# CIVENG 3C03 Assignment 2

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## Question 1

If the number of bronze, silver, and gold passes issued are $X_1$, $X_2$, and $X_3$, then the profit margins for the park can be represented as:

$$\text{Max: } Z = X_1 + 3X_2 + 10X_3$$

The passes are also subject to the following constraints:
$X_1 + X_2 + 3.5X_3 \leq 22000$ (administrative working units constraint)
$X_1 \leq 10000$ (maximum units per type)
$X_2 \leq 10000$ (maximum units per type)
$X_3 \leq 10000$ (maximum units per type)
$X_1 \geq 1200$ (minimum number of bronze tickets)
$X_1$, $X_2$, $X_3 \geq 0$ (non-negativity constraint)

From the objective function and the constraints, we can represent the problem in canonical form:

Minimize:

$$Z^* = -X_1 - 3X_2 - 10X_3 + MA_1$$

Subject to: Subject to:

$$X_1 + X_2 + 3.5X_3 + S_1 = 22000$$
$$X_1 + S_2 = 10000$$
$$X_2 + S_3 = 10000$$
$$X_3 + S_4 = 10000$$
$$X_1 - E_1 + A_1 = 1200$$
$$X_1, X_2, X_3, S_1, S_2, S_3, S_4, E_1, A_1 \geq 0$$

## Question 2

The solution to Question 1 was redone using Excel solver, producing the same solution as the Simplex method using in question 1 as seen in Figure 1. The solution is $X_1 = 1200$, $X_2 = 10000$, and $X_3 = 3085.71$ for a total profit margin of \$62067.1. The Excel spreadsheet is included with the assignment submission as `question2.xlsx`.

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | Variables | | X1 | X2 | X3 | | | | | |
| 3 | | Values | | 1200 | 10000 | 3085.71 | | | | | |
| 4 | | Cost Cofficients | | -1 | -3 | -10 | | | -62057.1 | | |
| 5 | | | | | | | | | | | |
| 6 | | Struct Coeff | | 1 | 1 | 3.5 | | #1 | 22000 | <= | 22000 |
| 7 | | | | 1 | 0 | 0 | | #2 | 1200 | <= | 10000 |
| 8 | | | | 0 | 1 | 0 | | #3 | 10000 | <= | 10000 |
| 9 | | | | 0 | 0 | 1 | | #4 | 3085.71 | <= | 10000 |
| 10 | | | | 1 | 0 | 0 | | #5 | 1200 | >= | 1200 |

Figure 1: Excel Solver Solution

## Question 3

To determine if the current production policy can be continued, we check the sensitivity of the optimal solution due to the changes in each of the cost coefficients. However, this is not possible to calculate with the information provided, as the final iteration of the simplex tableau does not provide the $C^i$ values for the final iteration, and this cannot be calculated without the previous iteration.