HW 2 SOLUTION

Problem 1

Formulate the linear programming model for this problem:

(1) Decision variables:

A = number of pounds of brand A

B = number of pounds of brand B

(2) Objective: Minimize

Cost = $0.8 * A + $0.8 * B ($)

(3) Constraints:

Protein)	6A+4B >= 24	ounces
Carbohydrates)	3A+10B >= 30	ounces
Vitamins)	50A+100B >= 400	units

In LINDO:

```
min 0.8a+0.8b
st
6a+4b >= 24
3a+10b >= 30
50a+100b >= 400
```

```
 LP OPTIMUM FOUND AT STEP      2

        OBJECTIVE FUNCTION VALUE

        1)       4.000000

  VARIABLE         VALUE          REDUCED COST
         A         2.000000          0.000000
         B         3.000000          0.000000


       ROW    SLACK OR SURPLUS      DUAL PRICES
        2)          0.000000          -0.100000
        3)          6.000000           0.000000
        4)          0.000000          -0.004000

 NO. ITERATIONS=        2
```

Optimal solution is 2 pounds of brand A and 3 pounds of brand B. The minimum cost is $4.

The first and third bounds (protein and vitamin) are binding.

Problem 2

Million $ Money in:

First mortgages: x1

Second mortgages: x2

Personal loans: x3

Commercial loans: x4

Government securities: x5

Objective:

Max 9*x1+12*x2+15*x3+8*x4+6*x5

Constraints:

Budget) x1+x2+x3+x4+x5 = 100 million $

Avg Risk) (3*x1+6*x2+8*x3+2*x4+x5)/(x1+x2+x3+x4+x5) <= 5

or (3*x1+6*x2+8*x3+2*x4+x5)<= 5*(x1+x2+x3+x4+x5)

or 3*x1+6*x2+8*x3+2*x4+x5 <= 500

commercial loans) x4 >= 20 million $

two mortgages) x1+x2 <= 50 million $

second mortgage and personal loans) x2+x3-x1 <= 0

Problem 3

Formulate the linear programming model for this problem:

(1) Decision variables:

x1b = number of units of product buying in Month 1

x2b = number of units of product buying in Month 2

x3b = number of units of product buying in Month 3

x4b = number of units of product buying in Month 4

x1s = number of units of product selling in Month 1

x2s = number of units of product selling in Month 2

x3s = number of units of product selling in Month 3

x4s = number of units of product selling in Month 4

(2) Objective: Maximize profits ($)

Profits = income from sales – payment of purchase – storage fees for four months

= 55*x1s + 44*x2s + 66*x3s + 55*x4s – 50*x1b – 40*x2b – 60*x3b – 50*x4b – (300+x1b-x1s) – (300+x1b-x1s+x2b-x2s) – (300+x1b-x1s+x2b-x2s+x3b-x3s) – (300+x1b-x1s+x2b-x2s+x3b-x3s+x4b-x4s)

= 59*x1s + 47*x2s + 68*x3s + 56*x4s – 54*x1b – 43*x2b – 62*x3b – 51*x4b – 1200 $

(3) Constraints:

Storage1) 300+x1b-x1s <= 500 %warehouse limitation for the first month

Storage2) 300+x1b-x1s+x2b-x2s <= 500

Storage3) 300+x1b-x1s+x2b-x2s+x3b-x3s <= 500

Storage4) 300+x1b-x1s+x2b-x2s+x3b-x3s+x4b-x4s = 300 %end of month 4 requirement

No exceed1) x1s <= 300 % sales in Month 1 should not exceed initial inventories

No exceed1) x2s <= 300+x1b-x1s % sales in Month 2 should not exceed Month 1 inventories

No exceed1) x3s <= 300+x1b-x1s+x2b-x2s

No exceed1) x4s <= 300+x1b-x1s+x2b-x2s+x3b-x3s

In LINDO:

```
max 59x11+47x21+68x31+56x41-54x12-43x22-62x32-51x42-c
st
c = 1200
x12-x11 <= 200
x12-x11+x22-x21 <= 200
x12-x11+x22-x21+x32-x31 <= 200
x12-x11+x22-x21+x32-x31+x42-x41 = 0
x11 <= 300
x21-x12+x11 <= 300
x31-x12+x11-x22+x21 <= 300
x41-x12+x11-x22+x21-x32+x31 <= 300
```

```
LP OPTIMUM FOUND AT STEP      6

        OBJECTIVE FUNCTION VALUE

        1)      13700.00

 VARIABLE        VALUE          REDUCED COST
      X11       300.000000          0.000000
      X21         0.000000          7.000000
      X31       500.000000          0.000000
      X41         0.000000          6.000000
      X12         0.000000          0.000000
      X22       500.000000          0.000000
      X32         0.000000          0.000000
      X42       300.000000          0.000000
        C      1200.000000          0.000000


       ROW    SLACK OR SURPLUS     DUAL PRICES
        2)         0.000000         -1.000000
        3)       500.000000          0.000000
        4)         0.000000         25.000000
        5)       500.000000          0.000000
        6)         0.000000        -51.000000
        7)         0.000000          5.000000
        8)         0.000000         11.000000
        9)         0.000000          6.000000
       10)         0.000000         11.000000

NO. ITERATIONS=        6
```

So the optimal buying and selling choice should be:

Month	Units of selling	Units of buying	Inventories
1	300	0	0
2	0	500	500
3	500	0	0
4	0	300	300

The optimal profits thereby should be $13700.