Solution Hints

Sol 5) With the given conditions, the cost matrix can be written as:

C3

C3’

C1

C2

C2’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1  -3  +  5 | 7 | 30  7 | 6  30  5 | 6 |
| 0  +  2 | +  5  3 | 3 | 40  0 | 35  -M  5 |
| 50  -3  0 | 55  +  0 | -M  + | + |  |

u

C2’

C3

C3’

C2

C1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1  -3  +  5 | 7 | -3  7 | 6  60  5 | 6 |
| 0  +  2 | 5  3 | 30  3 | 10  0 | 35  -M  5 |
| 50  -3  0 | 55  +  0 | -M  + |  | +  105 |

50

60

30

70

35

80

600

5

3

5

3

3

v

5

5

3

3

3

C2

Profit= 35+210+225+175+150=795

C3’

C3

C2’

C1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1  +  5 | 5  7 | 30  7 | 6  25  5 | 6 |
| 0  +  2 | +  3 | 3 | 45  0 | 35  -M  5 |
| 50  -3  0 | 55  +  0 | -M  + | + |  |

Sol 6) Here total supply is 90 units and total demand is 115 units which shows unbalanced transportation problem. Therefore a dummy row is to be adding, to balance the problem.

After incorporating the conditions given in problem the transportation table will be:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 3’ | 4 | Capacity |
| A | 7 | 10 | 14 | 14 | 8 | 30 |
| B | 7 | 11 | 12 | 12 | 6 | 35 |
| C | 5 | 8 | 15 | 15 | 8 | 25 |
| Dummy | M | 0 | 0 | M | 0 | 53 |
| Demand | 20 | 20 | 35 | 28 | 40 |  |

Applying VAM for getting the IBFS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 3’ | 4 | Capacity | Penalty |
| A | 7 | 10 | 14 | 14 (28) | 8 (2) | 30 | 1 |
| B | 7 | 11 | 12 | 12 | 6 (35) | 35 | 1 |
| C | 5 (20) | 8 (2) | 15 | 15 | 8 (3) | 25 | 3 |
| Dummy | M | 0 (18) | 0 (35) | M | 0 | 53 | 0 |
| Demand | 20 | 20 | 35 | 28 | 40 |  |  |
| Penalty | 2 | 8 | 12 | 2 | 6 |  |  |

Checking the optimality

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | V | -3 | 0 | 0 | 6 | 0 |  |  |
| U |  | 1 | 2 | 3 | 3’ | 4 | Capacity | Penalty |
| 8 | A | (+) 7 | (+) 10 | (+) 14 | 14 (28) | 8 (2) | 30 | 1 |
| 6 | B | (+) 7 | (+) 11 | (+) 12 | 12 | 6 (35) | 35 | 1 |
| 8 | C | 5 (20) | 8 (2) | (+) 15 | 15 | 8 (3) | 25 | 3 |
| 0 | Dummy | M | 0 (18) | 0 (35) | M | 0 | 53 | 0 |
|  | Demand | 20 | 20 | 35 | 28 | 40 |  |  |
|  | Penalty | 2 | 8 | 12 | 2 | 6 |  |  |

Optimal solution has reached

TC = 14\*28 + 8\*2 + 6\*35 + 5\*20 + 8\*2 + 8\*3 = 758

Sol 7)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Job 1 | Job 3 | Job 3 | Job 4 |
| Machine 1 | 10 | 2 | 3 | 15 |
| Machine 2 | 5 | 10 | 15 | 2 |
| Machine 3 | 15 | 5 | 14 | 7 |
| Machine 4 | 20 | 15 | 13 | - |

Converting maximization problem into a minimization problem

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Job 1 | Job 3 | Job 3 | Job 4 |
| Machine 1 | 10 | 18 | 17 | 5 |
| Machine 2 | 15 | 10 | 5 | 18 |
| Machine 3 | 5 | 15 | 6 | 13 |
| Machine 4 | 0 | 5 | 7 | - |

Row reduction

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | J1 | J3 | J3 | J4 |
| M 1 | 5 | 13 | 12 | 0 |
| M 2 | 10 | 5 | 0 | 13 |
| M 3 | 0 | 10 | 1 | 8 |
| M 4 | 0 | 5 | 7 | - |
| Column reduction | | | | |
|  | J1 | J3 | J3 | J4 |
| M 1 | 5 | 8 | 12 | 0 |
| M 2 | 10 | 0 | 0 | 13 |
| M 3 | 0 | 5 | 1 | 8 |
| M 4 | 0 | 0 | 7 | - |

Allocation

|  |  |
| --- | --- |
| M/C | Job |
| 1 | 4 |
| 2 | 3 |
| 3 | 1 |
| 4 | 2 |

Total profit of allocation = (15+15+15+15)\*100

= 6000

Sol 8)

Stationed at B stationed at A

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 10 | 20 | 30 | 40 |
| 1 | 23 | 24.75 | 8 | 11.5 |
| 2 | 20.75 | 22.5 | 5.75 | 9.25 |
| 3 | 15.5 | 17.25 | 24.5 | 4.0 |
| 4 | 14 | 15.75 | 23 | 26.5 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 |
| 10 | 20.5 | 22.75 | 4 | 5.5 |
| 20 | 18.75 | 21.0 | 21.75 | 3.75 |
| 30 | 11.5 | 13.75 | 19 | 20.5 |
| 40 | 8 | 10.25 | 15.5 | 17 |

Final layover matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 10 | 20 | 30 | 40 |
| 1 | 20.5A | 18.75A | 8B | 8A |
| 2 | 20.75B | 21.0A | 5.75B | 9.25B |
| 3 | 4A | 17.25B | 19.0A | 4.0B |
| 4 | 5.5A | 3.75A | 20.5A | 17.0A |

Minimizing using hungarian algorithm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 10 | 20 | 30 | 40 |
| 1 | 20.5A | 18.75A | 8B | 8A |
| 2 | 20.75B | 21.0A | 5.75B | 9.25B |
| 3 | 4A | 17.25B | 19.0A | 4.0B |
| 4 | 5.5A | 3.75A | 20.5A | 17.0A |

|  |  |  |
| --- | --- | --- |
| Flight | Station | Layover time |
| 1:40 | A | 8.00 |
| 2:30 | B | 5.75 |
| 3:10 | A | 4.00 |
| 4:20 | A | 3.75 |

Total layover time = 21.50