Registration No : | | | | | | | | | | |

Total Number of Pages : 03

Course: B.Tech
Sub_Code: ROE6A001

6th Semester Regular/Back Examination: 2022-23
SUBJECT: Optimization in Engineering
BRANCH(S): All
Time : 3 Hour
Max Marks : 100
Q.Code : M244

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions: (2 x 10)

a) What is the feasible region of a linear programming problem?

b) How can we identify an unbounded solution in a simplex method?

c) How can we identify the existence of alternate solution from the optimal table of the simplex method?

d) What is the objective function of the phase I of the two phase method?

e) What type of variable we will get in the dual LPP corresponding to an equality constraint in the primal LPP?

f) What is an unbalanced assignment problem? What arrangements are to be done to make it balanced?

g) Find a starting solution to the given transportation problem by North West Corner rule. The values given in the interior boxes are the cost of transportation between the corresponding source (S) and destination (D) and the values given in the right margin and lower margin are the supply capacity and demands of the sources and destinations respectively.

	D_1	D_2	D_3	Supply
S_1	7	4	5	12
S_2	4	6	3	8
S_3	2	5	4	14
Demand	9	10	15	

h) In an M/M/1 queue with arrival rate λ and service rate μ what is the probability that the system is empty?

i) In a birth and death process which states are accessible from the state 1?

j) When we call the Hessian matrix positive definite?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 × 8)**

a) Solve the given linear programming problem using graphical method.
Maximize: 5x + 7y; subject to: x + y ≤ 4, 3x + 8y ≤ 24, 10x + 7y ≤ 35, x ≥ 0 & y ≥ 0.

b) Solve the given linear programming problem using simplex method.
Maximize: $Z = 3x_1 + 2x_2 + 5x_3$
Subject to: $x_1 + 4x_2 \le 420;\ 3x_1 + 2x_3 \le 460;\ x_1 + 2x_2 + x_3 \le 430;\ x_1, x_2, x_3 \ge 0$

c) Construct the dual of the given primal LPP.
Maximize: $Z = x_1 + 2x_2 + 3x_3$
Subject to: $4x_1 + x_2 + 2x_3 \ge 30;\ 2x_1 + x_2 + 5x_3 = 24;\ 3x_1 + x_2 + 2x_3 \le 17$
$x_1 \le 0,\ x_2$ is unrestricted in sign and $x_3 \ge 0$

d) Solve the given LPP using dual simplex method
Minimize: $Z = x_1 + 2x_2 + 3x_3$
Subject to: $x_1 - x_2 + x_3 \ge 4;\ x_1 + x_2 + 2x_3 \le 8;\ x_2 - x_3 \ge 2;\ x_1, x_2, x_3 \ge 0$

e) Find a starting solution to the given transportation problem by Vogel's Approximation Method. The values given in the interior boxes are the cost of transportation between the corresponding source (S) and destination (D) and the values given in the right margin and lower margin are the supply capacity and demands of the sources and destinations respectively.

	D_1	D_2	D_3	D_4	Supply
S_1	21	16	25	13	11
S_2	17	18	14	23	13
S_3	32	27	18	41	19
Demand	6	10	12	15	

f) Solve the given assignment problem by Hungerian method.

5	40	20	5
25	35	30	25
15	25	20	10
15	5	30	15

g) Solve the given integer programming problem using branch and bound method.
Maximize: 2x + 2y; subject to: 5x + 3y ≤ 8, 2x + 4y ≤ 8, x ≥ 0 & y ≥ 0 and x & y are integers.

h) Minimize the function $f(x) = 3x^3 + x^2 - 18x - 16,\ 1 \le x \le 3,$ using golden section method. Perform five iterations to reach an approximate solution.

i) Find the minimum distance of the surface $x^2 + 3y^2 - 2z = 7$ from the origin using Lagrange multiplier method.

j) Find the maximum and minimum of the function $x^2 - 12x + y^2 - 8y + z^2 - 4z$

k) Customers arrive at a shop at a rate of 5 per hour. The service is provided by the shop to the customers at a rate of 8 per hour. Find the probability that there is no customer at the shop. Also find the average time spent by a customer at the shop.

l) In a single window consulting centre customers arrive with an exponential inter arrival time with mean 45 minutes. The consulting time is also exponential with mean 30 minutes. Find the average waiting time of a customer before joining the consultancy. What is probability that the consultant is idle?

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Solve the given linear programming problem by any suitable method. **(16)**
Maximize: $Z = 3x_1 + 2x_2 + 5x_3$; subject to $x_1 + 2x_2 + x_3 \geq 430$, $3x_1 + 2x_3 \geq 460$, $x_1 + 4x_2 \leq 420$ and $x_j \geq 0$ for $j = 1, 2, 3$.

Q4 Find the optimum solution to the given transportation problem. The values given in the interior boxes are the cost of transportation between the corresponding source (S) and destination (D) and the values given in the right margin and lower margin are the supply capacity and demands of the sources and destinations respectively. **(16)**

	D_1	D_2	D_3	D_4	Supply
S_1	40	25	22	33	100
S_2	44	35	30	30	30
S_3	38	38	28	30	70
Demand	40	20	60	30	

Q5 Determine x, y, z so as to maximize $Z = -x^2 - y^2 - z^2 + 4x + 6y$ subject to $x + y \leq 2$; $2x + 3y \leq 12$ and $x, y \geq 0$. **(16)**

Q6 A shopping mall has two billing counters. The service time in each counter follows the exponential distribution with mean of 8 minutes and customers arrive in a Poisson process at the rate of 10 per hour. Find the probability that a customer has to wait for service. What proportion of time the station remain idle? **(16)**