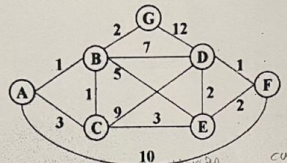
Example # 1: Given the graph in the Figure shown below, find the shortest paths to all nodes using the vertex A as the starting source. Use Dijkstra's algorithm.



Iteration	A	B	C	D	E	F	G	P	PERM	PERM
0	0(0)*	∞(-1)	∞(-1)	∞(-1)	∞(-1)	∞(-1)	∞(-1)		∅	N
1	0(0)*	1(A)	3(A)	∞(-1)	∞(-1)	10(A)	∞(-1)	A	A	N/{A}
2	—	1(A)*	2(B)	8(B)	6(B)	10(A)	3(B)	B	A,B	N/{A,B}
3	—	—	2(B)*	8(B)	5(C)	10(A)	3(B)	C	A,B,C	N{A,B,C}
4	—	—	—	8(B)	5(C)	10(A)	3(B)*	G	{A,B,C,G}	{D,E,F}
5	—	—	—	7(E)	5(C)*	7(E)	—	E	N{D,E}	D,E
6	—	—	—	7(E)*	—	7(E)	—	D	N{E}	E
7	—	—	—	—	—	7(E)*	—	F	N	∅

Question 2: Suppose that you are working as a consultant for Sears on home appliance delivery logistics. After developing a travel time network model of their Atlanta delivery region, you arrive at the job site for your first day at work. Joan, one of Sears' dispatchers, says she's about to route a truck from their warehouse through a set of 5 customers and then back to their warehouse, and she wants to know whether she's chosen the tour that minimizes travel time. Her proposed tour will take 2.81 hours. To answer this question, you realize that you'd like to solve a TSP problem but you don't have enough time. Suppose that instead you do the following:

Step 1: You use your network model to extract the minimum travel times between the depot and each of the customers in the delivery set, and also to find the minimum travel times between the customers. This data creates a complete undirected graph, G, connecting all of the customers and the depot with costs defined as travel times.

Step 2: Suppose now that you find the minimum cost tree on G that excludes exactly one node, which in this case is node 3. Let $1TREE_3^*$ be this tree, with cost $C(1TREE_3^*) = \sum_{(i,j) \in 1TREE_3^*} c_{ij}$ equal to 2.29 hours. Suppose that you then print out the costs of the arcs adjacent to node 3 (in no particular order) and they turn out to be: (0.21, 1.54, 0.79, 0.31).

a) Without any additional computation, you run to Joan to tell her that she's already found the optimal tour! Are you correct, or have you made a grave mistake? If you think Joan has found the optimal TSP tour, explain precisely why using your knowledge of trees, minimum spanning trees, and TSP tours. Otherwise, explain precisely why not. (**1.5 points**)

b) Suppose that later in your consulting assignment with Sears, you use Christofides' heuristic to solve a TSP problem, and the resulting tour T has a cost of $C(T) = 48$. Working on the same problem, your co-worker claims to have found a tour BS with a cost $C(BS) = 31$. You turn to your co-worker, and tell her that she has made a mistake. Explain (**1.5 points**)

uestion 2: Suppose that you are working as a consultant for Sears on home appliance delivery gistics. After developing a travel time network model of their Atlanta delivery region, you arrive the job site for your first day at work. Joan, one of Sears' dispatchers, says she's about to route truck from their warehouse through a set of 5 customers and then back to their warehouse, and he wants to know whether she's chosen the tour that minimizes travel time. Her proposed tour ill take 2.81 hours. To answer this question, you realize that you'd like to solve a TSP problem ut you don't have enough time. Suppose that instead you do the following:

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Step 2: Suppose now that you find the minimum cost tree on G that excludes exactly one node, which in this case is node 3. Let $1TREE^*$ be this tree, with cost $C(1TREE_3^*) = \sum_{e \in 1TREE_3^*} c_e$ equal to 2.29 hours. Suppose that you then print out the costs of the arcs adjacent to node 3 (in no particular order) and they turn out to be: (0.31, 1.54, 0.79, 0.31).

a) Without any additional computation, you run to Joan to tell her that she's already found the optimal tour! Are you correct, or have you made a grave mistake? If you think Joan has found the optimal TSP tour, explain precisely why using your knowledge of trees, minimum spanning trees, and TSP tours. Otherwise, explain precisely why not. (1.5 points)

b) Suppose that later in your consulting assignment with Sears, you use Concorde heuristic to solve a TSP problem, and the resulting tour T has a cost of $C(T) = 46$. Working on the same problem, your co-worker claims to have found a tour S with a cost $C(S) = 35$. You turn to your co-worker, and tell her that she has made a mistake. Explain. (1.5 points)

$\frac{5(4)}{2}$

stion 1: (7 points)

