ORDRE DES INGÉNIEURS DU QUÉBEC

SESSION DE NOVEMBRE 2015

Toute documentation permise
Calculatrices : modèles autorisés seulement
Durée de l'examen : 3 heures

# 14-IN-B3 LOGISTICS : TRANSPORTATION ASPECTS

## Question 1 (20 marks)

1. Apply the Dijkstra algorithm to find the shortest path between the nodes A and L in the oriented graph below (figure 1). Provide all steps of the execution of the algorithm. Provide the total length of the shortest path between nodes A and L. Note that distance shown in each arc.

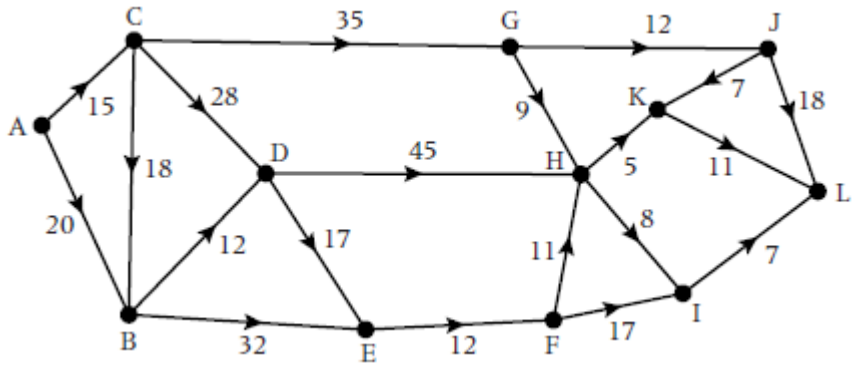


Figure 1 : Oriented graph.

## Question 2 (20 marks)

A company aims to find the best location site of warehouse to satisfy the customer's demand (6 customers) at minimum cost. Table below shows the coordinate and demand of the 6 customers.

Let's suppose that freight transportation cost is correlated to the square of the Euclidian distance between two sites, find the optimal location of the warehouse that minimize the total transportation cost between the warehouse and all its customers. Provide the name of the method you have used to find the optimal location. Locate the warehouse and the customers in the two dimensions plan in figure below.

| Customers | Coordinate (X) | Coordinate (Y) | Demand |
|---|---|---|---|
| A | 8,00 | 6,00 | 3 |
| B | 7,00 | 3,00 | 5 |
| C | 3,00 | 6,00 | 4 |
| D | 5,00 | 4,00 | 2 |
| E | 2,00 | 6,00 | 1 |
| F | 4,00 | 7,00 | 6 |

Table 1: Coordinates (X&Y) of the customers to be delivered and their demand.

