DA-IICT Gandhinagar
IE402, Autumn 2022-2023
In Semester Examination-I
Date: 16/09/2022, Duration: 120 minutes
Maximum Marks: 25

General Instructions

- Answer all questions.
- Use of Scientific Calculator is NOT allowed.
- Kindly ensure that no relevant books and notes are open during the exam duration.

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1. Samsung is manufacturing 2 processors: Exynos-2100 (E2100) and Exynos -990 (E990). Consider that manufacturing each unit of E2100 processor requires 3 hours of Design Engineer, 7 hours of Software Engineer, and 3 hours of Verification Engineer. On the other hand, manufacturing each unit of E990 processor requires 2 hours of Design Engineer, 2 hours of Software Engineer, and 6 hours of Verification Engineer. The maximum available hours for the Design Engineer, Software Engineer and Verification Engineer are 60 hours, 84 hours, 72 hours respectively. The profit per unit of E2100 and E990 processors are US Dollar (USD) 50 and USD 35 respectively.
   (a) Formulate the LPP from the details available above for manufacturing the processors at Samsung manufacturing facility. **[2 marks]**
   (b) Solve the formulated LPP using the Algebraic method listing all the cases and their solution. Obtain the optimal value of the LPP, i.e., the objective function and the decision variables. **[4 marks]**

2. For the LPP:

$$Max\ Z = 5x_1 + 5x_2 \tag{1}$$

s.t.

$$x_1 + 2x_2 \leq 3$$
$$4x_1 + 3x_2 \geq 6$$
$$3x_1 + x_2 = 3$$

$x_i \geq 0, \forall i$

   (a) Solve the LPP using the Graphical method. Find the feasible region of the LPP and comment on the feasible region by listing the obtained corner points. State the nature of the solution for this LPP. **[4 marks]**
   (b) Deduce the optimal value of the LPP illustrating the optimal values of the objective function and the decision variables. **[2 marks]**

3. For the LPP:

$$Max\ Z = x_1 - x_2 + 3x_3 \tag{2}$$

s.t.

$$\begin{aligned} 6x_1 + 2x_2 + x_3 &\leq 15 \\ x_1 + 2x_2 - 5x_3 &\geq 6 \\ 4x_1 + x_2 - 3x_3 &\geq -3 \\ x_1 + 2x_2 + 3x_3 &= 3 \end{aligned}$$

x_1 is unrestricted in sign, $x_2 \geq P$ and $x_3 \geq 0$.

(a) Derive the standard form of the LPP and present the revised objective function, list of constraints. Find the finite range value of P for which the LPP is in the standard form. **[4 marks]**

(b) Obtain the coefficient matrix from the standard form of the LPP. What would be total number of possible cases, the number of basic variables and the number of non-basic variables for each case, if this problem is to be solved using Algebraic method. **[2 marks]**

4. Given the LPP:

$$Max\ Z = 4x_1 + 7x_2 \tag{3}$$

s.t.

$$\begin{aligned} 3x_1 + 3x_2 &\leq 21 \\ 4x_1 + 3x_2 &\geq 24 \\ x_1 - x_2 &\geq 5 \end{aligned}$$

$x_i \geq 0, \forall i$.

(a) Solve the LPP using Algebraic method and identify the Basic feasible solution (BFS), degenerate BFS (D-BFS), non-degenerate BFS (ND-BFS). **[4 marks]**

(b) Find the corner points of the LPP upon solving using the Graphical method and illustrate the correspondence between the corner points and the BFS, i.e., mention the corner points and the cases in Algebraic method which are associated with the corner points. **[3 marks]**

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DA-IICT Gandhinagar
IE402, Autumn 2022-2023
In Semester Examination-II
Date: 22/10/2022, Duration: 60 minutes
Maximum Marks: 25

General Instructions

- Answer all questions.
- Use of Calculator of any type is NOT allowed.
- Kindly ensure that no books and notes are open during the exam duration.

NOTE for Simplex Method: Present the Pivot element (PE), Pivot row (PR), Minimum Ratio Value (MRV) and Row operations mandatorily for every Simplex table (wherever applicable).

1. For the LPP:

$$Max\ Z = x_1 + 2x_2 + x_3 \tag{1}$$

s.t.

$$\begin{aligned} 2x_1 + x_2 - x_3 &= 2 \\ -2x_1 + x_2 - 5x_3 &\geq -6 \\ 4x_1 + x_2 + x_3 &\leq 6 \end{aligned}$$

$x_i \geq 0, \forall i.$

(a) Solve the above Maximization LPP stepwise using the Big-M method illustrating the optimal solution and degeneracy/non-degeneracy of the obtained Basic Feasible solution. **[6 marks]**

(b) Discuss the Nature of the obtained optimal solution based on the observation from the Simplex table. **[2 marks]**

2. For the LPP:

$$Max\ Z = -x_1 + x_2 \tag{2}$$

s.t.

$$\begin{aligned} 2x_1 + 3x_2 &\leq 6 \\ x_1 + x_2 &\geq -1 \\ 2x_1 + x_2 &\leq 3 \end{aligned}$$

$x_i \geq 0, \forall i.$

(a) Solve the LPP using the Graphical method and present the optimal solution. Comment on the obtained feasible region and the Nature of optimal solution. **[4 marks]**

(b) Upon solving the LPP using the Simplex method, list out the corner points of the Graphical method which are covered in the Simplex tables. **[6 marks]**

3. For the LPP:

$$Min\ Z = x_1 - 3x_2 + 2x_3 \tag{3}$$

s.t.

$$\begin{aligned} 3x_1 - x_2 + 3x_3 &\leq 7 \\ -2x_1 + 4x_2 &\leq 12 \\ -4x_1 + 3x_2 + 8x_3 &\leq 10 \end{aligned}$$

$x_i \geq 0, \forall i.$

(a) Solve the LPP using the Simplex method presenting the optimal solution. **[5 marks]**

(b) Adding a new constraint to the above LPP may disturb which of the following: **[2 marks]**

- Feasibility
- Optimality
- Both Feasibility and Optimality

Provide a brief explanation to the answer.

