AdTrans project , 2023-1-PL01-KA220-HED-000158917

ADTRANS
ADVANCED DATA ANALYSIS FOR TRANSPORTATION AND MOBILITY ACADEMIC TEACHERS

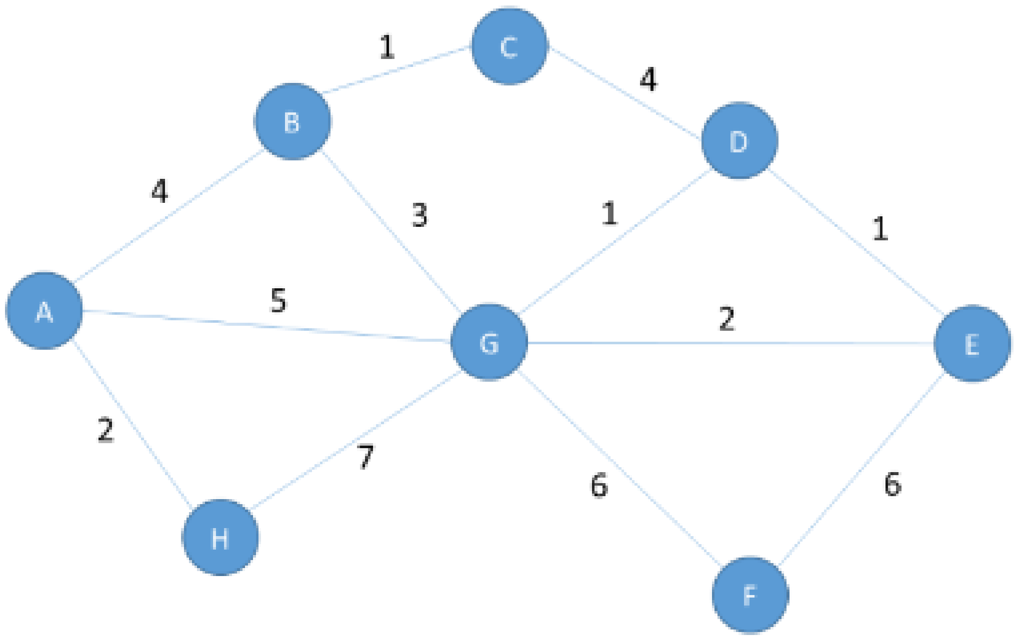
Operational Research - Graphs

Lukasz Jelinski

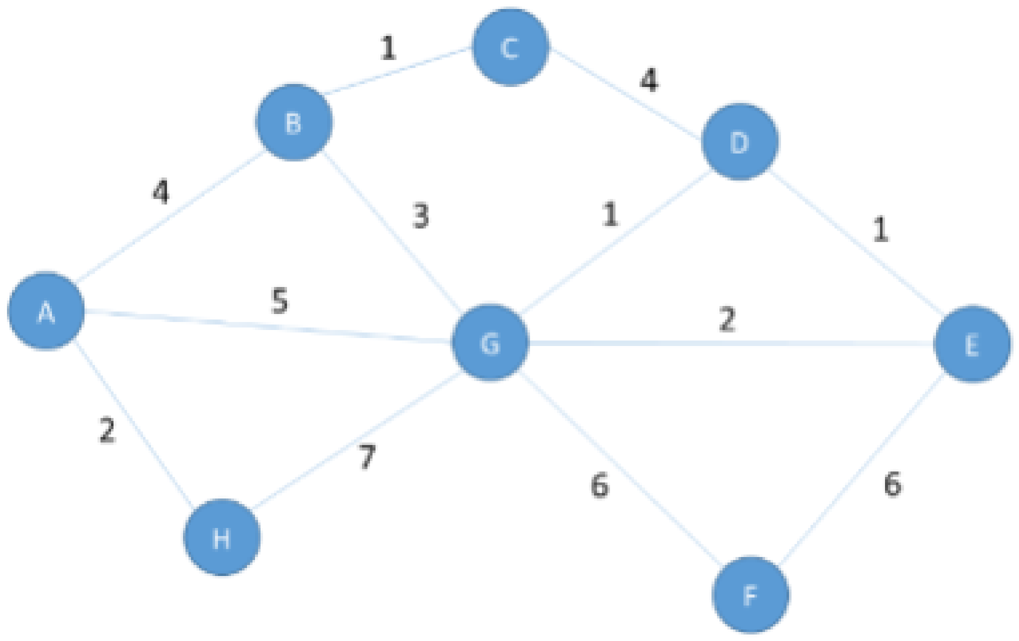
Co-funded by the European Union

Task 3a

3 a) Solve the Chinese Postman Problem for the graph:

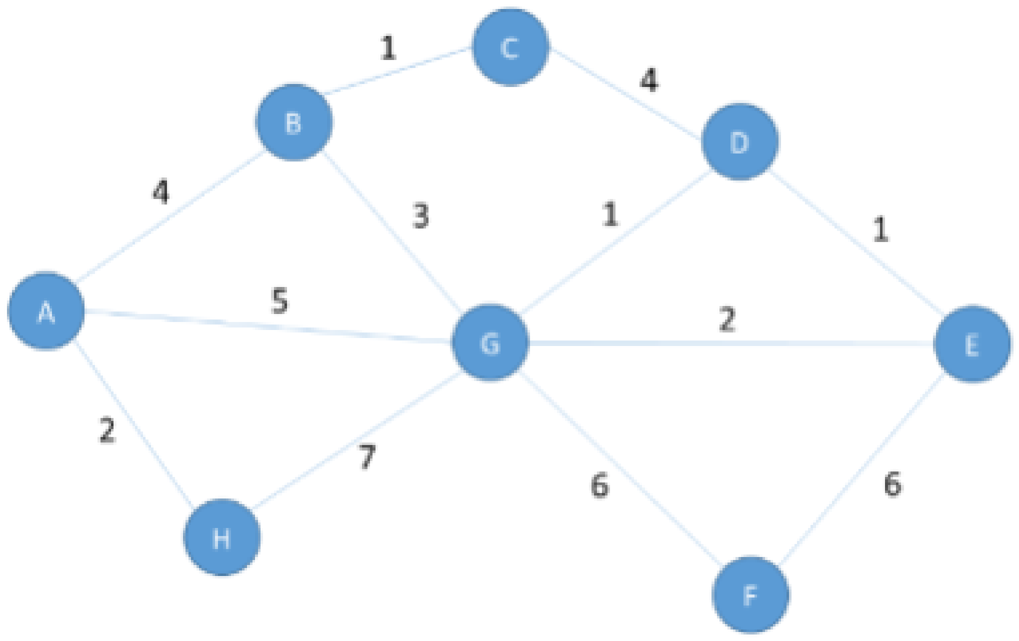


Task 3



1. Is the graph Eulerian? – No, some vertices have odd degree
2. We are looking for vertices with odd degree: ABDE
3. We connect them in pairs and look for the shortest paths

Task 3

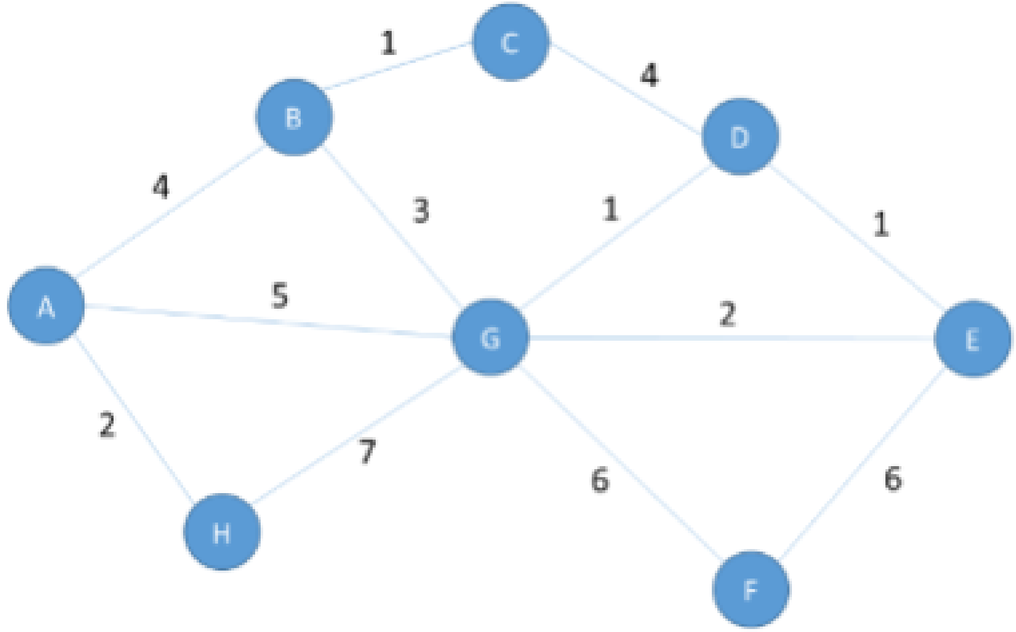


Lowest cost???

Couples	The lowest cost
AB DE	4 1
AD* BE*	6 5
AE* BD*	7 4

* indirect connection

Task 3



4. We duplicate the paths on AB and DE – now the graph is Eulerian
5. Total cost in the problem = sum of edges + sum of duplicate edges

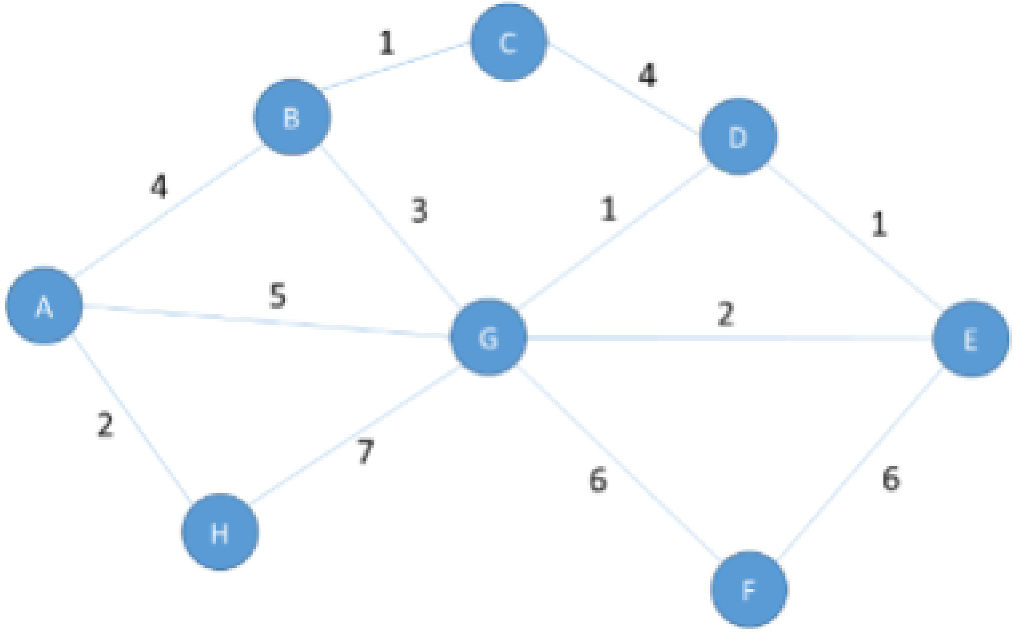
Sum of edges = 42
Total Edge Area = 5

Total cost = 42+5 47

This is the minimum cost of transition
from the starting point
through all edges
and return to the starting point