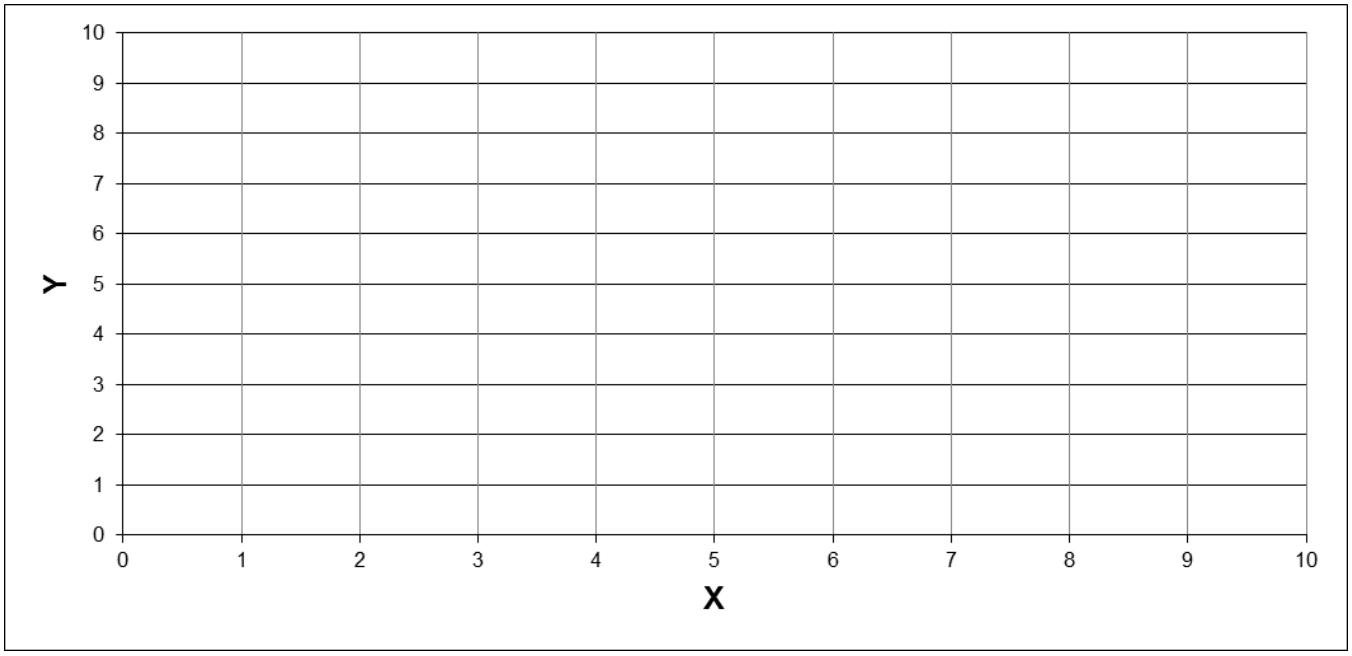


Figure 2 :Two dimensions (2D) plan to locate the warehouse and customers.

## Question 3 (30 marks)

Table 2 below represents the tariff structure ($/cwt or $/100 pounds) for freight transportation of classes 70, 100 and 125 between two north American cities (A and B).

| | **L5C** | **M5C** | **M1M** | **M2M** | **M5M** | **M10M** | **M20M** | **M30M** | **M40M** |
|---|---|---|---|---|---|---|---|---|---|
| **Class 70** | 153 | 124 | 106 | 89 | 76 | 63 | 55 | 47 | 44 |
| **Class 60** | 129 | 104 | 89 | 75 | 64 | 53 | 46 | 40 | 37 |

Table 2: Data for tariff structure of classes 60 and 70.

For each the following questions provide detailed steps of your calculation:

1. Calculate the freight cost to ship 750 pounds for class 70 between the two cities A and B.
2. Calculate the freight cost to ship 1500 pounds for class 60 between the two cities A and B.
3. Calculate the freight cost to ship simultaneously 750 pounds for class 70 and 1500 pounds for class 60 between the two cities A and B.
4. Calculate the freight cost to ship simultaneously 4000 pounds for class 70 and 8000 pounds for class 60 between the two cities A and B.

## Question 4 (30 points)

1. Apply the Clarke and Wright heuristic to find the best travel salesman tour (TSP tour). Suppose that Point # 1 as the depot (original and final destination). The coordinates (X&Y) of customers to be visited are shown in Table 2. Tables 3 and 4 show the Euclidian distances between points to be visited. Some cells in the table are not calculated and must be calculated to have all distances between all points. Provide details steps of how you execute the heuristic and show the travel salesman's tours for each step in the figures below.
2. Apply the closest neighbour heuristic to the same problem and compare it with the results obtained in question 1 using the Clarke and Wright heuristic

| Point | X | Y |
|---|---|---|
| **1** | 20 | 30 |
| **2** | 35 | 25 |
| **3** | 20 | 10 |
| **4** | 40 | 40 |
| **5** | 10 | 30 |
| **6** | 15 | 40 |

Table 2: Coordinates (X&Y) of the customers to be visited.

| DE / À | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|
| **1** | 0,00 | | | 22,36 | 10,00 | 11,18 |
| **2** | | 0,00 | 21,21 | 15,81 | 25,50 | 25,00 |
| **3** | | | 0,00 | 36,06 | 22,36 | 30,41 |
| **4** | | | | 0,00 | 31,62 | 25,00 |
| **5** | | | | | 0,00 | |
| **6** | | | | | | 0,00 |

Table 3: Euclidian distance matrix to be completed.

| | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|
| **2** | 0,00 | | | 0,32 | 1,99 |
| **3** | | 0,00 | 6,31 | 7,64 | 0,77 |
| **4** | | | 0,00 | 0,74 | 8,54 |
| **5** | | | | 0,00 | |
| **6** | | | | | 0,00 |

Table 4: Saving matrix to be completed.

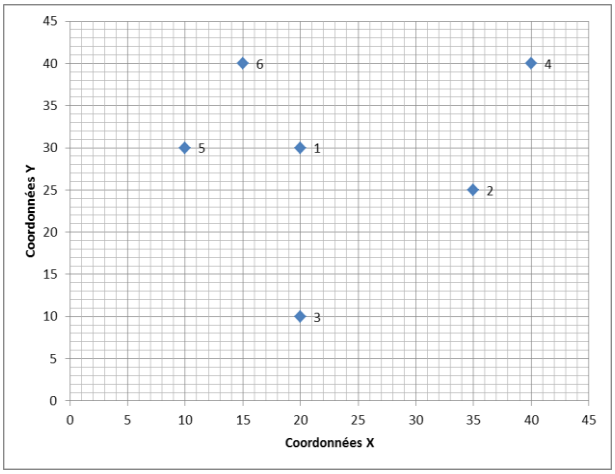

Figure 3 : Salesman tour (Iteration 1)