Number of possible tours in the undirected complete graph G with 5 vertices is :

a) 60
b) 30
c) 24
d) 12
e) 6

Christofides' heuristic is an effective practical heuristic that has the best-known worst-case performance bound for the traveling salesman problem on complete networks satisfying the triangle-inequality

a) True
b) False

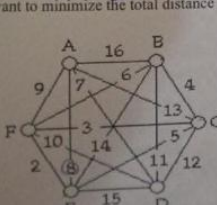
For complete graphs with positive arcs, always the cost of the optimal MST is less than or equal to the cost of optimal TSP

a) True
b) False

4. Christofides heuristic will produce a walk with the same total cost regardless of which is node is selected in the initialization.
   a) True
   b) False

5. Given a set of nodes N and a set of arcs representing a spanning tree T, the number of nodes with odd degree with respect to the arc set T is even.
   a) True
   b) False

6. A delivery truck must deliver packages to 6 different store locations (A, B, C, D, E, and F). The trip must start and end at A. The graph below shows the distances (in miles) between locations. We want to minimize the total distance traveled.

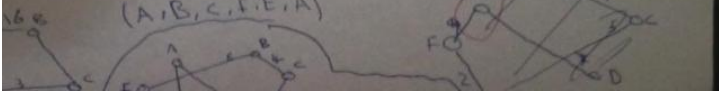


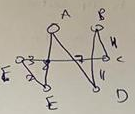
(F,E) → (E,E)
(F,C) → (E,C)
(C,B) → (E,B)
(E,A) → (A,B)
(A,B)

(A,D) → (A,D)
(A,E) → (E,D)
(F,F) → (F,D)
(E,B) → (D,B)
(C,B) → (D,B)

The nearest-neighbor algorithm starting at vertex A yields the Tour T = {A,D,C,B,E,F,A} cost is 31

(A,B,C,F,E,A)





So cost 35

A (~~7~~, ~~9~~, 11, 15)

B (4, 6, 11, 14, 16)

C (~~3~~, 4, 5, 12, 13)

D (7, 6, 11, 12, 15) Next neighbour

E (2, 5, ~~9~~, 14, 15)

F (~~3~~, ~~8~~, ~~6~~, 9 6)

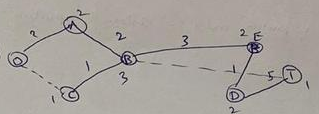
* Christofied Question →

Part 2

	O	A	B	C	D	E	T
O	0	2	44	8	7		13
A	2	0	2	3	6	5	11
B	4	2	0	x	4	2	9
C	4	3	x	0	5	4	10
D	8	6	4	5	0	x	5
E	7	5	3	4	x	0	6
T	13	11	9	10	5	6	0

Find the least no on the matrix then see the no in alternating way and see if there is cycle or not

① MST



* no of tours, based on nodes

$\frac{(n-1)!}{2}$

② S = { O, AC, B, T }

$\frac{14}{2} = 2$

O C - B T = $C_{OC} + C_{BT} = 4 + 9 = 13$ ←

O B - C T = $C_{OB} + C_{CT} = 4 + 10 = 14$

O T , C B = $C_{OT} + C_{CB} = 13 + 1 = 14$

③ walk = { O, A, B, T, D, E, B, C, O }

④ = { O, A, B, T, D, E, C O } = 27 Cost

⑦

OR

⑤ walk = { O, C, B, E, D, T, B, A, O }

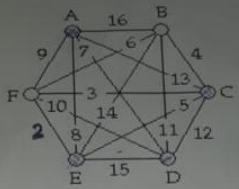
④ = { O, C, B, E, D, T, A, O }

Cost = 27

Reem

Use the following to answer questions (1 – 4)

Consider the following symmetric, undirected network G where the numbers next to each arc are the arc costs. Suppose that your goal is to find a good traveling salesman tour that visits all of the nodes of G.



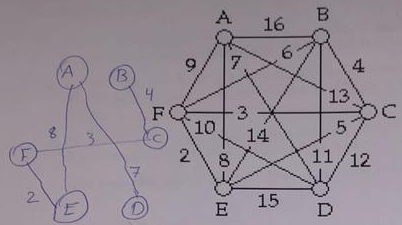
1. Complete the following table that shows the lower bounds using several techniques: (2.5 points)

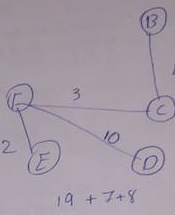
technique	Lower bound
MST+arc	
$1-TREE_A$	
$1-TREE_B$	
$1-TREE_C$	
$1-TREE_D$	

2. Suppose the Nearest Neighbor heuristic is used to build a TSP tour starting at vertex A yields the Tour---------- , cost is ------- (2 points)

Use the following to answer questions (1 - 4)

Consider the following symmetric, undirected network G where the numbers next to each arc are the arc costs. Suppose that your goal is to find a good traveling salesman tour that visits all of the nodes of G.