6. Route planning

Task 3



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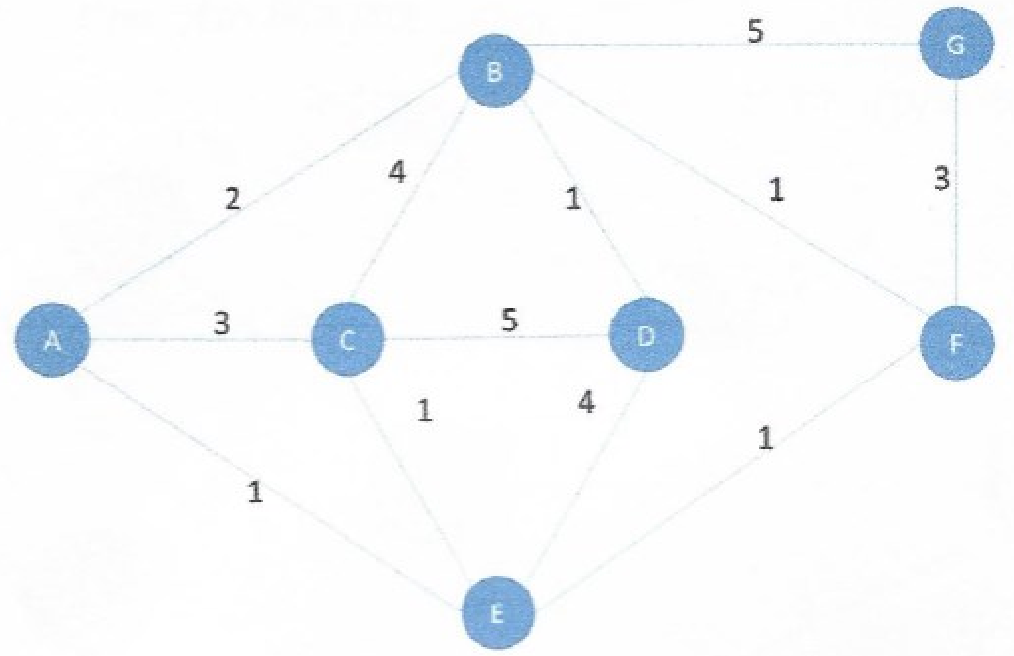
AHGFEGABGDEDC

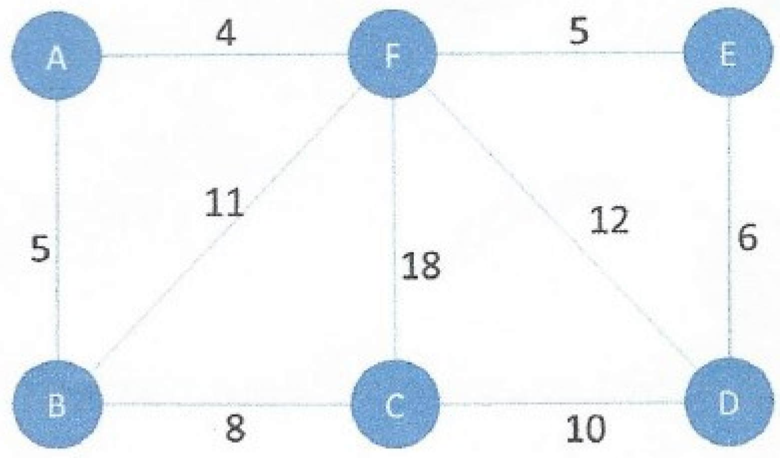
Task 3b

3 b) Solve the Chinese Postman Problem for the graph:



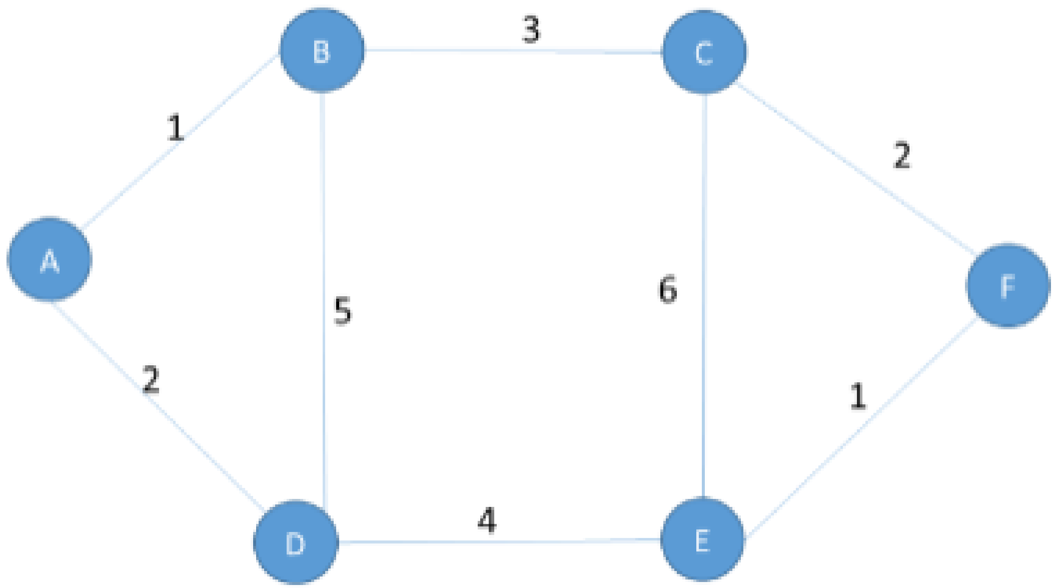
Task 3c

3 c) Solve the Chinese Postman Problem for the graph:



Task 3d

3 d) Solve the Chinese Postman Problem for the graph:



Task 4

Determine the maximum number of trucks that we can send from point s to point t, taking into account road capacity.