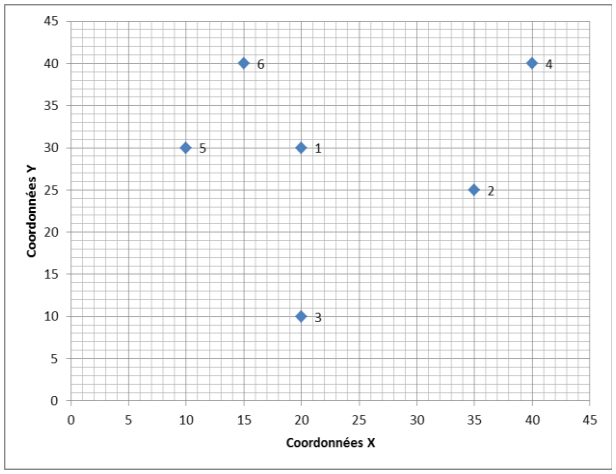

Figure 4 : Salesman tour (Iteration 2)

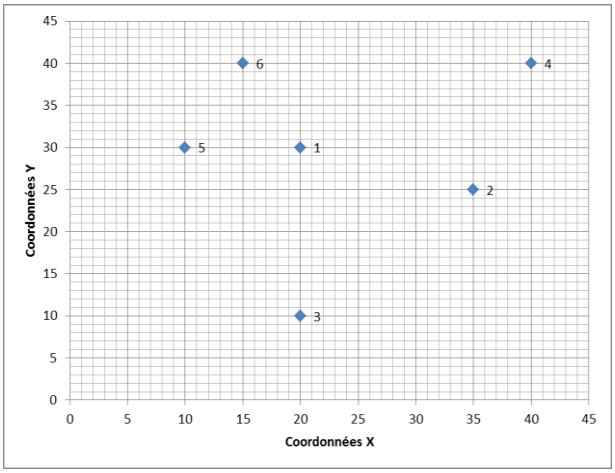

Figure 5 : Salesman tour (Iteration 3)

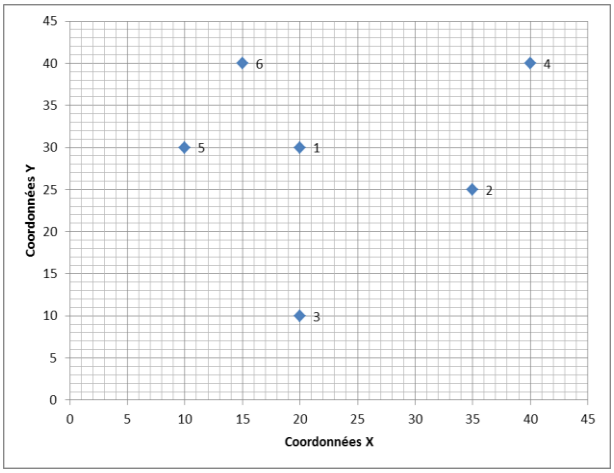

Figure 6 : Salesman tour (Iteration 4)

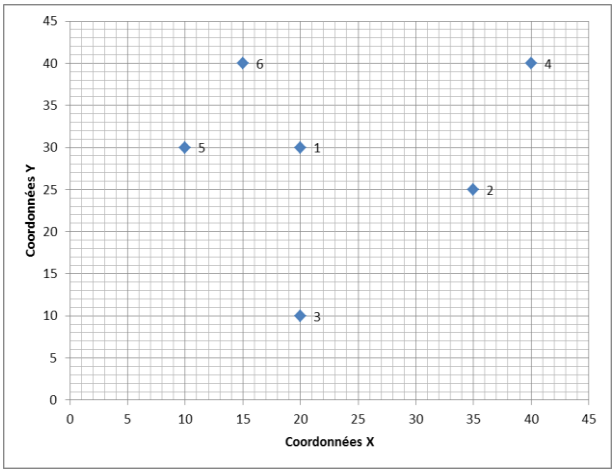

Figure 7 : Salesman tour (Iteration 5)

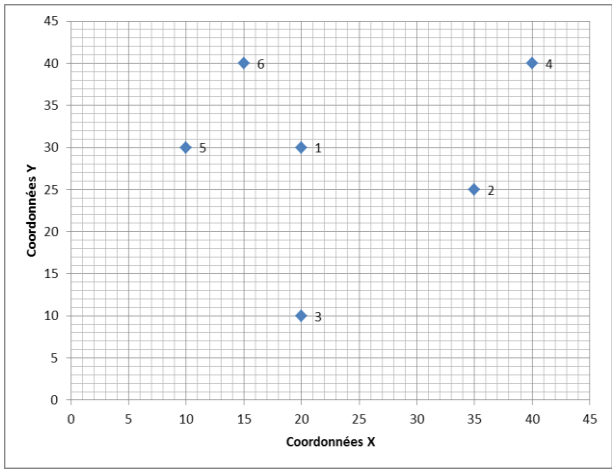

Figure 8 : Salesman tour -  closest neigbhour heurisitic