Oregon State University

Project Group 21

CS 325: Project 3

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1 Problem 1

Part A:
i. Linear Problem Formulation

Let each route be represented as variables of the form "SourceDestination." For example a route from Plant 1 to Warehouse 1 would be "p1w1."

Objective function:

Minimize:

10 p1w1 + 15 p1w2 + 11 p2w1 + 8 p2w2 + 13 p3w1 + 8 p3w2 + 9 p3w3 + 14 p4w2 + 8 p4w3 + 5 w1r1 + 6 w1r2 + 7 w1r3 + 10 w1r4 + 12 w2r3 + 8 w2r4 + 10 w2r5 + 14 w2r6 + 14 w3r4 + 12 w3r5 + 12 w3r6 + 6 w3r7

Subject To:

Supply Constraints:
p1w1 + p1w2 = 150
p2w1 + p2w2 = 450
p3w1 + p3w2 + p3w3 = 250
p4w2 + p4w3 = 150

Demand Constraints:
w1r1 = 100
w1r2 = 150
w1r3 + w2r3 = 100
w1r4 + w2r4 + w3r4 = 200
w2r5 + w3r5 = 200
w2r6 + w3r6 = 150
w3r7 = 100

Balancing Constraints:
p1w1 + p2w1 + p3w1 - w1r1 - w1r2 - w1r3 - w1r4 <= 0
p1w2 + p2w2 + p3w2 + p4w2 - w2r3 - w2r4 - w2r5 - w2r6 <= 0
p3w3 + p4w3 - w3r4 - w3r5 - w3r6 - w3r7 <= 0

Non-negativity Constraints:
p1w1, p1w2, p2w1, p2w2, p3w1, p3w2, p3w3, p4w2, p4w3, w1r1, w1r2, w1r3, w1r4, w2r3, w2r4, w2r5, w2r6, w3r4, w3r5, w3r6, w3r7 >= 0

ii. LINDO Code and Output

```
MIN 10 p1w1 + 15 p1w2 + 11 p2w1 + 8 p2w2 + 13 p3w1 + 8 p3w2 + 9 p3w3
  + 14 p4w2 + 8 p4w3 + 5 w1r1 + 6 w1r2 + 7 w1r3 + 10 w1r4 + 12 w2r3
  + 8 w2r4 + 10 w2r5 + 14 w2r6 + 14 w3r4 + 12 w3r5 + 12 w3r6 + 6 w3r7
ST
   p1w1 + p1w2 = 150
   p2w1 + p2w2 = 450
   p3w1 + p3w2 + p3w3 = 250
   p4w2 + p4w3 = 150
   w1r1 = 100
   w1r2 = 150
   w1r3 + w2r3 = 100
   w1r4 + w2r4 + w3r4 = 200
   w2r5 + w3r5 = 200
   w2r6 + w3r6 = 150
   w3r7 = 100
   p1w1 + p2w1 + p3w1 - w1r1 - w1r2 - w1r3 - w1r4 <= 0
   p1w2 + p2w2 + p3w2 + p4w2 - w2r3 - w2r4 - w2r5 - w2r6 <= 0
   p3w3 + p4w3 - w3r4 - w3r5 - w3r6 - w3r7 <= 0
   p1w1 > 0
   p1w2 > 0
   p2w1 > 0
   p2w2 > 0
   p3w1 > 0
   p3w2 > 0
```

```
   p3w3 > 0
   p4w2 > 0
   p4w3 > 0
   w1r1 > 0
   w1r2 > 0
   w1r3 > 0
   w1r4 > 0
   w2r3 > 0
   w2r4 > 0
   w2r5 > 0
   w2r6 > 0
   w3r4 > 0
   w3r5 > 0
   w3r6 > 0
   w3r7 > 0
END


 LP OPTIMUM FOUND AT STEP     13

        OBJECTIVE FUNCTION VALUE

        1)      17100.00

  VARIABLE        VALUE          REDUCED COST
      P1W1       150.000000          0.000000
      P1W2         0.000000          8.000000
      P2W1       200.000000          0.000000
      P2W2       250.000000          0.000000
      P3W1         0.000000          2.000000
      P3W2       150.000000          0.000000
      P3W3       100.000000          0.000000
      P4W2         0.000000          7.000000
      P4W3       150.000000          0.000000
      W1R1       100.000000          0.000000
      W1R2       150.000000          0.000000
      W1R3       100.000000          0.000000
      W1R4         0.000000          5.000000
      W2R3         0.000000          2.000000
      W2R4       200.000000          0.000000
      W2R5       200.000000          0.000000
      W2R6         0.000000          1.000000
      W3R4         0.000000          7.000000
      W3R5         0.000000          3.000000
```

W3R6	150.000000	0.000000
W3R7	100.000000	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-10.000000
3)	0.000000	-11.000000
4)	0.000000	-11.000000
5)	0.000000	-10.000000
6)	0.000000	-5.000000
7)	0.000000	-6.000000
8)	0.000000	-7.000000
9)	0.000000	-5.000000
10)	0.000000	-7.000000
11)	0.000000	-10.000000
12)	0.000000	-4.000000
13)	0.000000	0.000000
14)	0.000000	3.000000
15)	0.000000	2.000000
16)	150.000000	0.000000
17)	0.000000	0.000000
18)	200.000000	0.000000
19)	250.000000	0.000000
20)	0.000000	0.000000
21)	150.000000	0.000000
22)	100.000000	0.000000
23)	0.000000	0.000000
24)	150.000000	0.000000
25)	100.000000	0.000000
26)	150.000000	0.000000
27)	100.000000	0.000000
28)	0.000000	0.000000
29)	0.000000	0.000000
30)	200.000000	0.000000
31)	200.000000	0.000000
32)	0.000000	0.000000
33)	0.000000	0.000000
34)	0.000000	0.000000
35)	150.000000	0.000000
36)	100.000000	0.000000

NO. ITERATIONS= 13

iii. Optimal Shipping Routes and Minimum Cost

The optimal shipping routes and quantity of refrigerators per route are:

Route	Refrigerators
P1W1	150
P2W1	200
P2W2	250
P3W2	150
P3W3	100
P4W3	150
W1R1	100
W1R2	150
W1R3	100
W2R4	200
W2R5	200
W3R6	150
W3R7	100

The optimal minimum cost is $17,100

Part B:

Part C:

Part D:

2 Problem 2

Part A:

i.

ii.

iii.

Part B:

i.

ii.

iii.

Part C:

i.

ii.

iii.

3 Problem 3

Part A:

i.

ii.
iii.
Part B:
i.
ii.
iii.
iv.
Part C: