_2 \leq 6 \quad X_1, X_2 \geq 0 \end{array} \quad (9 \text{ Marks})$$

**PART C**

7. a. Explain the importance of different learning rules associated with artificial neural network (ANN). (6 Marks)

- b. Find the route that minimizes the total distance travelled by the salesman

	To					
From city		A	B	C	D	E
A	-	12	15	17	21	
B	12	-	13	18	12	
C	15	13	-	14	17	
D	17	18	14	-	8	
E	21	12	17	8	-	

(6 Marks)

8. a. Find the minimum spanning tree connecting all the given nodes using Kruskal's algorithm

Arc	Distance	Arc	Distance	Arc	Distance	Arc	Distance
A-B	16	B-G	12	D-F	11	F-I	13
A-C	13	C-E	14	D-G	15	G-I	13
A-D	12	C-F	13	E-H	11	G-H	13
B-E	14	C-G	17	E-I	14	H-J	13
B-F	14	D-E	14	F-H	16	I-J	14

(6 Marks)

- b. Bring out the importance parameters involved in Particle Swarm Optimization (PSO) algorithm with a simple example. (6 Marks)
9. a. Explain the procedure to find the shortest path using Dijkstra's algorithm using a simple example. (6 Marks)
- b. Explain various crossover strategies available clearly stating the applicability of each with simple examples. (6 Marks)