Fulkerson algorithm

Assumptions:

- The flow in the channel cannot exceed its capacity.
- Residual network - difference: capacity - flow

⬇

we have some spare capacity

⬇

when the stock is 0, we can't let any more flow through it

Network flow: the sum of flows from source s to all other nodes of the network

maximum flow = minimum throughput

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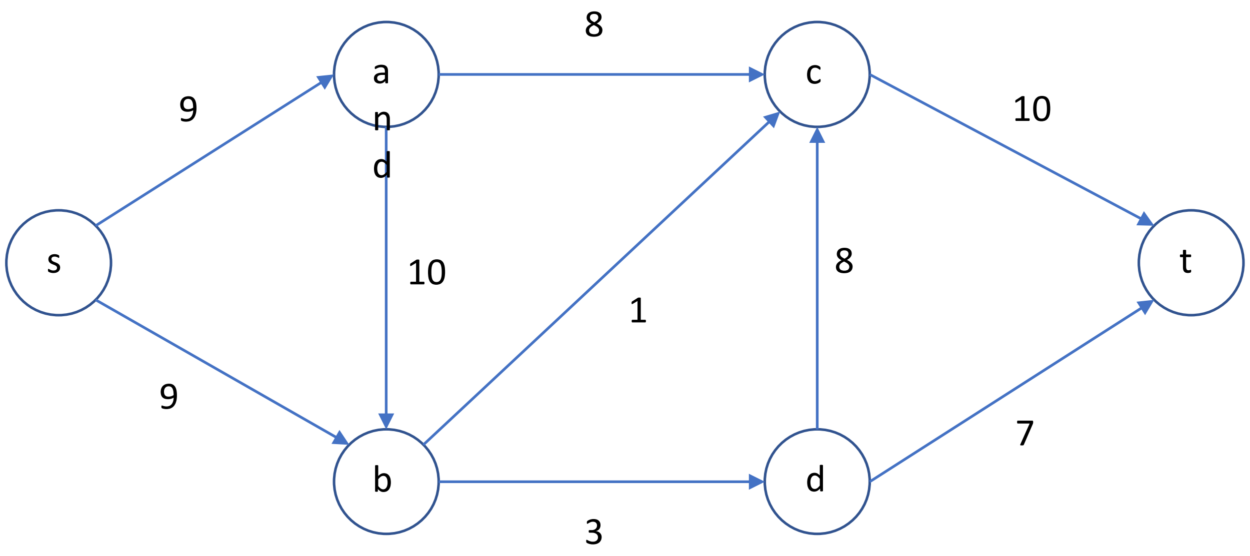

1) We are looking for a path with the smallest number of edges e.g. s – a – c – t

- I determine the smallest throughput = 8 ⇒ f(u,v)=8
- We add it from the maximum flow Fm = 0+8 and update the graph

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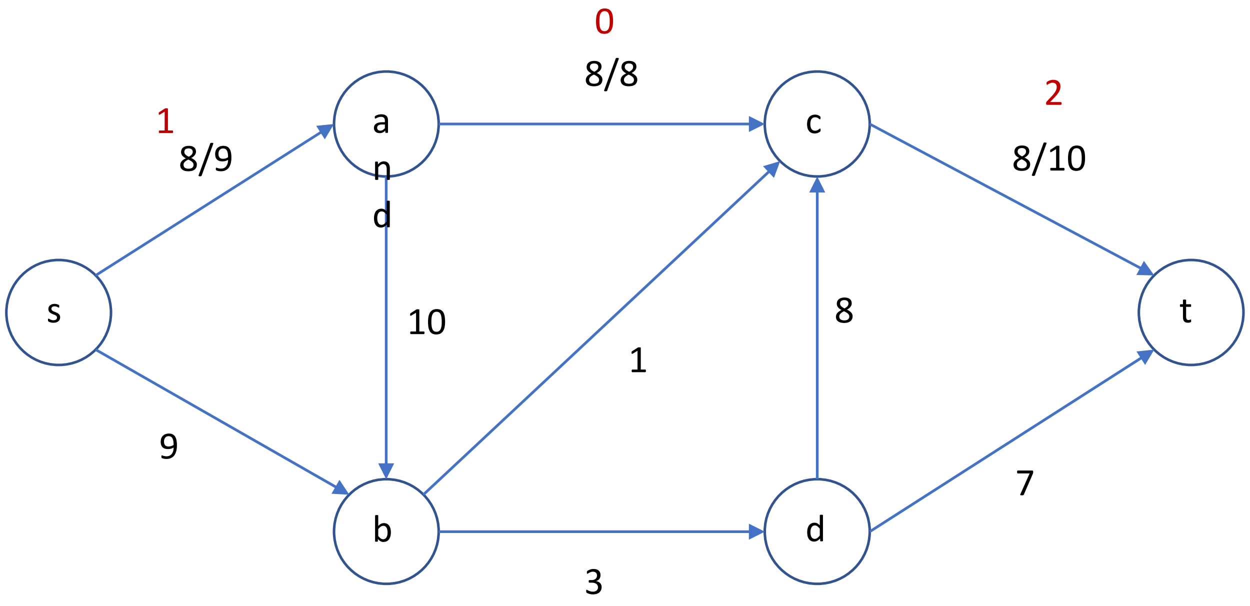

