



**AUTONOMOUS UNIVERSITY OF NUEVO LEÓN**  
**FACULTY OF MECHANICAL AND ELECTRICAL ENGINEERING**



**Semester January-June 2024**

# **Select Optimization Topics**

## **Task 4**

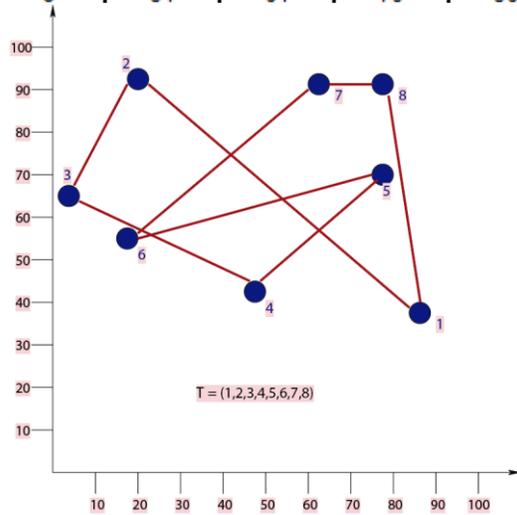
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**Enrollment: 1970685**

**Major: Software Technology Engineer (ITS)**

## Initial Information

	1	2	3	4	5	6	7	8
1	0	89	87	38	33	71	59	54
2	89	0	32	59	65	39	45	61
3	87	32	0	50	75	17	64	79
4	38	59	50	0	40	33	50	56
5	33	65	75	40	0	62	26	21
6	71	39	17	33	62	0	57	70
7	59	45	64	50	26	57	0	16
8	54	61	79	56	21	70	16	0



## Rules

**2-OPT (c1 , c2) [non adjacent]** = Remove edges (i , j) and (k , l) and reconnect to form a tour (i , k) + (j , l)

$\Delta f < 0$  -> **good change**

$\Delta f > 0$  -> **bad change**

ITERATION #1

$$2\text{-OPT}(6,7 ; 1,2) \Delta f = -d_{67} - d_{12} + d_{61} + d_{72} = -30$$

Stir (6.7) and (1.2). Add (6.1) and (7.2).

$$T = [6,1,2,3,4,5,8,7]$$

$$2\text{-OPT}(6,7 ; 2,3) \Delta f = -d_{67} - d_{23} + d_{62} + d_{73} = 14$$

Stir (6.7) and (2.3). Add (6.2) and (7.3).

$$T = [6,2,7,3,4,5,8,1]$$

$$2\text{-OPT}(6,2 ; 3,4) \Delta f = -d_{62} - d_{34} + d_{63} + d_{24} = -13$$

Stir (6.2) and (3.4). Add (6.3) and (2.4).

$$T = [6,3,2,4,5,8,7,1]$$

$$2\text{-OPT}(6,3 ; 4,5) \Delta f = -d_{63} - d_{45} + d_{64} + d_{35} = -4$$

Stir (6.3) and (4.5). Add (6.4) and (3.5).

$$T = [6,4,2,3,5,8,7,1]$$

$$2\text{-OPT}(6,4 ; 5,8) \Delta f = -d_{64} - d_{58} + d_{65} + d_{48} = 15$$

Stir (6.4) and (5.8). Add (6.5) and (4.8).

$$T = [6,5,2,3,4,8,7,1]$$

$$2\text{-OPT}(6,5 ; 8,7) \Delta f = -d_{65} - d_{87} + d_{68} + d_{57} = 18$$

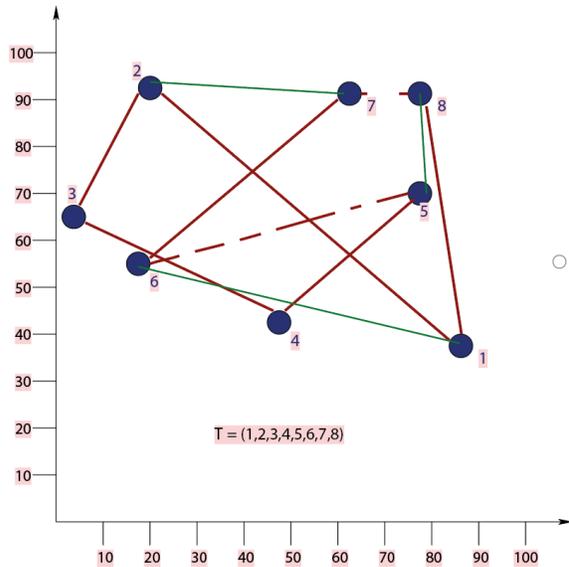
Stir (6.5) and (8.7). Add (6.8) and (5.7).

$$T = [6,8,2,3,4,5,7,1]$$

$$2\text{-OPT}(6,8 ; 1,7) \Delta f = -d_{68} - d_{71} + d_{67} + d_{81} = 18$$

Stir (6.8) and (1.7). Add (6.7) and (8.1).

$$T = [6,7,2,3,4,5,8,1]$$



## ITERATION #2

$$2\text{-OPT}(1,6 ; 7,2) \Delta f = -d_{16} - d_{72} + d_{17} + d_{62} = 39$$

Stir (1.6) and (7.2). Add (1.7) and (6.2).

$$T = [1,7,6,2,3,4,5,8]$$

$$2\text{-OPT}(1,7 ; 6,2) \Delta f = -d_{17} - d_{62} + d_{16} + d_{72} = -39 \text{ (Previous change reverts)}$$

Stir (1.7) and (6.2). Add (1.6) and (7.2).