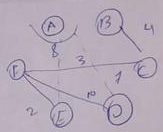


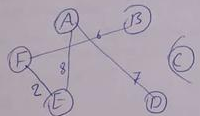
19 + 7 + 8

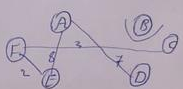
1. Complete the following table that shows the lower bounds using several techniques: (2.5 points)

technique	Lower bound
MST+arc	24 + 5 = 29 ✓✓
$1-TREE_A$	34
$1-TREE_B$	20 + 4 + 6 = 30
$1-TREE_C$	23 + 7 = 30
$1-TREE_D$	34

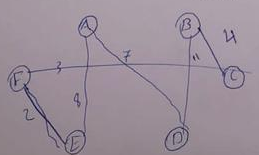
Simple



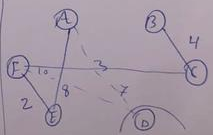




2. Suppose the Nearest Neighbor heuristic is used to build a TSP tour starting at vertex A yields the Tour---------- , cost is ------- (2 points)



Cost = 35



Inventory Cost at Plant
Space Cost = $30/unit.year * q unit = $30q/year
Holding Cost = 0.15 × 500 × $\frac{q}{2}$ = 37.5q

⇒ Inventory Cost = 30q/year + 37.5q = 67.5q/year

Inv Cost at the center
Space Cost = $40/unit.year ($800+q$)
= 32000 + 40q /year
Holding Cost = 0.15 × 700 × ($\frac{q}{2}$ + 800)
= 52.5q + 84000 /year

⇒ inventory cost = 32000 + 40q + 52.5q + 84000 = 92.5q + 116000

Pipeline inv Cost = 0.15 ($\frac{500+700}{2}$) = 90

pipeline inv Cost by ocean:
120000 $\frac{\text{unit}}{\text{year}}$ × $\frac{20 \text{ days}}{365}$ × 90 = $591780.8/year

by air
120000 × $\frac{2}{365}$ × 90 = $59178.08/year

Transportation Cost by ocean
$\frac{120000}{q_{ocean}} \times 11500 = \frac{1380000000}{q_{ocean}}$

Transportation by air
$\frac{120000}{q_{air}} \times 2080 = \frac{249600000}{q_{air}}$

5(4)
7

...tion 1: (7 points)

...number of possible tours in the undirected complete graph G with 5 vertices is:

a) 60
b) 30
c) 24
d) 12
e) 6

Christofides' heuristic is an effective practical heuristic that has the best-known worst-case performance bound for the traveling salesman problem on complete networks satisfying the triangle-inequality.

a) True
b) False

For complete graphs with positive arcs, always the cost of the optimal MST is less than or equal to the cost of optimal TSP

a) True
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Christofides heuristic will produce a walk with the same total cost regardless of which is node is selected in the initialization.

a) True
b) False

Given a set of nodes N and a set of arcs representing a spanning tree T, the number of nodes with odd degree with respect to the arc set T is even.

a) True
b) False

A delivery truck must deliver packages to 6 different store locations (A, B, C, D, E, and F). The trip must start and end at A. The graph below shows the distances (in miles) between locations. We want to minimize the total distance traveled.



(F,E) → (E,F)
(F,C) → (E,C)
(C,B) → (E,B)
(E,A) → (A,B)
(A,B)

(A,D) → (A,C)
(A,E) → (E,D)
(E,F) → (F,D)
(E,B) → (D,B)
(C,B) → (D,B)

The nearest-neighbor algorithm starting at vertex A yields the Tour (A,D,C,B,E,F,A) Cost = 31

(A,B,C,F,E,A)

Question 2: Suppose that you are working as a consultant for Sears on home appliance delivery logistics. After developing a travel time network model of their Atlanta delivery region, you arrive at the job site for your first day at work. Joan, one of Sears' dispatchers, says she's about to route a truck from their warehouse through a set of 5 customers and then back to their warehouse, and she wants to know whether she's chosen the tour that minimizes travel time. Her proposed tour will take 2.81 hours. To answer this question, you realize that you'd like to solve a TSP problem but you don't have enough time. Suppose that instead you do the following:

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a) Without any additional computation, you run to Joan to tell her that she's already found the optimal tour! Are you correct, or have you made a grave mistake? If you think Joan has found the optimal TSP tour, explain precisely why using your knowledge of trees, minimum spanning trees, and TSP tours. Otherwise, explain precisely why not. (3.5 points)

b) Suppose that later in your consulting assignment with Sears, you use Chvátal-Gass' heuristic to solve a TSP problem, and the resulting tour T has a cost of $C(T) = 46$. Working on the same problem, your co-worker claims to have found a tour HA with a cost $C(HA) = 51$. You turn to your co-worker, and tell her that she has made a mistake. Explain. (3.5 points)