2) We look for the next path with the smallest number of edges e.g. s – b – d – t

- I determine the smallest throughput = 3 ⇒ f(u,v)=3
- We add it from the maximum flow Fm = 0+8+3 and update the graph

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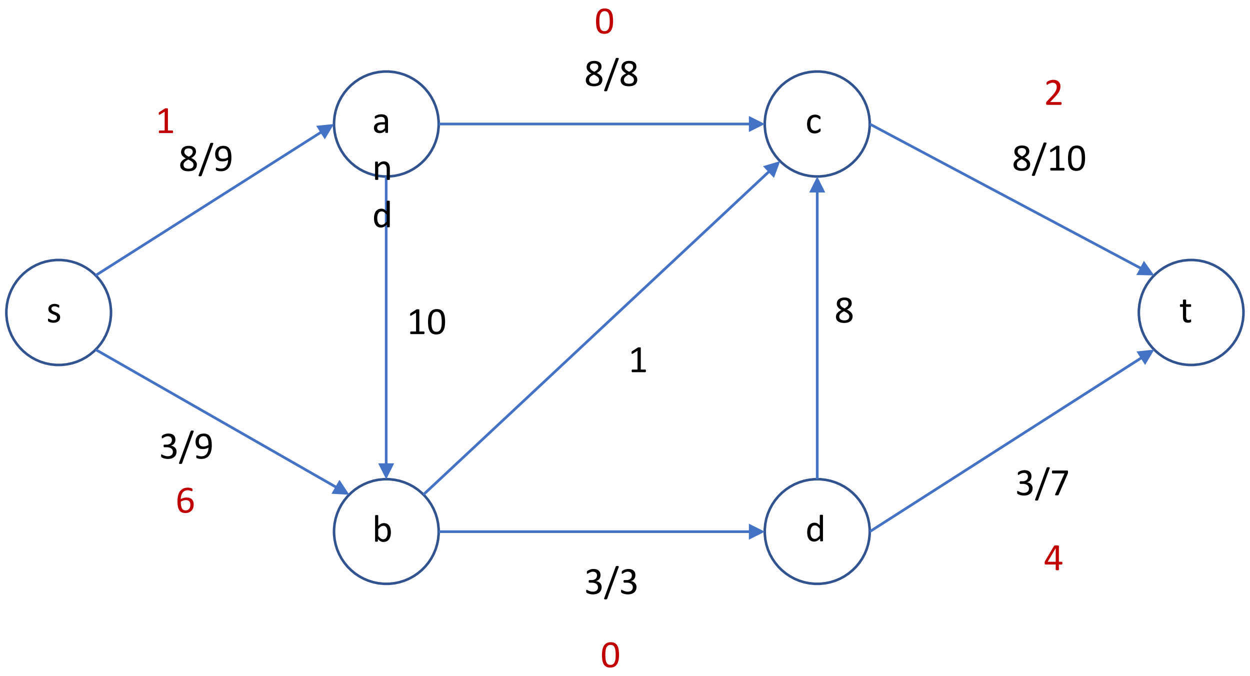

3) We look for the next path with the smallest number of edges e.g. s – b – c – t

- I determine the smallest throughput = 1 ⇒ f(u,v)=1
- We add it from the maximum flow Fm = 0+8+3+1 and update the graph

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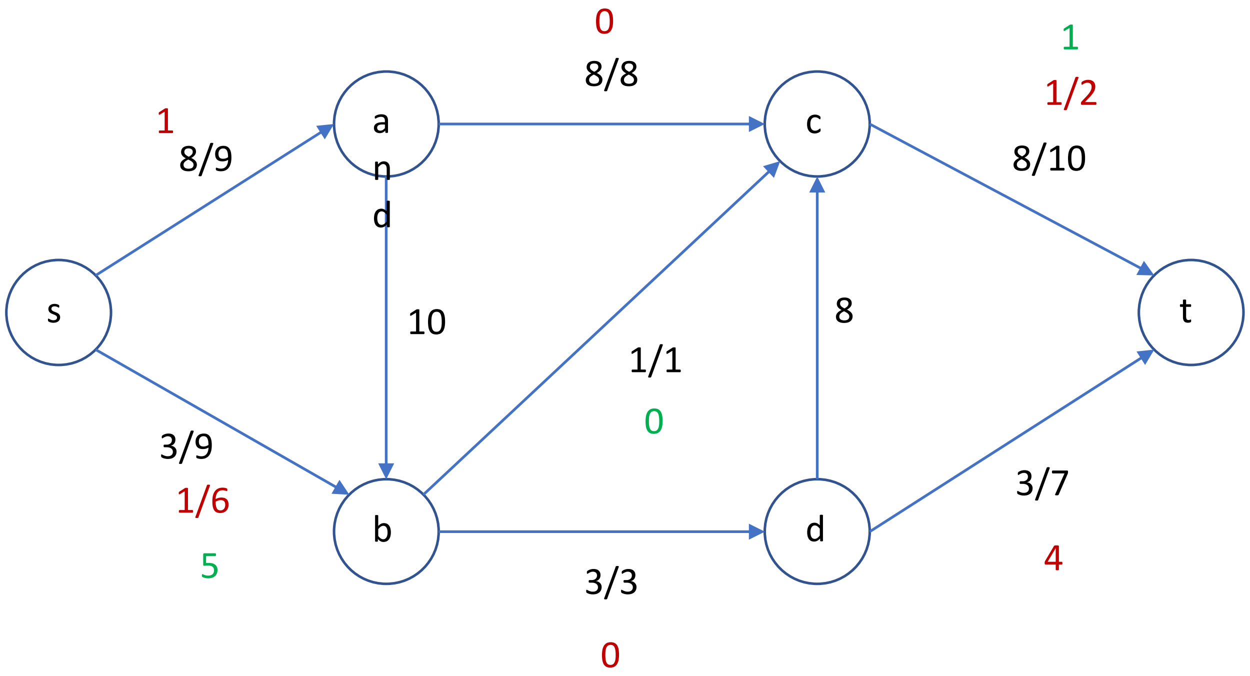

