IEOR 240 - Fall 2022
Homework 6
Due Date: 11/2/2022 (Wednesday) at 11:59pm

Homework requirement

- Homework 6 is due on Wednesday November 2nd at 11:59pm through bCourses.
- Submit your homework (typed, scanned or photographed) in a single pdf file.
- Make sure your homework is legible.
- For problems that require a mathematical formulation, please clearly state the definition of decision variables and the indexes of them. Write a sentence to explain each constraint and objective function.

1. **(Transportation problem with shortage)** A company supplies goods to 3 customers, who each require 30 units. The company has two warehouses. Warehouse 1 has 40 units available and warehouse 2 has 30 units available. The cost of shipping 1 unit from warehouse to customer are shown in the table below. There is a penalty for each unmet customer unit of demand: a penalty cost of \$90 is incurred with customer 1, \$80 is incurred with customer 2, \$110 is incurred with customer 3. Formulate the problem as a min-cost flow problem in order to minimize the sum of shortage and shipping costs.

From	Customer 1	Customer 2	Customer 3	Supply
Warehouse 1	\$15	\$35	\$25	40
Warehouse 2	\$10	\$50	\$40	30
Demand	30	30	30	
Penalty cost	\$90	\$80	\$110	

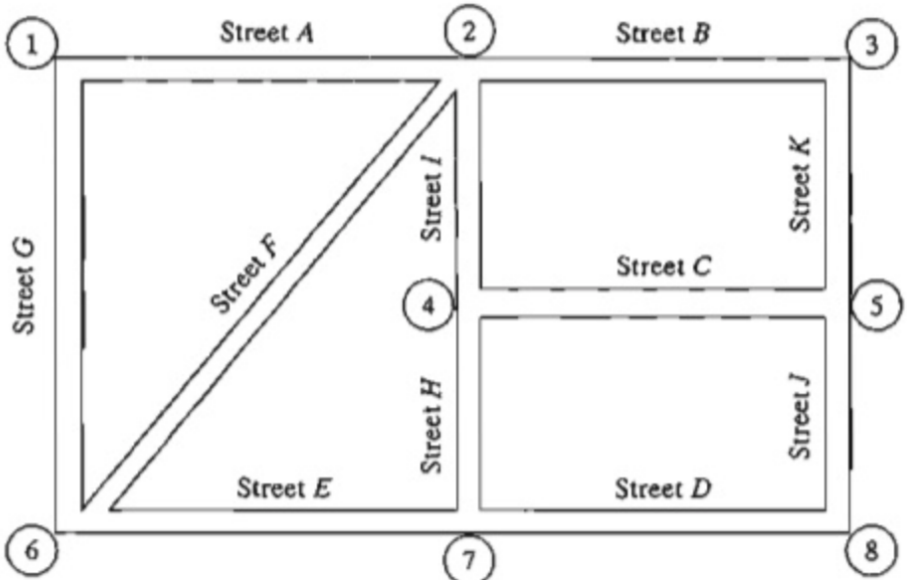
2. **(Shortest path problem)** Look at the problem below

Your parents are out of town for ten days, and they have asked you to look after your house. Soon after they asked, you took out an ad on EBay to try and rent out their house. You can't have anybody show up before the first day your parents are out of town, and any potential renter must be gone at the end of day ten. You receive the bids in the table below for house rental. Select the set of bids that is most profitable to you:

Arrival Day	Departure Day	Bid ($)
1	2	20
1	5	70
2	4	20
3	7	40
3	8	110
4	5	10
4	6	60
5	6	30
5	9	70
7	8	40
7	9	50
8	10	30

Please present the problem as a min-cost flow problem. It is not required to write the linear program formulation.

3. **(Set covering problem)** A university plans to install warning sirens strategically on the campus. The figure below maps the principal streets. Location $1-8$ are the possible locations of sirens. The sirens will be at the intersections of the streets, thus each siren can at least cover two streets. For example, the siren at location 1 can serve street A and street G. To control the total cost, the university wants to install the sirens to cover the campus (all streets) while minimizing the total number of sirens. Formulate an integer programming formulation that will help the university make decisions.



4. **(Airplane Ticketing)**

A small airline, Ivy Air, flies between three cities: Ithaca, Newark, and Boston. They offer several flights, but, for this problem, let us focus on the Friday afternoon flight that departs from Ithaca, stops in Newark, and continues to Boston. There are three types of passengers :

- Those traveling from Ithaca to Newark.
- Those traveling from Newark to Boston.
- Those traveling from Ithaca to Boston

The aircraft is a small commuter plane that seats 30 passengers. The airline offers three fair classes :

- Y class: full coach.
- B class: nonrefundable.
- M class: nonrefundable, 3-week advance purchase.

Ticket prices, which are largely determined by external influences (i.e. competitors) have been set and advertised as follows :

	Ithaca-Newark	Newark-Boston	Ithaca-Boston
Y	300	160	360
B	220	130	280
M	100	80	140

Based on past experience, demand forecasters at Ivy Air have determined the following expected number of potential customers in each of the 9 possible origin-destination fair class combinations :

	Ithaca-Newark	Newark-Boston	Ithaca-Boston
Y	4	8	3
B	8	13	10
M	22	20	18

The goal is to decide how many tickets from each of the 9 origin/destination/fare combinations to sell. The constraints are that the plane cannot be overbooked on either of the two legs of the flight and that the number of tickets made available cannot exceed the forecasted maximum demand. The objective is to maximize the revenue. Formulate this problem as a min cost flow problem. Please present the problem as a min-cost flow problem. It is not required to write the linear program formulation. [*Hint*: In addition to having a node to represent each city, consider creating a node for each ticket fare type between each pair of cities. The flow from these nodes to their departing city would represent the number of ticketed passengers; the flow to these nodes from their arriving city would represent unfulfilled demand.]