PART A

(1/1 point)

A school wants to illuminate six corridors, labeled A, B, C, D, E and F. The corridors are portrayed in Figure 1. Each corridor can be illuminated by placing lights at one or both ends of the corridor, which we label as intersections 1 to 5. The luminosity required for each corridor is given in Table 1. For example, the luminosity in Corridor A is required to be 250. This requirement should be interpreted as meaning that the sum of the luminosities of bulbs at Intersections 1 and 2 must be at least 250. Remember that one cannot place bulbs at an intersection unless one first puts in a lighting fixture.

The cost of placing the light fixtures is $450 per corner. (There is no cost if there is no light fixture in a corner.) The cost of the bulbs is $2 per luminosity unit. The maximum luminosity that can be placed in any light fixture is 300 units. The number of units of luminosity is permitted to be fractional. As an illustration, to create a luminosity of 60.5 at a corner with a light fixture requires an expense of $121 in bulbs plus an expense of $450 for putting in the light fixture.

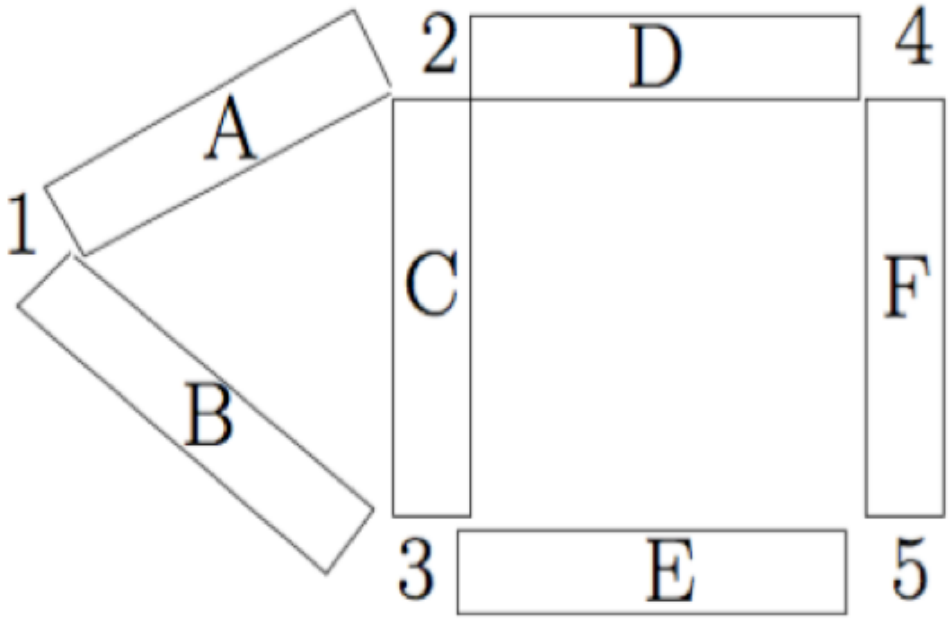

Figure 1 : Corridors: A, B, C, D, E, and F.
Intersections: 1, 2, 3, 4, and 5.

Corridor	A	B	C	D	E	F
Luminosity Required [units]	250	300	150	200	350	180

Table 1

Formulate this problem as a mixed integer linear program in which the objective is to minimize the cost. For this first formulation, the decision variables should be represented as follows:

- y_i equals 1 if we place a light fixture in intersection i; 0, otherwise. $i \in \{1, \ldots, 5\}$
- x_i the luminosity units of light bulb(s) in intersection i. $i \in \{1, \ldots, 5\}$

Choose the correct objective function from below

- MIN $2 \sum_{i=1}^{5} y_i + 450 \sum_{i=1}^{5} x_i$
- MIN $250 \sum_{i=1}^{5} y_i + \sum_{i=1}^{5} x_i$
- MIN $1250 \sum_{i=1}^{5} y_i - 2 \sum_{i=1}^{5} x_i$
- MIN $450 \sum_{i=1}^{5} y_i - \sum_{i=1}^{5} x_i$
- MIN $450 \sum_{i=1}^{5} y_i + 2 \sum_{i=1}^{5} x_i$ ✔

