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ME 181 OE 11

Roll No. of candidate | | | | | | | | | | |

28/2/22 2021

B.Tech. 7th Semester End-Term Examination

Mechanical Engineering

OPERATION RESEARCH

(New Regulation (w.e.f. 2017-18) and New Syllabus (w.e.f. 2018-19))

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *four* from the rest.

1. Choose the correct answer : (10 × 1 = 10)

(i) In which form the following linear programming problem (LPP) is:

Maximize $Z = 5x_1 + 4x_2$

Subject to constraints,

$6x_1 + 4x_2 \leq 24$

$x_1 + 2x_2 \leq 6$

$x_2 - x_1 \leq 1$

$x_2 \geq 2$

Where,

$x_1, x_2 \geq 0$

(a) Canonical Form

(b) Standard Form

(c) General Form

(d) Both (a) and (c)

(ii) Which of the following is an indication that a linear programming problem does not have a feasible solution?

(a) A feasible solution space in the graphical solution

(b) Presence of an artificial variable in the basic solution at a positive level when the optimality condition is reached

(c) Inability to identify a Leaving Basic Variable in any iteration of Simplex Algorithm even though the optimality condition is not reached

(d) A tie between the required Replacement Ratio Values for identifying a Leaving Basic Variable in any iteration of Simplex Algorithm even though the optimality condition is not reached

(iii) Degeneracy in a linear programming problem is an indication that ________. [Fill in the blank]

(a) there could be a redundant constraint present in the model

(b) the number of constraints is less than that required

(c) the problem has multiple optimal solutions

(d) none of the above

(iv) In the process of solving a linear programming problem, when the initial basic solution comes out to be infeasible, then which of the following methods can be adopted to find out the optimal solution to the problem, provided an optimal solution exists for the problem?

(a) Big-M method

(b) Two-phase method

(c) Dual Simplex method (algorithm)

(d) All of the above

(v) Which of the following methods or algorithms is used in the solution of integer linear programming problems?

(a) Branch-and-Bound (B&B) method

(b) Kuhn-Tucker method

(c) Cutting Plane method

(d) Both (a) and (c)

(vi) In a balanced transportation problem comprising m number of rows and n number of columns, and if x_{ij} is the number of units shipped from source i to destination j $[x_{ij} \geq 0]$, where $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$; what are the necessary conditions for the basic feasible solution to be non-degenerate?

(a) $x_{ij} > m + n - 1$ and allocations are in independent positions

(b) $x_{ij} = m + n - 1$ and allocations are in independent positions

(c) $x_{ij} < m + n - 1$ and allocations are in independent positions

(d) $x_{ij} \neq m + n - 1$ and allocations are in independent positions

(vii) Which of the following is a method to test optimality of the basic feasible solution in a transportation problem?

(a) Vogel's Approximation method (VAM)

(b) North-West Corner method (NWCM)

(c) Both (a) and (b)

(d) Modified Distribution Method ($u - v$ method)

(viii) A particular product ABC is produced by assembling three parts A, B and C. These A, B and C parts are manufactured in three different production lines L1, L2 and L3 respectively. The production capacities of these three production lines are in the order of L1 > L2 > L3. The production lines are run for 8 hours every day. But the production manager usually runs L2 and L3 for 12 hours on every Friday and keeps the extra produced quantity of part B and C as _____ inventory so that the production of ABC can be carried out smoothly throughout the week. [Fill in the blank]

(a) Anticipation inventory

(b) MRO inventory

(c) Decoupling inventory

(d) Cycle Inventory

(ix) "When uncertainties are involved, Simulation Techniques always give the Optimum results" – regarding the quoted statement, choose the correct comment.

(a) Always TRUE

(b) NOT TRUE. Simulation results are only reliable approximations subject to statistical errors

(c) Simulation results are not reliable

(d) None of the above

(x) "Classical Optimization Techniques are not applicable to non-differentiable or discontinuous functions" – State whether TRUE or FALSE.