Q2 (a) 5 customers

2.81 hours → optimal

minimum travel time

remove node 3

$1 - TBEE_3 = 2.29$

(0.21, 0.31) → nodes out of 3 with min cost

$LB = 2.29 + 0.21 + 0.31 = 2.81$ equals

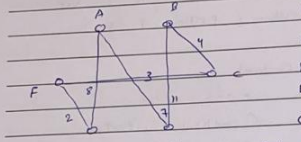
optimal ✓ feasible ✓

Subject Christofides Question In Quiz

Date

No.

& nearest neighbour



A = 7, 8, 9, 13, 16

B = 4, 6, 11, 14, 16

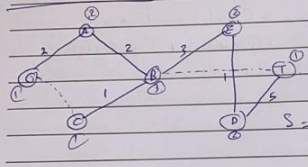
F = 2, 3, 6, 9,

E = 2, 5, 8, 14, 16

D = 7, 10, 11, 12, 15

C = 8, 4, 5, 12, 13

A,D A,E E,F F,C C,B



Look for the smallest integer in the table & X the ends

S = {O, C, B, T}

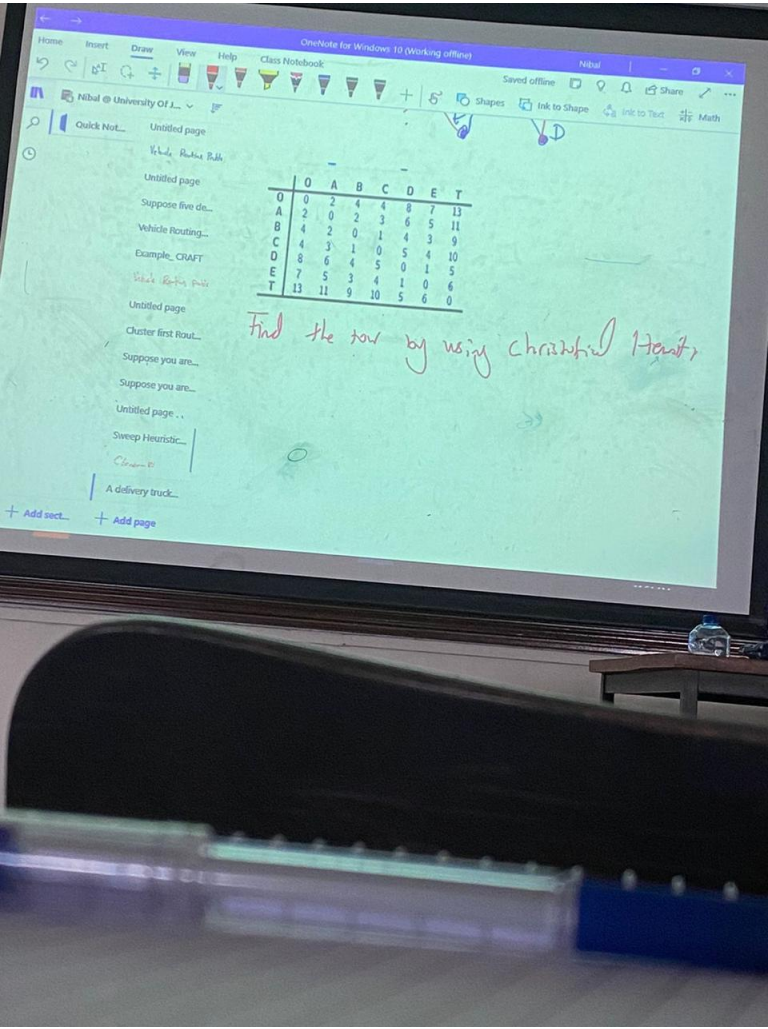
O,C - B,T = $C_{OC} + C_{BT}$ = 4+10 = 13* ✓

O,B - C,T = $C_{OB} + C_{CT}$ = 4+9 = 13*

O,T - B,C = $C_{OT} + C_{BC}$ = 12+2 = 14

Walk = {O, A, B, T, D, E, B, C, O} cost = 27

NOTEBOOK



	O	A	B	C	D	E	T
O	0	2	4	4	8	7	13
A	2	0	2	3	6	5	11
B	4	2	0	1	4	3	9
C	4	3	1	0	5	4	10
D	8	6	4	5	0	1	5
E	7	5	3	4	1	0	6
T	13	11	9	10	5	6	0

OneNote for Windows 10 (Working offline) Nibal

Insert Draw View Help Class Notebook Saved offline Share

Shapes Ink to Shape Ink to Text Math

Nibal @ University Of J...

