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CS 325
Homework 6

1. A)

```
max h

st
        a = 0
        b-a < 10
        b-e < 1
        c-b < 2
        c-e < 4
        c-g < 2
        d-a < 5
        e-d < 2
        e-f < 2
        e-g < 4
        f-d < 10
        g-f < 7
        g-c < 2
        h-g < 3
        h-c < 8
end
```

```
LP OPTIMUM FOUND AT STEP      0

       OBJECTIVE FUNCTION VALUE

       1)      15.00000

 VARIABLE         VALUE          REDUCED COST
        H        15.000000          0.000000
        A         0.000000          0.000000
        B         8.000000          0.000000
        E         7.000000          0.000000
        C        10.000000          0.000000
        G        12.000000          0.000000
        D         5.000000          0.000000
        F         5.000000          0.000000


      ROW   SLACK OR SURPLUS     DUAL PRICES
       2)         0.000000          1.000000
       3)         2.000000          0.000000
       4)         0.000000          1.000000
       5)         0.000000          1.000000
       6)         1.000000          0.000000
       7)         4.000000          0.000000
       8)         0.000000          1.000000
       9)         0.000000          1.000000
      10)         0.000000          0.000000
      11)         9.000000          0.000000
      12)        10.000000          0.000000
      13)         0.000000          0.000000
      14)         0.000000          1.000000
      15)         0.000000          1.000000
      16)         3.000000          0.000000

NO. ITERATIONS=       0
```

The shortest path from vertex 0 to 7 is 15.

B)

```
max b+c+d+e+f+g+h

st
        a = 0
        b-a < 10
        b-e < 1
        c-b < 2
        c-e < 4
        c-g < 2
        d-a < 5
        e-d < 2
        e-f < 2
        e-g < 4
        f-d < 10
        g-f < 7
        g-c < 2
        h-g < 3
        h-c < 8
end
```

```
LP OPTIMUM FOUND AT STEP      0

       OBJECTIVE FUNCTION VALUE

       1)      72.00000

 VARIABLE        VALUE          REDUCED COST
        B         8.000000          0.000000
        C        10.000000          0.000000
        D         5.000000          0.000000
        E         7.000000          0.000000
        F        15.000000          0.000000
        G        12.000000          0.000000
        H        15.000000          0.000000
        A         0.000000          0.000000


      ROW   SLACK OR SURPLUS     DUAL PRICES
       2)         0.000000          7.000000
       3)         2.000000          0.000000
       4)         0.000000          4.000000
       5)         0.000000          3.000000
       6)         1.000000          0.000000
       7)         4.000000          0.000000
       8)         0.000000          7.000000
       9)         0.000000          5.000000
      10)        10.000000          0.000000
      11)         9.000000          0.000000
      12)         0.000000          1.000000
      13)        10.000000          0.000000
      14)         0.000000          2.000000
      15)         0.000000          1.000000
      16)         3.000000          0.000000

NO. ITERATIONS=       0
```

The distances of the shortest path from vertex 0 to all other vertices:
0 to 1 = 8, 0 to 2 = 10, 0 to 3 = 5, 0 to 4 = 7, 0 to 5 = 15, 0 to 6 = 12, 0 to 7 = 15.

2. max 3.45S + 2.32P + 2.81B + 3.25C
   st
   S >= 6000
   S <= 7000
   P >= 10000
   P <= 14000
   B >= 13000
   B <= 16000
   C >= 6000
   C <= 8500
   .125S <= 1000
   .08P + .05B +.03C <= 2000
   .05B + .07C <= 1250
   end

```
MAX 3.45S + 2.32P +2.81B + 3.25C

ST
        S >= 6000
        S <= 7000
        P >= 10000
        P <= 14000
        B >= 13000
        B <= 16000
        C >= 6000
        C <= 8500
        .125S <= 1000
        .08P + .05B + .03C <= 2000
        .05B + .07C <= 1250
END
```

```
LP OPTIMUM FOUND AT STEP      4

       OBJECTIVE FUNCTION VALUE

       1)      120196.0

 VARIABLE        VALUE          REDUCED COST
        S      7000.000000          0.000000
        P     13625.000000          0.000000
        B     13100.000000          0.000000
        C      8500.000000          0.000000


      ROW   SLACK OR SURPLUS     DUAL PRICES
        2)      1000.000000          0.000000
        3)         0.000000          3.450000
        4)      3625.000000          0.000000
        5)       375.000000          0.000000
        6)       100.000000          0.000000
        7)      2900.000000          0.000000
        8)      2500.000000          0.000000
        9)         0.000000          0.476000
       10)       125.000000          0.000000
       11)         0.000000         29.000000
       12)         0.000000         27.200001

NO. ITERATIONS=       4

RANGES IN WHICH THE BASIS IS UNCHANGED:

                        OBJ COEFFICIENT RANGES
VARIABLE         CURRENT        ALLOWABLE         ALLOWABLE
                   COEF          INCREASE          DECREASE
       S         3.450000         INFINITY          3.450000
       P         2.320000         2.176000          0.952000
       B         2.810000         0.340000          1.360000
       C         3.250000         INFINITY          0.476000

                       RIGHTHAND SIDE RANGES
     ROW         CURRENT        ALLOWABLE         ALLOWABLE
                   RHS           INCREASE          DECREASE
       2      6000.000000      1000.000000         INFINITY
       3      7000.000000      1000.000000      1000.000000
       4     10000.000000      3625.000000         INFINITY
       5     14000.000000         INFINITY       375.000000
       6     13000.000000       100.000000         INFINITY
       7     16000.000000         INFINITY      2900.000000
       8      6000.000000      2500.000000         INFINITY
       9      8500.000000        71.428574      2071.428711
      10      1000.000000         INFINITY       125.000000
      11      2000.000000        30.000000       290.000000
      12      1250.000000       145.000000         5.000000
```

The maximum profit would be $120,196 by producing the following ties: 7000 silk, 13,625 polyester, 13,100 blend1, and 8500 blend2.