$$T = [6,7,2,3,4,5,8,1]$$

$$2\text{-OPT}(1,6 ; 7,8) \Delta f = -d_{16} - d_{87} + d_{17} + d_{68} = 31$$

Stir (1.6) and (7.8). Add (1.7) and (6.8).

$$T = [1,7,2,3,4,5,6,8]$$

$$2\text{-OPT}(1,7 ; 2,3) \Delta f = -d_{17} - d_{23} + d_{12} + d_{73} = 46$$

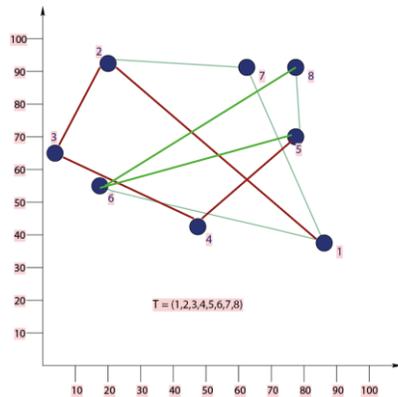
Stir (1.7) and (2.3). Add (1.2) and (7.3).

$$T = [1,2,7,3,4,5,6,8]$$

$$2\text{-OPT}(1,2 ; 7,3) \Delta f = -d_{12} - d_{73} + d_{17} + d_{23} = -46 \text{ (Se revierte)}$$

Stir (1.2) and (7.3). Add (1.7) and (2.3).

$T = [1,7,2,3,4,5,6,8]$



ITERATION #3

2-OPT(8,1 ; 7,2)  $\Delta f = -d_{81} - d_{72} + d_{87} + d_{12} = 39$

Stir (8.1) and (7.2). Add (8.7) and (1.2).

$T = [8,7,1,2,3,4,5,6]$

2-OPT(2,1 ; 8,7)  $\Delta f = -d_{21} - d_{87} + d_{28} + d_{17} = 15$

Stir (2.1) and (8.7). Add (2.8) and (1.7).

$T = [2,8,1,7,3,4,5,6]$

2-OPT(3,2 ; 8,1)  $\Delta f = -d_{32} - d_{81} + d_{38} + d_{21} = 77$

Stir (3.2) and (8.1). Add (3.8) and (2.1).

$T = [3,8,2,1,7,4,5,6]$

2-OPT(7,3 ; 8,2)  $\Delta f = -d_{73} - d_{82} + d_{78} + d_{32} = 63$

Stir (7.3) and (8.2). Add (7.8) and (3.2).

$T = [7,8,3,2,1,4,5,6]$

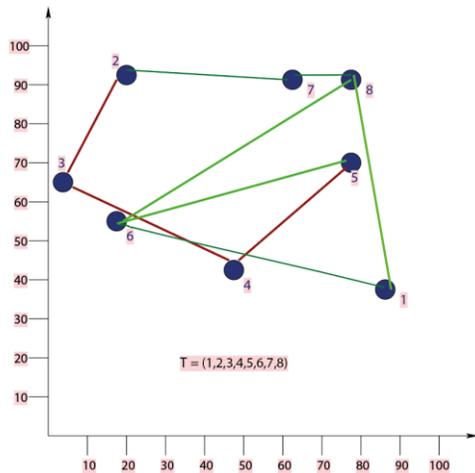
2-OPT(1,7 ; 8,3)  $\Delta f = -d_{17} - d_{83} + d_{18} + d_{73} = 63$

Stir (1.7) and (8.3). Add (1.8) and (7.3).

$T = [1,8,7,3,2,4,5,6]$

No more improvements. Optimal route found:

$T = [1,8,7,3,2,4,5,6]$



## Frist Found

ITERATION #1

2-OPT(6,7 ; 1,2)  $\Delta f = -d_{67} - d_{12} + d_{61} + d_{72} = -30$

No changes are made, as  $\Delta f > 0$  (worsens the path)

2-OPT(6,7 ; 2,3)  $\Delta f = -d_{67} - d_{23} + d_{62} + d_{73} = 14$

Stir (6.7) and (2.3). Add (6.2) and (7.3).

$T = [1,6,2,7,3,4,5,8]$

First improvement found, iteration stops according to First Found.

ITERATION #2

2-OPT(8,1 ; 6,2)  $\Delta f = -d_{81} - d_{62} + d_{86} + d_{12} = 39$

Stir (8.1) and (6.2). Add (8.6) and (1.2).

$T = [8,6,1,2,7,3,4,5]$

First improvement found, iteration stops according to First Found.

ITERATION #3

2-OPT(5,8 ; 6,1)  $\Delta f = -d_{58} - d_{61} + d_{56} + d_{81} = 31$

No changes are made, as  $\Delta f > 0$  (worsens the path)

$$2\text{-OPT}(5,8 ; 1,2) \Delta f = -d_{58} - d_{12} + d_{51} + d_{82} = -26$$

No changes are made, as  $\Delta f > 0$  (worsens the path)

$$2\text{-OPT}(5,8 ; 2,7) \Delta f = -d_{58} - d_{27} + d_{52} + d_{87} = 21$$

Stir (5.8) and (2.7). Add (5.2) and (8.7).

$$T = [8,6,1,5,2,7,3,4]$$

First improvement found, iteration stops according to First Found.

ITERATION #4

$$2\text{-OPT}(4,8 ; 6,1) \Delta f = -d_{48} - d_{61} + d_{46} + d_{81} = 71$$

Stir (4.8) and (6.1). Add (4.6) and (8.1).

$$T = [8,1,5,2,7,3,4,6]$$

First improvement found, iteration stops according to First Found.

No more iterations, the final First Found path is: [8,1,5,2,7,3,4,6]