You have used 1 of 3 submissions

PART B

(1 point possible)
Below is a partial formulation. Which of the following constraints should be added to the formulation to make it correct?

$$
\begin{array}{lrcl}
\min & 450\sum_{i=1}^{5} y_i + 2\sum_{i=1}^{5} x_i & & \\
\text{s.t.:} & & & \\
(1) & x_1 + x_2 & \geq & 250 \\
(2) & x_1 + x_3 & \geq & 300 \\
(3) & x_2 + x_3 & \geq & 150 \\
(4) & x_2 + x_4 & \geq & 200 \\
(5) & x_3 + x_5 & \geq & 350 \\
(6) & x_4 + x_5 & \geq & 180 \\
(7) & y_i \in \{0,1\}, & \forall i \in \{1,\ldots,5\} & \\
(8) & x_i \geq 0, & \forall i \in \{1,\ldots,5\} &
\end{array}
$$

- ◉ $x_i \leq 300 y_i$ ✔
- ○ $x_i \geq 300 y_i$
- ○ Neither i nor ii

You have used 2 of 2 submissions

PART C

(1/1 point)

Solve the cost-minimization problem you formulated using Julia/JuMP or Excel. What is the total cost you get under the optimal solution (rounded to the nearest whole number)? Error checking hint: the answer is between 2800 and 2819.

2810 ✔

2810

You have used 1 of 3 submissions

PART D

(1/1 point)

Under the optimal solution, in which of the intersections should a light fixture be placed?

- [ ] Intersection 1
- [x] Intersection 2
- [x] Intersection 3
- [ ] Intersection 4
- [x] Intersection 5

- [ ] None

✔

You have used 1 of 3 submissions

PART E

(3/3 points)
Consider the following new requirements:

- At least one of the corners 1 and 4 must be illuminated with at least 300 units of illumination.
- At least three or more of the corners must be illuminated by 150 units of illumination or less.
- The luminosity at corner 1 is at most 40% of the luminosity in Corridor B.

- w equals 1 if there is a light bulb at intersection 1 with at least 300 units of luminosity, 0 otherwise.
- z_i equals 1 if the light bulb at intersection i is required to have less at most 150 units of luminosity, 0 otherwise.

What are the additional (seven) constraints needed to model these new requirements?

- [x] $x_1 \geq 300w$
- [ ] $x_1 \leq 300w$
- [ ] $x_4 \leq 300(1-w)$

- [x] $x_4 \geq 300(1-w)$
- [x] $w \in \{0,1\}$
- [ ] $x_i \leq 150 z_i \forall i \in \{1,\ldots,5\}$
- [ ] $x_i \leq 150(1-z_i) \forall i \in \{1,\ldots,5\}$
- [x] $x_i \leq 150 + 150(1-z_i) \forall i \in \{1,\ldots,5\}$
- [x] $\sum_{i=1}^{5} z_i \geq 3$
- [ ] $\sum_{i=1}^{5} z_i \leq 3$
- [x] $z_i \in \{0,1\}, \forall i \in \{1,\ldots,5\}$
- [ ] $\frac{x_1}{x_1+x_3} \leq 0.4$
- [x] $0.6x_1 - 0.4x_3 \leq 0$

✔

You have used 1 of 3 submissions

PART F

(1/1 point)

Incorporate these new constraints to the original model and solve the problem using Julia and JuMP or Excel. What is the total cost you get under the optimal solution (rounded to the nearest whole number)? Error checking hint. The value is between 4040 and 4065.

4050 ✔

4050

You have used 1 of 3 submissions

PART G

(1/1 point)

Under the optimal solution, in which of the intersections should a light fixture be placed?

- [x] Intersection 1
- [x] Intersection 2
- [x] Intersection 3
- [x] Intersection 4

- [x] Intersection 5
- [ ] None

✔

You have used 1 of 3 submissions