Indian Institute of Technology, Kharagpur
Department of Industrial & Systems Engineering

Spring 2022-23
IM29204: Operations Research Laboratory
L-T-P : 0-0-3, Credits - 2

Lab Assignment – 6

Maximum Marks: 10

Instructions:

1. Attempt **all Questions**.
2. All questions carry **equal** marks.
3. Assume any missing data suitably and state all your assumptions clearly.
4. You need to make this submission via **MS teams**.
5. The usage of **mobile phones** and **internet** during the lab hours is **strictly prohibited** unless specially instructed.
6. Write your name and roll number inside the file. Name your file as: Your Roll No_Name. For example, if your Roll No. is 10IM9999 and your name is Ravi, then you should name your file as: **10IM9999_Ravi**
7. Submission Deadline – The file must be submitted during the lab hours. **Assignments submitted after due date and time will NOT be evaluated.**
8. Do not submit multiple files for same assignment. In case of multiple files compress them in one ".zip" file and then submit.

Problem 1. The objective of the Quadratic Assignment Problem (QAP) is to assign n facilities to n locations in such a way as to minimize the assignment cost. The assignment cost is the sum, over all pairs, of the flow between a pair of facilities multiplied by the distance between their assigned locations.

Consider the following Quadratic Assignment Problem. Assign each facility (1, 2, 3, 4, 5, 6, 7) to one location (A, B, C, D, E, F, G). The distance matrix and the required flows are shown below. Code the problem on CPLEX-OPL and solve using the CP optimizer.

Distance Matrix:

	A	B	C	D	E	F	G
A	0	35	71	99	71	75	41
B	35	0	42	80	65	82	47
C	71	42	0	45	49	79	55
D	99	80	45	0	36	65	65
E	71	65	49	36	0	31	32
F	75	82	79	65	31	0	36
G	41	47	55	65	32	36	0

Flow Matrix:

	1	2	3	4	5	6	7
1	0	2	0	0	0	0	2
2	2	0	3	0	0	1	0
3	0	3	0	0	0	1	0
4	0	0	0	0	3	0	1
5	0	0	0	3	0	0	0
6	0	1	1	0	0	0	0
7	2	0	0	1	0	0	0

Hint(s):

1. The objective function of QAP is a non-linear cost expression. You may write this floating-point expression with the *dexpr* keyword in your code.

2. use: *alldifferent()* syntax in your code.

Problem 2. The world-renowned logic puzzle, Sudoku, deals with a 9 * 9 grid subdivided into 9 nonoverlapping 3 * 3 subgrids. The puzzle calls for assigning the numerical digits 1 through 9 to the cells of the grid such that each row, each column, and each subgrid contain distinct digits. Some of the cells may be fixed in advance. Solve the following Sudoku problem using CP optimizer on CPLEX.

	6		1		4		5	
		8	3		5	6		
2						7		
8			4		7			6
		6				3		
7			9		1			4
5								2
		7	2		6	9		
	4		5		8		7	

Hint: use: *alldifferent()* syntax in your code.