4) We look for the next path with the smallest number of edges e.g. s – b – c – t

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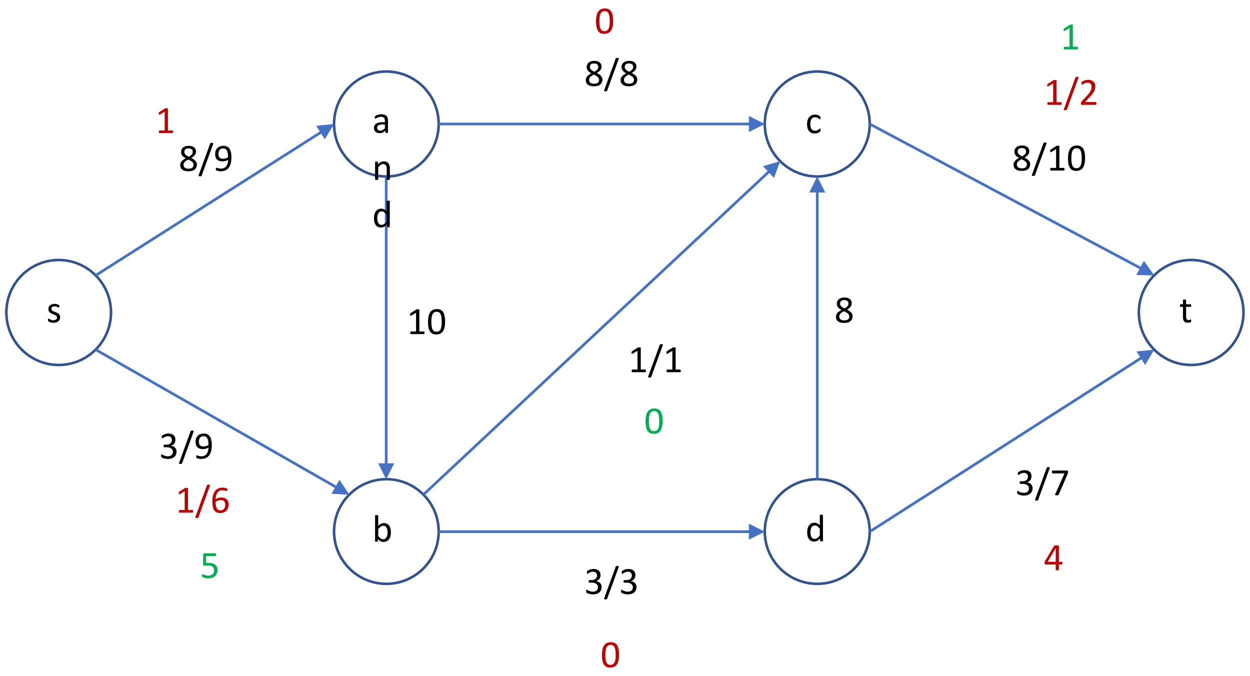

5) No paths - end of algorithm
6) Maximum flow is
 Fm = 0+8+3+1=12
7) Flow distribution: GRAF
8) Minimum network cross-section?

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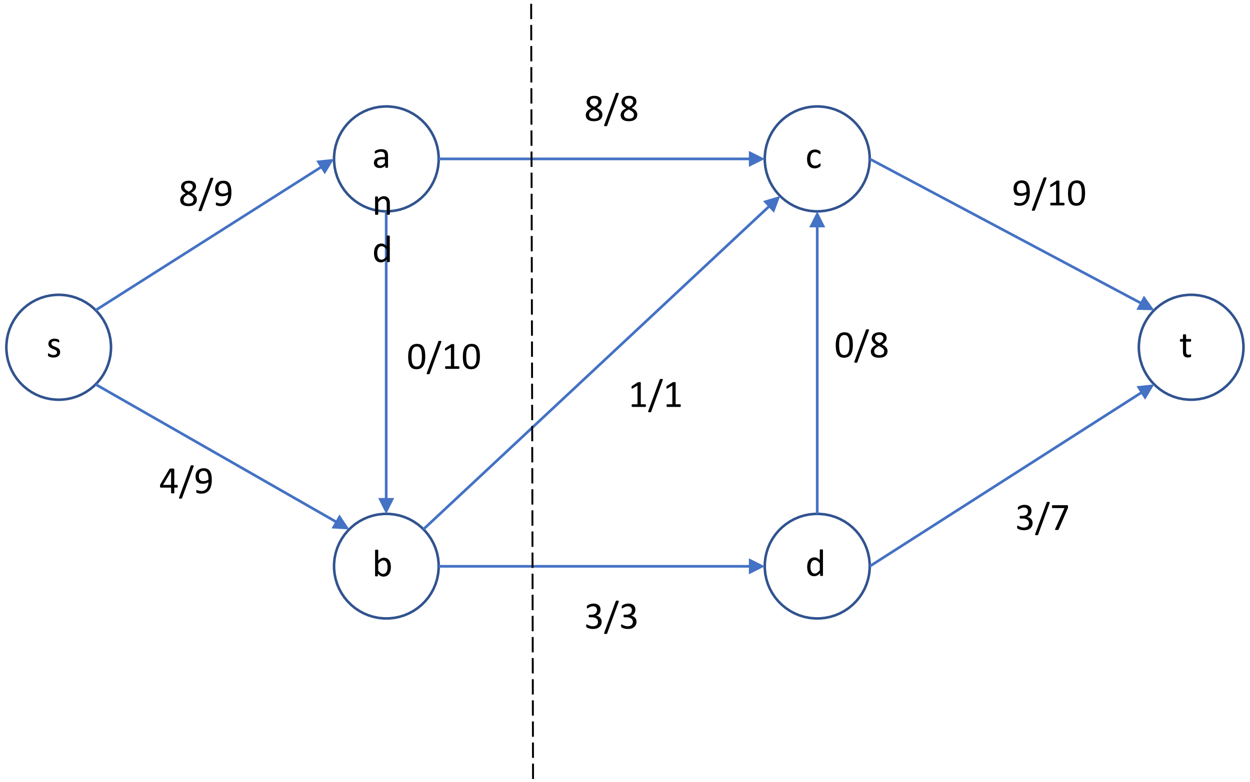

