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| **SESSION** | **JUL - AUG 2024** |
| **PROGRAM** | **MASTER OF BUSINESS ADMINISTRATION (MBA)** |
| **SEMESTER** | **3** |
| **COURSE CODE & NAME** | **DOMS304 APPLICATIONS OF OPERATIONS RESEARCH** |
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**Assignment Set – 1**

**1. A factory manufactures two products A and B. To manufacture one unit of A, 10 machine hours and 15 labour hours are required. To manufacture product B, 20 machine hours and 15 labour hours are required. In a month, 400 machine hours and 300 labour hours are available. Profit per unit for A is Rs. 75 and for B is Rs. 50. Formulate as LPP.**

**Ans 1.**

### Formulating the Linear Programming Problem (LPP)

In this scenario, a factory manufactures two products, A and B, using limited resources: machine hours and labor hours. The aim is to determine the optimal production quantities of these products to maximize profit while staying within the resource constraints. This problem can be formulated as a Linear Programming Problem (LPP) as follows:

#### Decision Variables

To represent the quantities of the two products, we define:

* : Number of units of product A to be produced.
* : Number of units of product B to be produced.

These variables must satisfy the constraints imposed by the resource availability and cannot

Its Half solved only

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**2. Find solution using Simplex method**

**MAX Z = 3x1 + 5x2 + 4x3**

**subject to**

**2x1 + 3x2 <= 8**

**2x2 + 5x3 <= 10**

**3x1 + 2x2 + 4x3 <= 15**

**and x1,x2,x3 >= 0**

**Ans 2.**

**Problem is**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Max Z | = |  | 3 | x1 | + | 5 | x2 | + | 4 | x3 | |
| subject to |
| |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | 2 | x1 | + | 3 | x2 |  |  |  | ≤ | 8 | |  |  |  |  | 2 | x2 | + | 5 | x3 | ≤ | 10 | |  | 3 | x1 | + | 2 | x2 | + | 4 | x3 | ≤ | 15 | |
| and x1,x2,x3≥0; |

The problem is converted to canonical form by adding slack, surplus and artificial variables as appropiate  
  
1. As the constraint-1 is of type '≤' we should add slack variable S1  
2. As the constraint-2 is of type '≤' we should add slack variable S2  
3. As the constraint-3 is of type '≤' we should add slack variable S3  
  
**After introducing slack variables**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Max Z | = |  | 3 | x1 | + | 5 | x2 | + | 4 | x3 | + | 0 | S1 | + | 0 | S2 | + | 0 | S3 | |
| subject to |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | 2 | x1 | + | 3 | x2 |  |  |  | + |  | S1 |  |  |  |  |  |  | = | 8 | |  |  |  |  | 2 | x2 | + | 5 | x3 |  |  |  | + |  | S2 |  |  |  | = | 10 | |  | 3 | x1 | + | 2 | x2 | + | 4 | x3 |  |  |  |  |  |  | + |  | S3 | = | 15 | |

**3. Solve the following LPP graphically**

**Max Z = 4x + 5y**

**Subject to**

**x + y ≤ 20**

**3x + 4y ≤ 72**

**x, y ≥ 0**

**Ans 3.**  
**Problem is**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | MAX *Z* | = |  | 4 | *x*1 | + | 5 | *x*2 | |
| subject to |
| |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | *x*1 | + |  | *x*2 | ≤ | 20 | |  | 3 | *x*1 | + | 4 | *x*2 | ≤ | 72 | |
| and *x*1,*x*2≥0; |

Hint to draw constraints  
1. To draw constraint *x*1+*x*2≤20→(1)  
  
Treat it as *x*1+*x*2=20  
  
When *x*1=0 then *x*2=?  
  
⇒(0)+*x*2=20  
  
⇒*x*2=20  
  
When *x*2=0 then *x*1=?  
⇒*x*1+(0)=20  
⇒*x*1=20

|  |  |  |
| --- | --- | --- |
| *x*1 | 0 | 20 |
| *x*2 | 20 | 0 |

Put *x*1=0,*x*2=0 (origin) in *x*1+*x*2≤20, then 0+0≤20, which is true,

**Assignment Set – 2**

**4. Obtain an optimum solution to the following transportation problem**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factory** | **Warehouse** | | | | **Capacity** |
|  | **W1** | **W2** | **W3** | **W4** |  |
| **F1** | **19** | **30** | **50** | **10** | **7** |
| **F2** | **70** | **30** | **40** | **60** | **9** |
| **F3** | **40** | **8** | **70** | **20** | **18** |
| **Requirements** | **5** | **8** | **7** | **14** |  |

### Ans 4.

### Step-by-Step Solution to the Transportation Problem

#### Problem Data:

| **Factory** | **Warehouse W1** | **Warehouse W2** | **Warehouse W3** | **Warehouse W4** | **Capacity** |
| --- | --- | --- | --- | --- | --- |
| **F1** | 19 | 30 | 50 | 10 | 7 |
| **F2** | 70 | 30 | 40 | 60 | 9 |
| **F3** | 40 | 8 | 70 | 20 | 18 |

| **Warehouse** | **Requirement** |
| --- | --- |
| **W1** | 5 |
| **W2** | 8 |
| **W3** | 7 |
| **W4** | 14 |

#### Step 1: Define the Decision Variables

Let represent the number of goods transported from factory to warehouse .

#### Step 2: Objective Function

Minimize the total cost:

**5. Consider the problem of assigning five jobs to five persons. The assignment costs are given as follows. Determine the optimum assignment schedule.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Job** | | | | | |
| **Person** | **1** | **2** | **3** | **4** | **5** |
| **A** | **8** | **4** | **2** | **6** | **1** |
| **B** | **0** | **9** | **5** | **5** | **4** |
| **C** | **3** | **8** | **9** | **2** | **6** |
| **D** | **4** | **3** | **1** | **0** | **3** |
| **E** | **9** | **5** | **8** | **9** | **5** |

**Ans 5.**

### Problem: Assignment of Jobs to Persons

The task involves assigning five jobs to five persons such that the total assignment cost is minimized. The cost matrix is given as:

|  | Job 1 | Job 2 | Job 3 | Job 4 | Job 5 |
| --- | --- | --- | --- | --- | --- |
| **A** | 8 | 4 | 2 | 6 | 1 |
| **B** | 0 | 9 | 5 | 5 | 4 |
| **C** | 3 | 8 | 9 | 2 | 6 |
| **D** | 4 | 3 | 1 | 0 | 3 |
| **E** | 9 | 5 | 8 | 9 | 5 |

We solve this using the **Hungarian Method**, which can be implemented algorithmically

**6. Discuss the applications of Integer programming.**

**Ans 6.**

**Applications of Integer Programming**

Integer Programming (IP) is a specialized field within optimization that focuses on problems requiring decision variables to take integer values. It is widely applied in various industries and sectors due to its ability to address real-world problems where solutions must be discrete, such as scheduling, allocation, and resource optimization. Below are key applications of Integer Programming, discussed in detail:

**1. Supply Chain Management**

Integer Programming is extensively used in supply chain optimization to address problems