1   Dorian Auto

Dorian Auto manufactures luxury cars and trucks. The company believes that its most likely customers are high-income women and men. To reach these groups, Dorian Auto has embarked on an ambitious TV advertising campaign and has decided to purchase 1-minute commercial spots on two types of programs: comedy shows and football games. Each comedy commercial is seen by 7 million high-income women and 2 million high-income men. Each football commercial is seen by 2 million high-income women and 12 million high-income men. A 1-minute comedy ad costs \$50,000, and a 1-minute football ad costs \$100,000. Dorian would like the commercials to be seen by at least 28 million high-income women and 24 million high-income men. You are asked to determine how Dorian Auto can meet its advertising requirements at minimum cost.

1.a   Formulate the advertising problem into a LP model by providing the following model components.

Endogenous/decision/dependent variables: Choosing how many comedy commercials C and how many football commercials F to run

Objective functions: $\underset{(C,F)}{\text{Minimize}}\ \text{cost} = 50,000C + 100,000F$

Constraints:

- $28 \leq 7C + 2F$, women viewer constraint
- $24 \leq 2C + 12F$, men viewer constraint
- $0 \geq C$, sign constraint
- $0 \geq F$, sign constraint

1.b   Solve your LP problem in MATLAB. Enclose your code for verification.

```
clear;clc;

f = [-50000 -100000]; % cost per unit of output

A = [7 2; % commercial seen by women constraint
2 12; % commercial seen by men constraint
-1 0; % sign constraint for comedy commercials
0 -1]; % sign constraint for football comercials

b = [28; 24; 0; 0];

[x, fval, exitflag, output, lambda] = linprog(f, A, b);

fprintf('To minimize cost, Dorian Auto purchases %2.0f comedy and %2.0f football
    commercials for the campaign\n',ceil(x)) % prints number of comedy and
    football commercials rounded to next smallest integer not smaller than x
```

Dorian Autos should buy 3.6 comedy commercials and 1.4 football commercials with a minimum total cost of \$320,000. However, if the commercials are not continuous (the cost cannot be expressed as dollars per second) but are instead discretized into 1-min blocks, Dorian autos should order 4 comedy commercials and 2 football commercials with a minimum total cost of \$400,000, in order to meet their goal of reaching at least 28 million women and 24 million men.

1.c   Assume that the CEO of Dorian Auto would like to evaluate the costs of advertisement required to reach a 20 to 40 million population range for high-income women customers, other things being equal. Develop the MATLAB code to conduct such an analysis, and produce a easy-to-understand graph to the CEO. Enclose your code for verification.
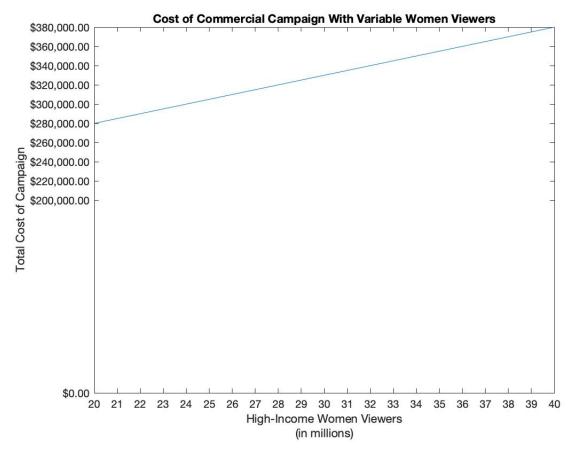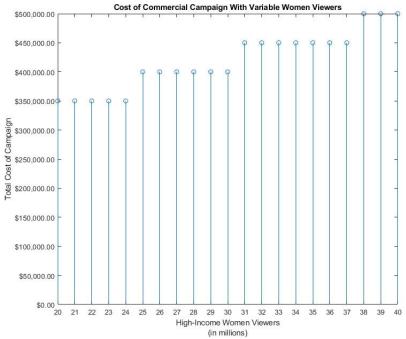
```
clear;clc;
```

```
                    W = 20:40; % Population range of high-income women viewers
                    z = zeros (5,numel(W)); % Create a zero matrix for storing results

                    f = [-50000 -100000]; % cost per unit of output

                    A = [7 2; % commercial seen by women constraint
                    2 12; % commercial seen by men constraint
                    -1 0; % sign constraint for comedy commercials
                    0 -1]; % sign constraint for football comercials

                    for k = 1:numel(W)
                    W1 = W(k); % number of women viewers
                    b = [W1; 24; 0; 0];
                    [x, fval, exitflag, output, lambda] = linprog(f,A,b);

                    z ([1 2], k) = x; % Stores comedy commericals in row 1, football
                        commercials in row 2
                    z (3, k) = -fval; % Stores total continuous cost in row 3
                    z (4, k) = W(k); % changing constraint number of women viewers from 20 to
                        40 million
                    z (5, k) = ceil(z(1,k))*50000+ceil(z(2,k))*100000; % calculates total cost
                         in terms for 1-min block commercial (discretized)
                    end

                    plot(W,z(3,:));
                    ylabel('Total Cost of Campaign')
                    xlabel({'High-Income Women Viewers', '(in millions)'})
                    title('Cost of Commercial Campaign With Variable Women Viewers')
                    xticks(20:40)
                    ytickformat('usd')
                    ylim([0 inf])
                    yticks([0 200000 220000 240000 260000 280000 300000 320000 340000 360000
                        380000])

                    stem(W,z(5,:));
                    ylabel('Total Cost of Campaign')
                    xlabel({'High-Income Women Viewers', '(in millions)'})
                    title('Cost of Commercial Campaign With Variable Women Viewers')
                    xticks(20:40)
                    ytickformat('usd')
```

If the costs are continuous, we would expect the total costs of the campaign to look like the first graph. However, if the costs are discretized into 1-min commercial blocks, then we should expect the total costs of the campaign to look like the second graph. Dorian Autos would need to round up to the nearest whole 1-minute commercial in order to achieve their goal of reaching a varying amount of high-income women viewers (from 20 to 40 million) and a constant high-income men viewers (24 million).

Cost of Commercial Campaign With Variable Women Viewers

Cost of Commercial Campaign With Variable Women Viewers