Quick Not...

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Vehicle Routing Prob

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Suppose five de...

Vehicle Routing...

Example_CRAFT

Vehicle Routing prob

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Cluster first Rout...

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Suppose you are...

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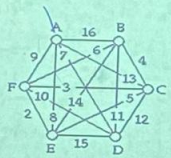
Sweep Heuristic...

Clarke-W

A delivery truck...

+ Add page

1. A delivery truck must deliver packages to 6 different store locations (A, B, C, D, E, and F). The trip must start and end at A. The graph below shows the distances (in miles) between locations. We want to minimize the total distance traveled.

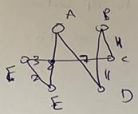


The nearest-neighbor algorithm starting at vertex A yields the Tour _____, cost is _____

A ● ○ B

○ F ○ C

E ○ ○ D



So Cost 35

A (~~7~~, ~~2~~, 9, 11, 15)

B (4, 6, 11, 14, 16)

C (~~3~~, 4, 5, 12, 13)

D (7, 6, 11, 12, 15) Next neighbour

E (~~2~~, 5, ~~2~~, 14, 15)

F (~~2~~, ~~3~~, ~~6~~, 9 6)

* Christofied Question →

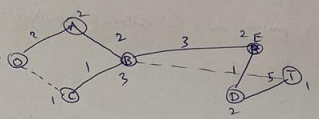
Part 2

	O	A	B	C	D	E	T
O	0	2	44	8	7		13
A	2	0	2	3	6	5	11
B	4	2	0	x	4	?	9
C	4	3	x	0	5	4	10
D	8	6	4	5	0	x	5
E	7	5	3	4	x	0	6
T	13	11	9	10	5	6	0

Find the least no on the matrix

then see the no in ascending way and see if there is cycle or not

① MST



* no of tours, based on nodes

$\frac{(n-1)!}{2}$

② S = { O, AC, B, T }

$\frac{14}{2} = 2$

O C - B T = $C_{OC} + C_{BT} = 4 + 9 = 13$ ←

O B - C T = $C_{OB} + C_{CT} = 4 + 10 = 14$

O T , C B = $C_{OT} + C_{CB} = 13 + 1 = 14$

③ walk = { O, A, B, T, D, E, B, C, O }

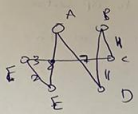
④ = { O, A, B, T, D, E, C O } = 27 Cost

⑦

or ③ walk = { O, C, B, E, D, T, B, A, O }

④ = { O, C, B, E, D, T, A, O }

Cost = 27



So Cost 35

A (~~7~~, ~~2~~, 9, 11, 15)

B (4, 6, 11, 14, 16)

C (~~3~~, 4, 5, 12, 13)

D (7, 6, 11, 12, 15) Next neighbour

E (~~2~~, 5, ~~2~~, 14, 15)

F (~~2~~, ~~3~~, ~~6~~, 9 6)

* Christofied Question →

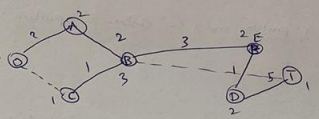
Part 2

	O	A	B	C	D	E	T
O	0	2	44	8	7		13
A	2	0	2	3	6	5	11
B	4	2	0	x	4	?	9
C	4	3	x	0	5	4	10
D	8	6	4	5	0	x	5
E	7	5	3	4	x	0	6
T	13	11	9	10	5	6	0

Find the least no on the matrix

then see the no in ascending way and see if there is cycle or not

① MST



* no of tours, based on nodes

$\frac{(n-1)!}{2}$

② S = { O, AC, B, T }

$\frac{14}{2} = 2$

O C - B T = $C_{OC} + C_{BT} = 4 + 9 = 13$ ←

O B - C T = $C_{OB} + C_{CT} = 4 + 10 = 14$

O T , C B = $C_{OT} + C_{CB} = 13 + 1 = 14$

③ walk = { O, A, B, T, D, E, B, C, O }

④ = { O, A, B, T, D, E, C O } = 27 Cost

⑦

or ③ walk = { O, C, B, E, D, T, B, A, O }

④ = { O, C, B, E, D, T, A, O }

Cost = 27

Example #2: Suppose you are the dispatcher for an LTL trucking firm, and you need t
small delivery trucks for the local delivery of freight. Suppose you have many trucks a
each with the capacity to haul 10 tons of freight. Suppose that the polar angle (relative
axis, and measured clockwise in degrees) of the seven customers are {45, 105, 220, 13
300}. Suppose that the demands of the seven customers in tons are {7, 3, 4, 5, 2, 4, 6}

Using the Sweep Heuristic, generate clusters of customers each to be served by a sing
Begin with a ray through customer 2 and rotate your ray clockwise.