3. **Part A**

min 21t + 16l + 40s + 41c + 585ss + 120st + 164cp + 884o
st
PROTIEN).85t + 1.62l + 2.86s + .93c + 23.4ss + 16st + 9cp >= 15
MT2GRAMFAT).33t + .2l + .39s + .24c + 48.7ss + 5st + 2.6cp + 100o >=2
LT8GRAMFAT).33t + .2l + .39s + .24c + 48.7ss + 5st + 2.6cp + 100o <=8
CARBOHYDRAYTES)4.64t + 2.37l + 3.63s + 9.58c + 15ss + 3st + 27cp >=4
SODIUM)9t + 28l + 65s + 69c + 3.8ss + 120st + 78cp <=200
PERCENTLEAFY).6s + .6l - .4t - .4c - .4ss - .4st - .4cp - .4o >= 0

t >= 0
l >= 0
s >= 0
c >= 0
ss >= 0
st >= 0
cp >= 0
o >= 0

end

The minimum calorie salad that meets all requirements has 114.7541 calories and contains 58.54801 g of lettuce, 87.82201 g smoked tofu, and costs $2.33.

PART B

min t + .75l + .5s + .5c + .45ss + 2.15st + .95cp + 2o
st
PROTIEN).85t + 1.62l + 2.86s + .93c + 23.4ss + 16st + 9cp >= 15
MT2GRAMFAT).33t + .2l + .39s + .24c + 48.7ss + 5st + 2.6cp + 100o >=2
LT8GRAMFAT).33t + .2l + .39s + .24c + 48.7ss + 5st + 2.6cp + 100o <=8
CARBOHYDRAYTES)4.64t + 2.37l + 3.63s + 9.58c + 15ss + 3st + 27cp >=4
SODIUM)9t + 28l + 65s + 69c + 3.8ss + 120st + 78cp <=200
PERCENTLEAFY).6s + .6l - .4t - .4c - .4ss - .4st - .4cp - .4o >= 0

t >= 0
l >= 0
s >= 0
c >= 0
ss >= 0
st >= 0

```
        cp >= 0
        o >= 0

end
```

The low cost salad costs $1.66 and has 278.4884 calories.

4.

```
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
        !supply constraints
        p1w1 + p1w2 <=150
        p2w1 + p2w2 <=450
        p3w1 + p3w2 + p3w3 <=250
        p4w2 + p4w3 <=150

        !warehouse input = output constraint
        w1r1 + w1r2 + w1r3 + w1r4 - p1w1 - p2w1 - p3w1 = 0
        w2r3 + w2r4 + w2r5 + w2r6 - p1w2 - p2w2 - p3w2 - p4w2 = 0
        w3r4 + w3r5 + w3r6 + w3r7 - p3w3 - p4w3 = 0


        !demand constraints
        w1r1 >= 100
        w1r2 >= 150
        w1r3 + w2r3 >= 100
        w1r4 + w2r4 + w3r4 >= 200
        w2r5 + w3r5 >= 200
        w2r6 + w3r6 >= 150
        w3r7 >= 100

!nonegativity constraint
        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
     R1W1       100.000000          0.000000
     R2W1       150.000000          0.000000
     R3W1       100.000000          0.000000
     R4W1         0.000000          5.000000
     R3W2         0.000000          2.000000
     R4W2       200.000000          0.000000
     R5W2       200.000000          0.000000
     R6W2         0.000000          1.000000
     R4W3         0.000000          7.000000
     R5W3         0.000000          3.000000
     R6W3       150.000000          0.000000
     R7W3       100.000000          0.000000


      ROW   SLACK OR SURPLUS     DUAL PRICES
       2)         0.000000          1.000000
       3)         0.000000          0.000000
       4)         0.000000          0.000000
       5)         0.000000          1.000000
       6)         0.000000        -16.000000
       7)         0.000000        -17.000000
       8)         0.000000        -18.000000
       9)         0.000000        -16.000000
      10)         0.000000        -18.000000
      11)         0.000000        -21.000000
      12)         0.000000        -15.000000
      13)         0.000000        -11.000000
      14)         0.000000         -8.000000
      15)         0.000000         -9.000000

NO. ITERATIONS=      13
```

The minimum cost is $17,100.00.

Route	Quantity	Cost ($)
P1W1	150	1500
P2W1	200	2200
P2W2	250	2000
P3W2	150	1200
P3W3	100	900
P4W3	150	1200
W1R1	100	500
W1R2	150	900
W1R3	100	700
W2R4	200	1600
W2R5	200	2000
TOTAL	**2000**	**$17,100**