DA-IICT Gandhinagar
IE402: Optimization, Autumn 2022-2023
End Semester Examination
Date: 13/12/2022, Duration: 120 minutes
Maximum Marks: 50

General Instructions

- Use of Calculator of any type is NOT allowed.
- **NOTE:** Present the Pivot element (PE), Pivot row (PR), Minimum Ratio Value (MRV) values and Row operations mandatorily for every Simplex table wherever applicable.

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1. Consider a transportation problem with 4 sources S_1, S_2, S_3 and S_4 with supply availability of 15, 18, 12 and 20 units respectively. There are 4 destinations D_1, D_2, D_3 and D_4 having a demand requirements of 14, 16, 20 and 15 units respectively. Let x_{ij} be the units of a particular quantity transported from source i to destination j. C_{ij} be the cost per unit in transportation from source i to destination j. Assume that the North West (NW) corner method leads to the optimal solution for this transportation problem. The values of Dual variables are $u_1 = 5$, $u_2 = 3$, $u_3 = -2$, $u_4 = 7$ and $v_1 = 6$, $v_2 = 10$, $v_3 = 8$, $v_4 = 5$.
   (a) Using the NW corner method, find the initial basic feasible solution and cell traversal path of the given transportation problem. Derive the cost values associated with each basic variable and the final cost value of the above transportation model, i.e., the value of the objective function. **[5 marks]**
   (b) Find the lower bound on the cost values associated with each of the non-basic variable/cell which will lead to optimality of this transportation problem. **[3 marks]**

2. For the LPP:

$$Max\ Z = 5x_1 - 4x_2 + 3x_3 \tag{1}$$

s.t.

$$\begin{aligned} 2x_1 + x_2 - 6x_3 &= 20 \\ 6x_1 + 5x_2 + 10x_3 &\leq 76 \\ 8x_1 - 3x_2 + 6x_3 &\geq 50 \end{aligned}$$

$x_1, x_2, x_3 \geq 0$.
   (a) Solve the LPP stepwise and present the optimal solution using the Two-Phase method using a Maximization objective function in Phase-1. **[8 marks]**
   (b) Comment on the Nature of the obtained solution and the degeneracy/non-degeneracy of the solution. **[2 marks]**

3. Intel in US is manufacturing 2 processors Atom P5900 and Atom P5000 at its production facility in Oregon and Arizona.

Intel Oregon: Manufacturing each unit of P5900 requires 6 hours of Design Engineer (DE), 7 hours of Validation Engineer (VE) and 30 units of Silicon wafer material (SWM). While manufacturing each unit of P5000 requires 4 hours of DE, 5 hours of VE and 60 units of SWM. The maximum availability of DE, VE and SWM are 120 hours, 105 hours and 720 units respectively. The profit associated with each unit of P5900 and P5000 are USD 15 and USD 12 respectively.

Intel Arizona: Manufacturing each unit of P5900 requires 7 hours of DE, 6 hours of VE and 35 units of SWM. While manufacturing each unit of P5000 requires 6 hours of DE, 4 hours of VE and 60 units of SWM. The maximum availability of DE, VE and SWM are 126 hours, 108 hours and 840 units respectively. The profit associated with each unit of P5900 and P5000 are USD 13 and USD 15 respectively.

(a) Using the data available for Manufacturing the processors at Intel Oregon and Intel Arizona, formulate it as an LPP for both the manufacturing sites. **[4 marks]**

(b) Solve the formulated LPPs using any method of your choice and illustrate with reasoning that which Manufacturing facility of Intel is yielding a better profitable business. **[10 marks]**

4. (a) For m constraints and n decision variables LPP, derive the mathematical formulation for the Algebraic method illustrating the expressions of the objective function and the list of constraints. Obtain the mathematical model explicitly in terms of Matrices and Vectors by clearly representing them. **[3 marks]**

   (b) Consider a transportation model with m sources and n destinations. Derive the mathematical model (comprising the expressions of the objective function and the constraints) of the transportation problem and the Dual transportation problem. Deduce the obtained mathematical models by representing in terms of Matrices and Vectors. **[5 marks]**

5. For the LPP:

$$Max\ Z = 5x_1 + 7x_2 \tag{2}$$

s.t.

$$\begin{aligned} x_1 + 2x_2 + 3x_3 &= 6 \\ 2x_1 + 3x_2 - x_4 &= 7 \\ x_1 - x_2 + x_5 &= 0 \end{aligned}$$

$x_i \geq 0\ \forall i$.

(a) Solve the above LPP using the Graphical method by presenting the Feasible region obtained and the optimal solution. **[4 marks]**

(b) Determine and list all the cases with Basic and Non-basic variables for the above LPP. Present the solution values for all the cases (listing out complete solution for cases with Basic Infeasible solution can be ignored). **[5 marks]**

(c) Illustrate the correspondence between the Corner points and the Basic Feasible solution mentioning the degeneracy/non-degeneracy of the Basic Feasible solution. **[1 marks]**