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Fm = 0+8+3+1=12
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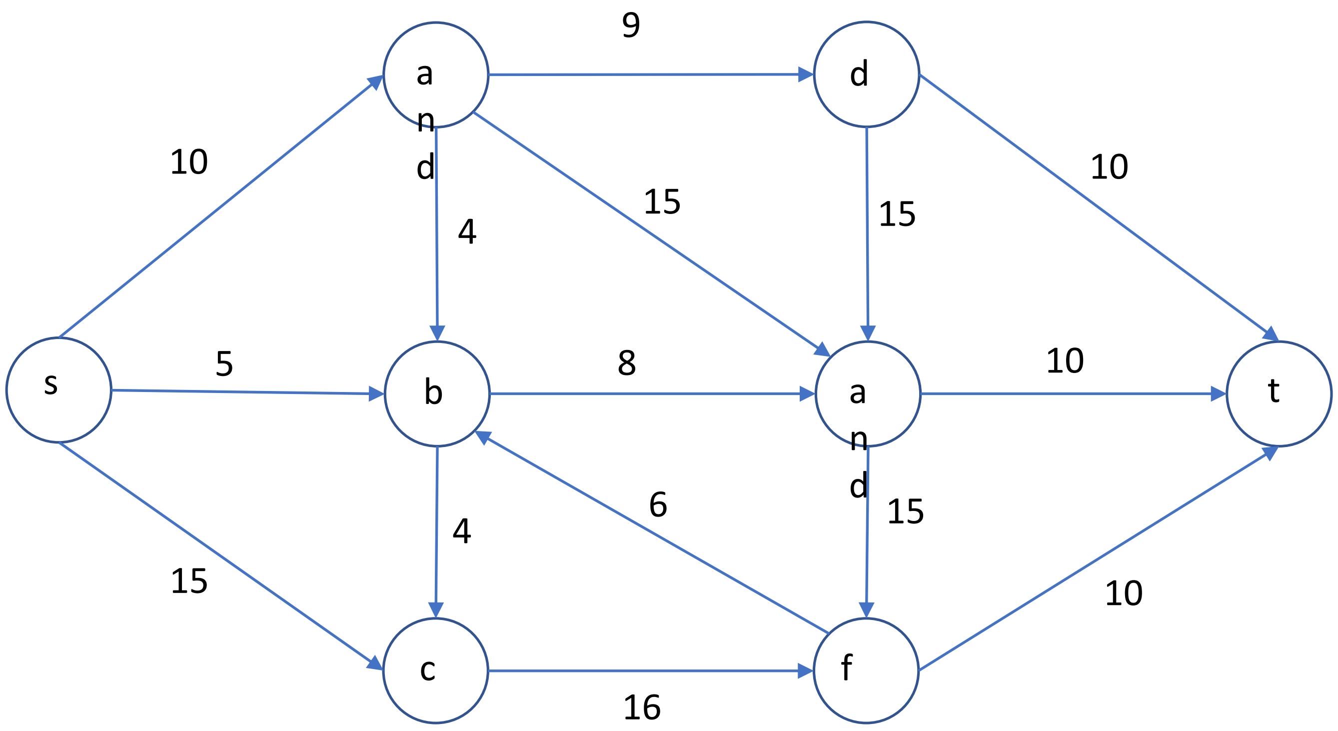
8) Minimum network cross-section?