$Q = 10$

Customer	Demand	polar angle	Δ
C_1	7	45°	
C_2	3	105°	0
C_3	4	220°	115
C_4	5	135°	30
C_5	2	60	
C_6	4	85	
C_7	6	300	

$T = \{C_2, C_4, C_3, C_4, C_1, C_5, C_6\}$

Cluster 1 : $\{C_2, C_4\} \longrightarrow \{0, C_2, C_4, 0\}$

Cluster 2 : $\{C_5, C_7\} \longrightarrow \{0, C_5, C_7, 0\}$

Cluster 3 : $\{C_1, C_3\} \longrightarrow \{0, C_1, C_3, 0\}$

Cluster 4 : $\{C_6\} \longrightarrow \{0, C_6, 0\}$

1) Inv space cost at the plant = $ 20q /year

2) Inv Holding cost at the plant = 400 * 0.2 * $\frac{q}{2}$ = $ 40 q /year

* Inv cost at the plant = space cost + holding cost = $60q /year

3) Inv space cost at the dc = $(30q + 12000) /year

4) Inv Holding cost at the dc = 450 * 0.2 * ($\frac{q}{2}$ + 40) = $(45q + 3600) /year

* Inv cost at the dc = space cost + holding cost = $(75q + 4800) /year

5) pipeline Inv → inventory cost in-transit

PI = 0.2 * value of item intransit

= $\frac{\text{it's value at the plant + it's value at the dc}}{2}$ = $425

Holding cost pipeline = 0.2 * 425 = $85 /unit * year

* Pipeline Inv cost by ocean = 85 * $\frac{30}{365}$ * 20000 = $6986.3 /year

* Pipeline Inv cost by air = 85 * $\frac{2}{365}$ * 20000 = $931.5 /year

6) Transportation cost by each mode:

# of shipments = $\frac{20000}{q}$

* ocean = $\frac{20000}{q}$ * 9000 = $\frac{180000000}{q}$ /year

* air = $\frac{20000}{q}$ * 16000 = $\frac{320000000}{q}$ /year

7) Total cost of each mode

$TC_{ocean}(q)$ = 135q + 144526 + $\frac{180000000}{q}$ $/year

$TC_{air}(q)$ = 135q + 14115 + $\frac{320000000}{q}$ $/year

1) Inv space cost at the plant = $30q /year

2) Inv Holding cost at the plant = $500 * 0.15 * \frac{q}{2}$ = $37.5q /year

* Inv cost at the plant = $67.5q /year

3) Inv space cost at the dc = $(40q + 32000) /year

4) Inv Holding cost at the dc = $700 * 0.15 * (\frac{q}{2} + 800)$ = $(52.5q + 84000) /year

* Inv cost at the dc = $(92.5q + 116000) /year

5) pipeline Inv

$P.I_{\text{Holding cost}} = 0.15 * (\frac{500 + 700}{2}) = \$90 /unit.year$

* Pipeline Inv cost by ocean = $90 * \frac{20}{365} * 120000 = \$591780 /year$

* Pipeline Inv cost by air = $90 * \frac{2}{365} * 120000 = \$59178 /year$

6) Transportation cost by each mode:

# of shipments = $\frac{120000}{q}$

* ocean = $\frac{120000}{q} * 10000 = \$\frac{1200000000}{q} /year$

* air = $\frac{120000}{q} * 20000 = \$\frac{2400000000}{q} /year$

7) Total cost without Handling cost

$TC(q)_{\text{ocean}} = 160q + 707780 + \frac{1200000000}{q}$

$TC(q)_{\text{air}} = 160q + 175178 + \frac{2400000000}{q}$

	plant	DC
Safety stock	0	800
space cost	30	40
Value of item	500	700

Holding cost rate : 15%

product rate at the plant and DC : 120000 units

* ocean

container capacity : 4500 units

transite time : 20 days

cost per shipment : $10000

handling cost : $1500 / container

air line

container capacity : 1400 units

transite time : 2 days

cost per shipment : $20000

handling cost : $800 / container

An electronics manufacturer ships partially assembled circuit boards (hereafter called units) from an assembly plant in Jordan to a distribution center in UK. We want to determine which transportation mode is lower in terms of total shipping cost. There are two options for shipping, the first is to ship in 40ft containers by ocean carriers or in airline containers by air carriers. Shipment by ocean costs $10,000 per container, and a 40ft container can hold 4,500 units. The handling cost is $1,500 per 40ft container. The journey by sea takes 20 days on average. Shipment by air costs $20,000 per container, and an airline container can hold 1,400 units. The handling cost is $800 per airline container. The journey by air takes 2 days on average (door to door). The forecasted demand is 120,000 units for the next year, which is also the planned production quantity. No safety stock is kept at the assembly plant, and a shipment is sent to the distribution center as soon as a container is filled. Safety stock of 800 units is kept at the distribution center. A unit is valued at $500 at the assembly plant and $700 at the distribution center. The inventory holding cost rate is estimated at 15% of the value per year. The space cost is estimated as $30/unit*year at the assembly plant and $40/unit*year at the distribution center.