(a) TRUE

(b) FALSE

(c) Cannot be commented

(d) Both (b) and (c)

2. (a) (i) A firm manufacturers pain relieving pills in two sizes A and B. Size A contains 4 grains of element X, 7 grains of element Y and 2 grains of element Z. Size B contains 2 grains of element X, 10 grains of element Y and 8 grains of element Z. It is found by users that it requires at least 12 grains of element X, 74 grains of element Y and 24 grains of element Z to provide immediate relief. It is required to determine the least number of pills a patient should take to get immediate relief. Formulate the problem as a General Linear Programming Model. (5)

(b) (i) A firm manufactures two products A and B on which the profits earned per unit are Rs. 3 and Rs. 4 respectively. Each product is processed on two machines M1 and M2. Product-A requires one minute of processing time on M1 and two minutes on M2, while Product-B requires one minute on M1 and one minute on M2. Machine M1 is available only for 7 hours 30 minutes while machine M2 is available only for 10 hours during any working day. Construct a Linear Programming Problem with the given information and find the number of units of Product-A and B to be manufactured to get maximum profit using the Simplex Method. (10)

Or

(ii) A company operates for 10 hours per day and manufactures two products using three different machines. The following table summarizes the required data for the problem. Solve by using Graphical Method to find out the optimal mix (in kilogram) of the two products. (10)

Product	Processing time (minutes per unit)			Unit Profit (Rs.)
	Machine 1	Machine 2	Machine 3	
1	10	6	8	2
2	5	20	10	3

3. (a) The following transportation matrix gives the unit transportation costs (in Rupees) from each Source to each Destination; the supply capacity of each Source and the demand at each Destination (in number of units). Find the initial basic feasible solution for this transportation problem by using the North-West Corner method and the corresponding total transportation cost. (4+1)

	Destination 1	2	3	4	Supply
Source 1	2	3	11	7	6
Source 2	1	0	6	1	1
Source 3	5	8	15	9	10
Demand	7	5	3	2	

(b) (i) The following transportation matrix gives the unit transportation costs (in Rupees) from each Source to each Destination; the supply capacity of each Source and the demand at each Destination (in number of units). Find the initial basic feasible solution for this transportation problem by using the Vogel's Approximation Method. Also test the optimality of the obtained initial basic feasible solution and if found non-optimal, then proceed to find the optimal solution to the problem. Use Modified Distribution ($u - v$) method for this purpose if required. (10)

Destination

Source	1	2	3	4	Supply
1	14	25	45	5	6
2	65	25	35	55	8
3	35	3	65	15	16
Demand	4	7	6	13	

Or

(ii) The processing cost of each Job on each Machine is mentioned in the following Table (in Rupees). Find out the optimal assignment of the Jobs to Machines so that the total processing cost is minimized. (10)

Machines

Jobs	M_1	M_2	M_3	M_4
J_1	5	7	11	6
J_2	8	5	9	6
J_3	4	7	10	7
J_4	10	4	8	3

4. (a) In connection to Inventory Control and Management, define the following : (3 × 1)

(i) Lead time

(ii) Reorder Level or Reorder Point

(iii) Work-in-Process inventory

(b) Show graphically the effect of Lot Size on the Order Setup Cost, Ordered Material Cost; Annual Inventory Holding Cost and Total Annual Inventory Cost under the assumptions of EOQ (Economic Order Quantity) model. Also, clearly indicate on the graph the quantity to be ordered each time a procurement is placed to keep the total annual inventory cost to minimum. (2)

(c) A company purchases 10,000 items per year for use in its production shop. The unit cost is Rs. 10 per unit, holding cost is Rs. 0.80 per unit per month and cost of making a purchase is Rs. 200. Interpret the given information and find the following if no shortages are allowed. (10)

(Rounding off fractional answers to get integer values is not necessary. Rounding off can be done up to two decimal points.)

(i) The optimum order quantity

(ii) The optimum total yearly cost

(iii) The number of orders per year

(iv) The time between orders

5. (a) What do you mean by Simulation? Define Analogue Simulation and Computer Simulation. (3 + 2)

(b) List down THREE Advantages and TWO Limitations of simulation as compared to mathematical programming and standard probability analysis. (3+2)

(c) Generate FIVE random numbers based on the multiplicative congruential method using $b = 9$, $c = 5$ and $m = 12$. The seed is $u_0 = 11$. (5 × 1)

Or

6. Determine the maximum and minimum values of the following function :

$f(x) = 3x^4 - 4x^3 - 24x^2 + 48x + 15$

Also comment whether the obtained maximum and minimum values are local (relative) values or the Global values. (15)