MCP 261 IE Lab 1

Exercise 5: Linear and Integer Programming

Due date: 11:59 PM, February 10, 2024

Please submit your files in a single zipped file. The zipped file should be named as follows: " Entry#_Ex5_ FirstName_LastName.zip".

Please follow the additional guidelines below.

1. Submit only in .zip files. For example .rar files are not allowed.

2. For question 1, upload the Excel file with the Solver solution. Also upload the Python script (.py file) developed to verify the Solver solution.

3. For question 2, prepare another Excel file with the Solver solution.

4. Each file in the folder should be named in the following format: "Entry#_Ex5_Q#_file#.xlsx".

Note that submissions that do not adhere to the above guidelines will not be graded.

All submissions will be checked for evidence of plagiarism. Students whose submissions are found to have evidence of plagiarism will be subject to, at minimum, losing all marks for the exercise.

1. (6.5 marks) Consider a traveling salesman problem with 5 nodes – nodes 1, 2, 3, 4 and 5. The tour starts at node 1 and must come back to node 1 after visiting all cities. The distance matrix for the nodes is given below.

Node	1	2	3	4	5
1	0	43	40	33	63
2	43	0	13	25	50
3	40	13	0	14	40
4	33	25	14	0	32
5	63	50	40	32	0

Find the optimal tour for this problem by implementing the MTZ formulation of the TSP in Excel solver. Please determine the meaning of the notation by yourself (note that V and N are the same in the equations below). In addition, verify the solution provided by the Solver implementation by an enumeration approach: that is, write a Python script that enumerates all possible routes and finds the best route. Your Python script should print the best route as well as the corresponding objective function value.

$$\min_{x} \quad \sum_{(i,j)\in A} d_{ij}x_{ij}$$

$$\text{s.t.} \quad \sum_{j\in V, j\neq i} x_{ij} = 1 \qquad \forall i \in V$$

$$\sum_{i\in V, i\neq j} x_{ij} = 1 \qquad \forall j \in V$$

$$u_i - u_j + nx_{ij} \leqslant n-1 \qquad \forall i \in N, j \in 2,\ldots,n, i \neq j$$

$$2 \leqslant u_i \leqslant n \qquad \forall i \geqslant 2$$

$$u_1 = 1$$

2. (3.5 marks) Use Excel solver to formulate the following problem as a linear programming problem such that the total cost of assigning jobs to machines is minimized. The costs are given in the table for each job-machine pair. Also, only one job can be assigned to one machine and vice-versa.

	M/C 1	**M/C 2**	**M/C 3**	**M/C 4**	**M/C 5**	**M/C 6**
Job1	**5**	**4**	**7**	**9**	**6**	**2**
Job 2	**6**	**4**	**2**	**7**	**9**	**3**
Job 3	**4**	**5**	**7**	**9**	**2**	**3**
Job 4	**5**	**6**	**2**	**4**	**1**	**6**
Job 5	**6**	**4**	**8**	**2**	**7**	**2**
Job 6	**3**	**5**	**8**	**5**	**4**	**7**