Faculty of Engineering
Civil Engineering Department
CIVENG 3C03 – Fall 2022

Assignment 4
Due: Friday, December 2, 2022 – 11:59 PM
Late submission is not permitted

Question 1 (20 points)

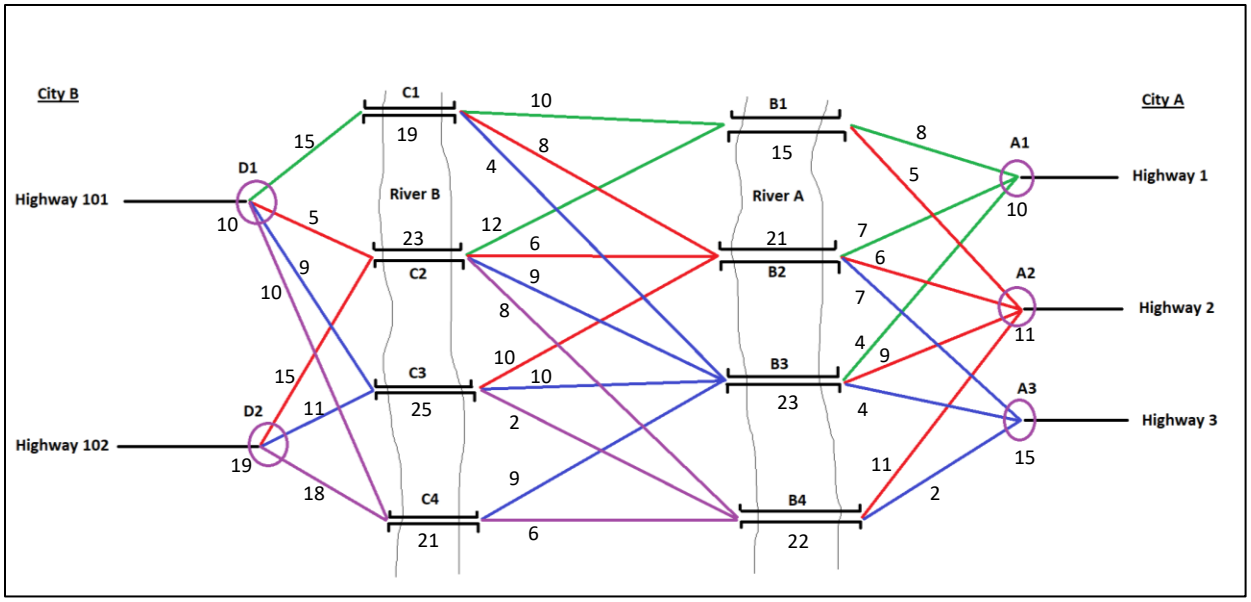
A contractor has one crane available at four different building sites at which work has just been completed. The contractor wants to move the four cranes to four new sites. The transportation time (in hours) between the old and the new sites is presented in the table below.

Old Sites	New Sites			
	A	B	C	D
I	3.50	4.25	6	4.00
II	4.00	5.50	5.50	7.00
III	8.50	9.25	7.50	7.50
IV	5.00	5.50	6.50	3.75

a) Develop a mathematical model that can be used to find the optimal way to move the cranes between old and new sites optimally.
b) Solve the problem using Microsoft Excel (Please, submit your Excel file along with your answer)

Question 2 (30 points)

An engineering firm was awarded a contract to construct a highway that connects two cities (A and B). The proposed highway will provide a connection between one of three existing highways at City A (Highways 1, 2, and 3) and one of two existing highways at City B (Highways 101 and 102). Two interchanges are needed at the beginning and the end of the proposed Highway. The construction costs of the interchanges at the three potential starting points (A1, A2, A3) and the two potential ending points (D1 and D2) are shown in the figure below. Furthermore, there are two rivers (River A and River B) that run in the North-South direction between the two cities. Hence, two bridges are required to pass the two rivers, as shown in the figure. Four alternative locations for each bridge are proposed. The estimated cost of the two bridges at each alternative location and the cost of all highway segments are also shown in the figure below. What is the optimal route for the proposed highway?



Question 3 (30 points)

A horizontal curve of radius (R) = 475 m exists on a Highway that has a design speed (v) of 100 km/h. Speed studies showed that the driver's operating speed on the highway follows a normal distribution, with mean = 94 km/h and a standard deviation = 8.5 km/h. The side friction factor (f_s) follows a normal distribution as well, with a mean value of 0.135 and a standard deviation of 0.022; however, a side friction factor of 0.12 was used for the design. If the relationship between the superelevation (e), Curve radius (in meters), and speed (in km/h) is expressed as $\left[e + f_s = \frac{v^2}{127R}\right]$.

a) What is the superelevation value used for design?
b) Using Monte Carlo Simulation, what is the mean and the standard deviation of the superelevation needed for the horizontal curve? (Use at least 10000 simulations)?
c) Based on the Simulation, what is the probability that the superelevation provided by the deterministic design will be inadequate?
d) Based on the Simulation, recommend an appropriate superelevation value.

Note: Please, submit your Excel sheet along with your answers.

Question 4 (20 points)

A local bus arrives at a specific stop at an average rate of 4 buses per hour. If the bus arrival follows the Poisson distribution

a) Find the probability that less than three busses arrive at the stop in a given hour
b) A passenger arrives at the stop while the bus has just left. What is the probability that the passenger will wait less than 13 minutes for the next bus?
c) Plot the cumulative distribution function of the waiting time at the stop (use a range from 0 to 60 minutes with a step of 5 minutes to develop your CDF)