Assignment 1

Due: 14th May 2020, 11:30PM

Total Marks: 100

Note: You have to do all programs in Gurobi. Make a different file for different question. The name of the file should be the same as problem name (for example problem1, problem2 and so on). Then finally make a zip file with these 4 files and submit the zip file. The name of the zip file should be your firstname_lastname.zip (for example, Salimur_choudhury.zip).

Expecations: It is a general expectation that your code should have enough comments. Variable and functions name are meaningful (in camel notation). If you need to add any special instructions on how to run your code, you can add a readme file too. Please make sure that your program runs without error. PLEASE do not submit any incomplete program.

Problem 1 (15):

There are three bottles of water, namely A, B, and C. The following table shows information about those three bottles of water.

Bottle	***A***	***B***	***C***
Price	$10/L	$20/L	$30/L
Quantity	2L	1.5L	0.5L

You have an empty bottle of 2.5L volume. You need to fill this empty bottle with the water from A, B, and C. The objective is maximizing the total value of the water in your 2.5L bottle.

Please design a linear programming model and use Gurobi optimizer to get the optimal solution (how much water from bottles A, B, and C, respectively; also report the total value).

Problem 2 (25):

An engineer would like to repair his car. He needs five types of tools. In the local store, there are four boxes of tools. The store only sells the whole box of tools. The following table shows the types of tools in each box ("yes" indicates the corresponding tool is in the box).

	Tool #1	**Tool #2**	**Tool #3**	**Tool #4**	**Tool #5**
Box #1 ($100)	yes		yes		
Box #2 ($120)		yes	yes	yes	
Box #3 ($280)	yes	yes			
Box #4 ($200)			yes	yes	yes

How to help him save the money? Please model this problem as an integer linear programming problem, and use Gurobi to find the solution (also report the total cost).

Problem 3 (25):

Given a 7x7 game board (see the following table), mark the grids to ensure no more than one grid in the same row or the same column are marked. Also, try to maximize the sum of the values in those marked grids.

5	4	6	7	1	5	6
9	8	5	1	1	2	3
1	7	4	6	2	3	5
1	1	2	4	2	6	2
15	12	1	3	10	8	2
16	17	1	1	6	6	2
3	5	8	1	2	1	1

For example, the following solution (the highlighted grid represents marked grid) is **valid** but not optimal.

5	4	6	7	1	5	6
9	8	5	1	1	2	3
1	7	4	6	2	3	5
1	1	2	4	2	6	2
15	12	1	3	10	8	2
16	17	1	1	6	6	2
3	5	8	1	2	1	1

The following solution is **not valid** because the second column has two marked grids.

5	**4**	6	7	1	5	6
9	**8**	5	1	1	2	3
1	**7**	4	6	2	3	5
1	**1**	2	4	2	6	2
15	**12**	1	3	10	8	2
16	**17**	1	1	6	6	2
3	**5**	8	1	2	1	1

Use Gurobi to solve this game. You can let your program print the row and column number of each marked grid. Please also show the sum of the values of those marked grids.

The game board (indicates the value of each grid) data is shown as follows, you can directly copy it to your code.

```
P = [
   [5,4,6,7,1,5,6],
   [9,8,5,1,1,2,3],
   [1,7,4,6,2,3,5],
   [1,1,2,4,2,6,2],
   [15,12,1,3,10,8,2],
   [16,17,1,1,6,6,2],
   [3,5,8,1,2,1,1]
]
```

Problem 4 (35):

(Again the whole program has to be written in Gurobi only)

Implement ILP for the vertex cover problem (that has been discussed in the lecture 1) using Gurobi. Your program should ask the user the number of vertices (say X) of the graph. Then you have to randomly generate a connected graph that will have X vertices. You have to randomly assign edges in such a way so that the range of edges for any vertex should be between 1 to X/2. Again, you have to make sure that your graph is connected. If your graph is not connected then you will not get any marks for this question. Once, your graph is ready then solve ILP to get the solution of the problem.

Please note that you will not get any marks for the hard coding (for example, making your own graph in the code). The generation of the graph should be as described above.