

- a. Formulate a mixed integer programming model for this problem.
 - b. Solve this model by using the computer.
9. The owner of the Consolidated Machine Shop has \$10,000 available to purchase a lathe, a press, a grinder, or some combination thereof. The following 0–1 integer linear programming model has been developed to determine which of the three machines (lathe, x_1 ; press, x_2 ; or grinder, x_3) should be purchased in order to maximize annual profit:

$$\begin{aligned} &\text{maximize } Z = 1,000x_1 + 700x_2 + 800x_3 \text{ (profit, \$)} \\ &\text{subject to} \\ &\quad \$5,000x_1 + 6,000x_2 + 4,000x_3 \leq 10,000 \text{ (cost, \$)} \\ &\quad x_1, x_2, x_3 = 0 \text{ or } 1 \end{aligned}$$

Solve this model by using the computer.

- 10. Solve the following mixed integer linear programming model by using the computer:

$$\begin{aligned} &\text{maximize } Z = 5x_1 + 6x_2 + 4x_3 \\ &\text{subject to} \\ &\quad 5x_1 + 3x_2 + 6x_3 \leq 20 \\ &\quad x_1 + 3x_2 \leq 12 \\ &\quad x_1, x_3 \geq 0 \\ &\quad x_2 \geq 0 \text{ and integer} \end{aligned}$$

11. Northwoods Backpackers is a retail catalog store in Vermont that specializes in outdoor clothing and camping equipment. Phone orders are taken each day by a large pool of computer operators, some of whom are permanent and some temporary. A permanent operator can process an average of 60 orders per day, whereas a temporary operator can process an average of 53 orders per day. The company averages at least 600 orders per day. The store has 10 computer workstations. A permanent operator processes about 1.3 orders with errors each day, whereas a temporary operator averages 1.5 orders with errors daily. The store wants to limit errors to 24 per day. A permanent operator is paid \$81 per day, including benefits, and a temporary operator is paid \$50 per day. The company wants to know the number of permanent and temporary operators to hire to minimize costs.

Formulate an integer programming model for this problem and solve it by using the computer.

12. Consider the following linear programming model:

$$\begin{aligned} &\text{maximize } Z = 20x_1 + 30x_2 + 10x_3 + 40x_4 \\ &\text{subject to} \\ &\quad 2x_1 + 4x_2 + 3x_3 + 7x_4 \leq 10 \\ &\quad 10x_1 + 7x_2 + 20x_3 + 15x_4 \leq 40 \\ &\quad x_1 + 10x_2 + x_3 \leq 10 \\ &\quad x_1, x_2, x_3, x_4 = 0 \text{ or } 1 \end{aligned}$$

Solve this problem by using the computer.

13. In the example problem solution for this chapter on page 203, a textbook company was attempting to determine how many sales representatives to assign to each of two new regions. The company has now decided that if any sales representatives are assigned to region 1, a sales office must be established there, at an annual cost of \$18,000. This altered problem is an example of a type of integer programming problem known as a “fixed charge” problem.
- a. Reformulate the integer programming model to reflect this new condition.
 - b. Solve this new problem by using the computer.