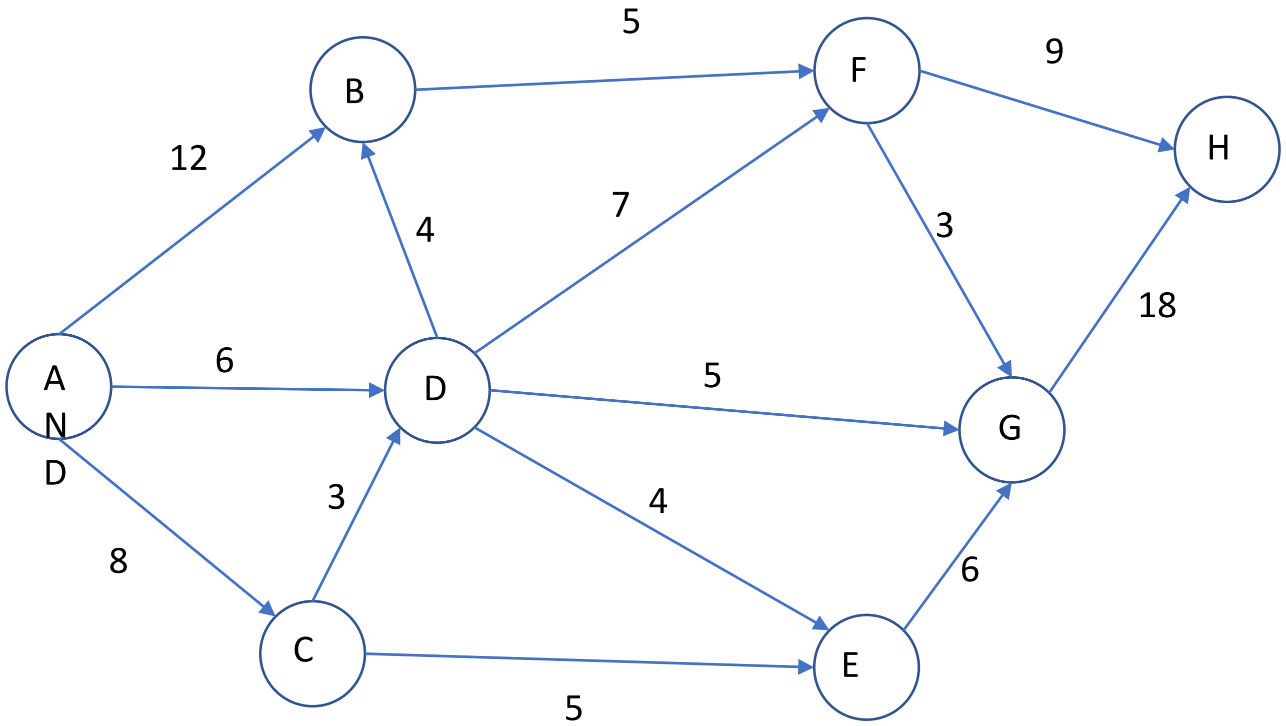
Task 5

Determine the maximum number of trucks that we can send from point s to point t, taking into account road capacity. Mark the minimum cross-section of the network.



Task 6

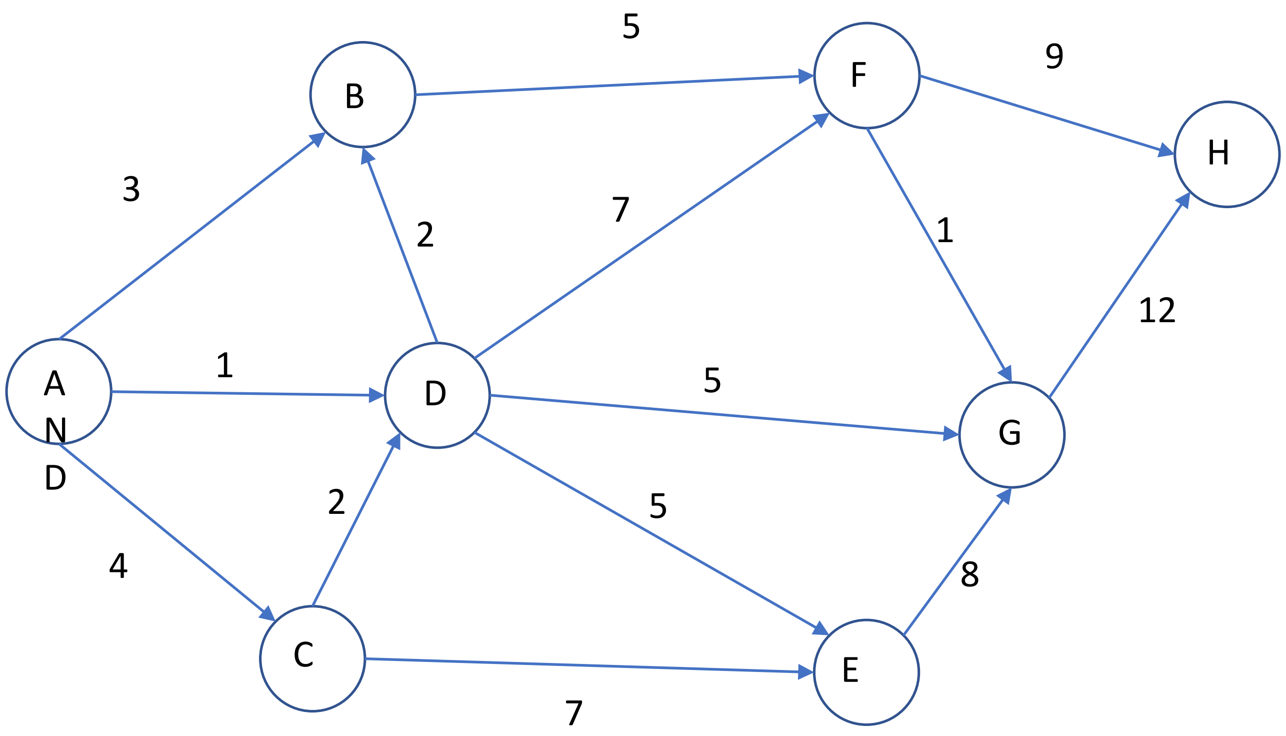
Given a flow network defined by the graph:



Determine the flow distribution in the network. Determine the maximum flow and determine the minimum cross-section of the network. Are there any connections in the network that can be eliminated without changing the flow? Define these connections

Task 7

Given a flow network defined by the graph:



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Sources:

- Materials from the subject posted on the eNauczanie website : Z. Kędra
- Z. Jędrzejczyk, J. Skrzypek, K. Kukuła, A. Walkosz : Operational research in examples and tasks. PWN. Warsaw, 1996
- M. Glinka: Elements of operational research in transport. Radom University of Technology Publishing House. Radom, 2009
- Other books and textbooks on Operational Research available in the PG Library