PART A

(Excerpted from Applied Mathematical Programming (AMP), Chapter 9, exercise 3).

Note to students. The following problem was written in 1977. The same problem is applicable today, except that it would include other forms of advertising, including Google and Facebook and other social media.

The marketing group of A. J. Pitt Company is considering the options available for its next advertising campaign program. After a great deal of work, the group has identified a selected number of options with the characteristics shown in the accompanying table.

Table 1: Advertising Campaign Options

	TV	Trade Magazine	Newspaper	Radio	Popular magazine	Promotional campaign	Total resource available

Customers reached	1,000,000	200,000	300,000	400,000	450,000	450,000	-
Cost ($)	500,000	150,000	300,000	250,000	250,000	100,000	1,800,000
Designers needed (man-hours)	700	250	200	200	300	400	1,500
Salesmen needed (man-hours)	200	100	100	100	100	1,000	1,200

The objective of the advertising program is to maximize the number of customers reached, subject to the limitation of resources (money, designers, and salesman) given in the table above. In addition, the following constraints have to be met:

- If the promotional campaign is undertaken, it needs either a radio or a popular magazine campaign effort to support it.
- The firm cannot advertise in both the trade and popular magazines.

Formulate an integer-programming model that will assist the company to select an appropriate advertising campaign strategy.

How many binary decision variables are in your integer program?

6

✔ **Answer:** 6

6

SOLUTION

There are multiple ways of formulating this problem. There are six decisions to make. No other binary decision variables are needed for the two additional logical constraints.

PART B

How many constraints are in your integer program, other than the constraints that a variable is binary?

5

✔ **Answer:** 5

5

SOLUTION

There are three resource constraints, and two additional logical constraints.

PART C

If you want the option of showing our integer programming formulation, click below.

◉ I am ready to have the answer shown ✔

SOLUTION

The objective is

$$1000000x_1 + 200000x_2 + 300000x_3 + 400000x_4 + 450000x_5 + 450000x_6 \text{ (number reached)}$$

The resource constraints are

- $500000x_1 + 150000x_2 + 300000x_3 + 250000x_4 + 250000x_5 + 100000x_6 \leq 1800000$ (cost)
- $700x_1 + 250x_2 + 200x_3 + 200x_4 + 300x_5 + 400x_6 \leq 1500$ (Designers needed)
- $200x_1 + 100x_2 + 100x_3 + 100x_4 + 100x_5 + 1000x_6 \leq 1200$ (Salesmen needed)

And the 2 logical conditions can be modeled as

- $x_6 \leq x_4 + x_5$ (i)
- $x_2 + x_5 \leq 1$ (ii)

Note. There are multiple ways of expressing integer programs. If your integer program is different from the one here, you may need to think carefully whether your formulation is an alternative correct formulation, or whether your formulation has an error.

PART D

Model the advertising problem using Excel and solve it using Solver or OpenSolver. An initial spreadsheet containing the data is here, with the headers and columns already removed.

Or model the advertising problem using Julia and JuMP, starting with the data in the spreadsheet

What is the optimal objective value?

2150000 ✔ **Answer:** 2150000

2150000

SOLUTION

2,150,000

See Julia/JuMP solution

See Spreadsheet solution