Module 2 Assignment

Question 1

a. The decision variables include:
   x_1: the number of Collegiates to produce per week
   x_2: the number of Minis to produce per week
b. The objective function is the total profit (in dollars) from selling the products, which is: $z = 32x_1 + 24x_2$
c. The constraints include:
   The amount of nylon used per week cannot exceed the amount received from supplier:
   $$3x_1 + 2x_2 \leq 5000$$
   The number of products produced cannot exceed the sales forecast:
   $$x_1 \leq 1000, \qquad x_2 \leq 1200$$
   The total hours labor per week cannot exceed the total time available:
   $$45x_1 + 40x_2 \leq 35 \times 40 \times 60 = 84000$$
   The number of products produced cannot be negative:
   $$x_1 \geq 0, \qquad x_2 \geq 0$$
d. The mathematical formulation for this problem is:
   $$\text{MAX } z = 32x_1 + 24x_2$$
   $$3x_1 + 2x_2 \leq 5000$$
   $$0 \leq x_1 \leq 1000$$
   $$0 \leq x_2 \leq 1200$$
   $$45x_1 + 40x_2 \leq 84000$$

Question 2

a. The decision variables in this problem include:
   The number of products of size *i* (1=large, 2=medium, 3=small) to be made in Plant *j* (j=1,2,3): x_{ij}, since both *i* and *j* has 3 values, there will be 9 decision variables in all.
b. The objective function is the total profit, as:
   $$z = 420(x_{11} + x_{12} + x_{13}) + 360(x_{21} + x_{22} + x_{23}) + 300(x_{31} + x_{32} + x_{33})$$
   The constraints include:
   1. The number of products produced at each plant should not exceed their capacity:
      $$x_{11} + x_{21} + x_{31} \leq 750$$
      $$x_{12} + x_{22} + x_{32} \leq 900$$
      $$x_{13} + x_{23} + x_{33} \leq 450$$
   2. The storage space required for the products should not exceed the plants' available space:
      $$20x_{11} + 15x_{21} + 12x_{31} \leq 13000$$
      $$20x_{12} + 15x_{22} + 12x_{32} \leq 12000$$
      $$20x_{13} + 15x_{23} + 12x_{33} \leq 5000$$
   3. The number of products produced for each size should not exceed the sales forecasts:
      $$x_{11} + x_{12} + x_{13} \leq 900$$
      $$x_{21} + x_{22} + x_{23} \leq 1200$$
      $$x_{31} + x_{32} + x_{33} \leq 750$$
   4. The number of products of any size produced at any plant should not be negative:
      $$x_{ij} \geq 0$$

   Therefore, the problem can be formulated as:
   $$\text{MAX } z = 420(x_{11} + x_{12} + x_{13}) + 360(x_{21} + x_{22} + x_{23}) + 300(x_{31} + x_{32} + x_{33})$$
   $$x_{11} + x_{21} + x_{31} \leq 750$$

$$
\begin{aligned}
x_{12} + x_{22} + x_{32} &\leq 900 \\
x_{13} + x_{23} + x_{33} &\leq 450 \\
20x_{11} + 15x_{21} + 12x_{31} &\leq 13000 \\
20x_{12} + 15x_{22} + 12x_{32} &\leq 12000 \\
20x_{13} + 15x_{23} + 12x_{33} &\leq 5000 \\
x_{11} + x_{12} + x_{13} &\leq 900 \\
x_{21} + x_{22} + x_{23} &\leq 1200 \\
x_{31} + x_{32} + x_{33} &\leq 750 \\
x_{ij} \geq 0, \qquad i = 1,2,3, \qquad j = 1,2,3
\end{aligned}
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