Which transportation mode is more economical in terms of total annual (transportation and inventory) cost? (Show your work for all cost elements and find the optimum shipment size). In the blank below, fill in the optimal shipment size for the ocean mode (round to the nearest integer).

Answer:

GISTICS ENGINEERING AND SUPPLY CHAIN MANAGEM

Time left 0:58

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A delivery vehicle has started its trip to serve 5 customers and return to the depot; two minutes after the car initiated the route (trip) a new customer request has arrived, the delivery man refused to take it into consideration. This is a static vehicle routing problem.

Select one:

- True
- False

Next page

v in touch
here to search

8) $\dot{TC}_{ocean}(q) = 160 - \frac{1200000000}{q^2} = 0 \Rightarrow q = 2738.6$ unit

For the handling cost $\Rightarrow q_{ocean} <$ container capacity

so, we will ship 1 container $\rightarrow$ \$1500

$\dot{TC}_{air}(q) = 160 - \frac{2400000000}{q^2} \Rightarrow q = 3872.9$

For the handling cost $\Rightarrow q_{air} >$ container capacity

so, we will ship $\frac{q_{air}}{capacity} \approx 3$ containers $\rightarrow 3 * 800 = \$2400$

9) choosing mode

$TC_{ocean} = 160 * 2738.6 + 707780 + \frac{1200000000}{2738.6} + 1500 = 1585636\ \$$

$TC_{air} = 160 * 3872.9 + 175178 + \frac{2400000000}{3872.9} * 3 + 2400 = 2656314\ \$$

choose ocean

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Problem 1: (24 points - 3 pts each)

1. Suggest appropriate effectiveness and efficiency measures for a delivery company

   a. Effectiveness: to be at time (customer satisfaction)

   b. Efficiency: number of units/shipment → if shipment capacity was 100%, the more it approaches to 100%, the more efficient the operation
   ~~customer satisfaction~~ least cost

   time, money, path, # of labors, # of trucks, fuel cost, waste, # of shipments

2. Improving service level is a reason for holding less inventory
   (a) True → Demand ↑
   (b) False

3. Locations of facilities and inventory policies are both decisions on a strategic level in logistics ✓ ✗ ↓ tactical
   a. True
   (b) False

4. Cycle is a set of edges that form a closed loop with a feasible direction. not necessarily
   a. True
   (b) False

5. Consider graph G in Figure 1 (shown below). Suppose a path P is specified in the form $(i_1, i_2, \ldots, i_k)$ for $i_k \in P$. Which of the following options are **paths** in G (if there are more than one, select all that apply):
   (a) (1, 2, 3, 2)
   (b) (2, 3, 5, 1)
   c. (2, 3, 1)
   (d) (1, 5, 4)



Figure 1: $G = (V, E)$ for problems

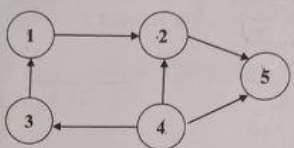
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Logistics Engineering & Supply Chain Management
First Exam/Fall 2021 Printed Name_____ ID _____

6. Consider the graph in Figure 1. Are vertices 2 and 5 connected in G?
   a. Yes
   b. No

7. A minimum spanning tree is a collection of n-1 vertices and no cycles exist
   a. True
   b. False

8. The sequence of vertices {1, 2, 5, 4} is not a path.
   a. True
   b. False



Problem 2: (36 points)
For the graph shown in Figure 2 below, find the shortest paths rooted at V_1 (source).

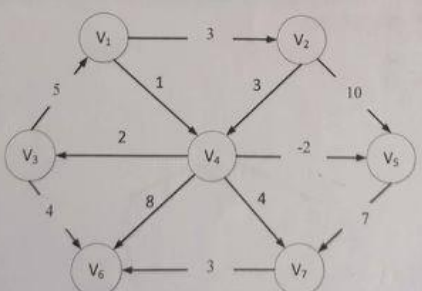
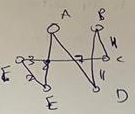


Figure 2 Graph for problem 2

Solution in the last page



So cost 35

A (~~7~~, ~~9~~, 11, 15)

B (4, 6, 11, 14, 16)

C (~~3~~, 4, 5, 12, 13)

D (7, 6, 11, 12, 15) Next neighbour

E (2, 5, ~~9~~, 14, 15)

F (~~3~~, ~~8~~, ~~6~~, 9 6)

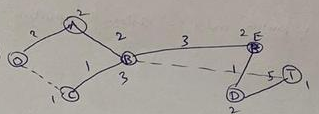
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Find the least no on the matrix then see the no in alternating way and see if there is cycle or not

① MST



* no of tours, based on nodes

$\frac{(n-1)!}{2}$

② S = { O, AC, B, T }

$\frac{14}{2} = 2$

O C - B T = $C_{OC} + C_{BT} = 4 + 9 = 13$ ←

O B - C T = $C_{OB} + C_{CT} = 4 + 10 = 14$

O T , C B = $C_{OT} + C_{CB} = 13 + 1 = 14$

③ walk = { O, A, B, T, D, E, B, C, O }

④ = { O, A, B, T, D, E, C O } = 27 Cost

⑦

OR

⑤ walk = { O, C, B, E, D, T, B, A, O }

④ = { O, C, B, E, D, T, A, O }

Cost = 27

uestion 2: Suppose that you are working as a consultant for Sears on home appliance delivery gistics. After developing a travel time network model of their Atlanta delivery region, you arrive the job site for your first day at work. Joan, one of Sears' dispatchers, says she's about to route truck from their warehouse through a set of 5 customers and then back to their warehouse, and he wants to know whether she's chosen the tour that minimizes travel time. Her proposed tour ill take 2.81 hours. To answer this question, you realize that you'd like to solve a TSP problem ut you don't have enough time. Suppose that instead you do the following:

tep 1: You use your network model to extract the minimum travel times between the depot and ach of the customers in the delivery set, and also to find the minimum travel times between the ustomers. This data creates a complete undirected graph, G, connecting all of the customers and he depot with costs defined as travel times.

Step 2: Suppose now that you find the minimum cost tree on G that excludes exactly one node, which in this case is node 3. Let $1TREE^*$ be this tree, with cost $C(1TREE_3^*) = \sum_{\text{edges } e \text{ of } 1TREE_3^*} c_e$ equal to 2.29 hours. Suppose that you then print out the costs of the arcs adjacent to node 3 (in no particular order) and they turn out to be: (0.21, 1.54, 0.79, 0.31).

a) Without any additional computation, you run to Joan to tell her that she's already found the optimal tour! Are you correct, or have you made a grave mistake? If you think Joan has found the optimal TSP tour, explain precisely why using your knowledge of trees, minimum spanning trees, and TSP tours. Otherwise, explain precisely why not. (1.5 points)

b) Suppose that later in your consulting assignment with Sears, you use Concorde heuristic to solve a TSP problem, and the resulting tour T has a cost of $C(T) = 48$. Working on the same problem, your co-worker claims to have found a tour S with a cost $C(S) = 51$. You turn to your co-worker, and tell her that she has made a mistake. Explain (1.5 points)

$C^H \leq \lceil 1.5 \times opt$

$C(T) = 4.2 \qquad C(BS) = 3.1$

3.

Christofide $\rightarrow$ 1.5×2.81

$= 4.215$

$C^H \leq 1.5 \times 2.81 = 4.215$ 4.2 $\rightarrow$ closer to optimal and more precise, that's why c(T) is better.

An electronics manufacturer ships partially assembled circuit boards (hereafter called units) from an assembly plant in Jordan to a distribution center in UK. We want to determine which transportation mode is lower in terms of total shipping cost. There are two options for shipping: the first is to ship in 40ft containers by ocean carriers or in airline containers by air carriers. Shipment by ocean costs $10,000 per container, and a 40ft container can hold 4,500 units. The handling cost is $1500 per 40ft container. The journey by sea takes 20 days on average. Shipment by air costs $20,000 per container, and an airline container can hold 1,400 units. The handling cost is $800 per airline container. The journey by air takes 2 days on average (door to door). The forecasted demand is 120,000 units for the next year, which is also the planned production quantity. No safety stock is kept at the assembly plant, and a shipment is sent to the distribution center as soon as a container is filled. Safety stock of 500 units is kept at the distribution center. A unit is valued at $500 at the assembly plant and $700 at the distribution center. The inventory holding cost rate is estimated at 15% of the value per year. The space cost is estimated as $30/unit*year at the assembly plant and $40/unit*year at the distribution center.

Which transportation mode is more economical in terms of total annual (transportation and inventory) cost? (Show your work for all cost elements and find the optimum shipment size). In the table below, fill in the optimal shipment size for the ocean mode (round to the nearest integer).

Answer:

demands 120,000 units for the next year
Plant: OS.S Center: 800 S.S

Ocean: Shipment Cost = $10000/Container
Container Can hold 4500 units
20 days

Air: Shipment Cost = $20000 /Container
Container Can hold 1400 units
2 days

Inventory Costs
Value of unit at Plant = $500 /unit
Value of unit at dist. center = $700/unit
Inventory holding cost rate = 15% of value per year
Plant space cost = $30 /unit•year
Center // // = $40 /unit•year