# CSCI 335
# Software Design and Analysis III
# Lecture 24:
# Ford-Fulkerson (lecture 22 background)

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# Agenda

- Ford-Fulkerson
- Minimum Spanning Trees
- DFS

# Definitions (lecture 22 addendum)

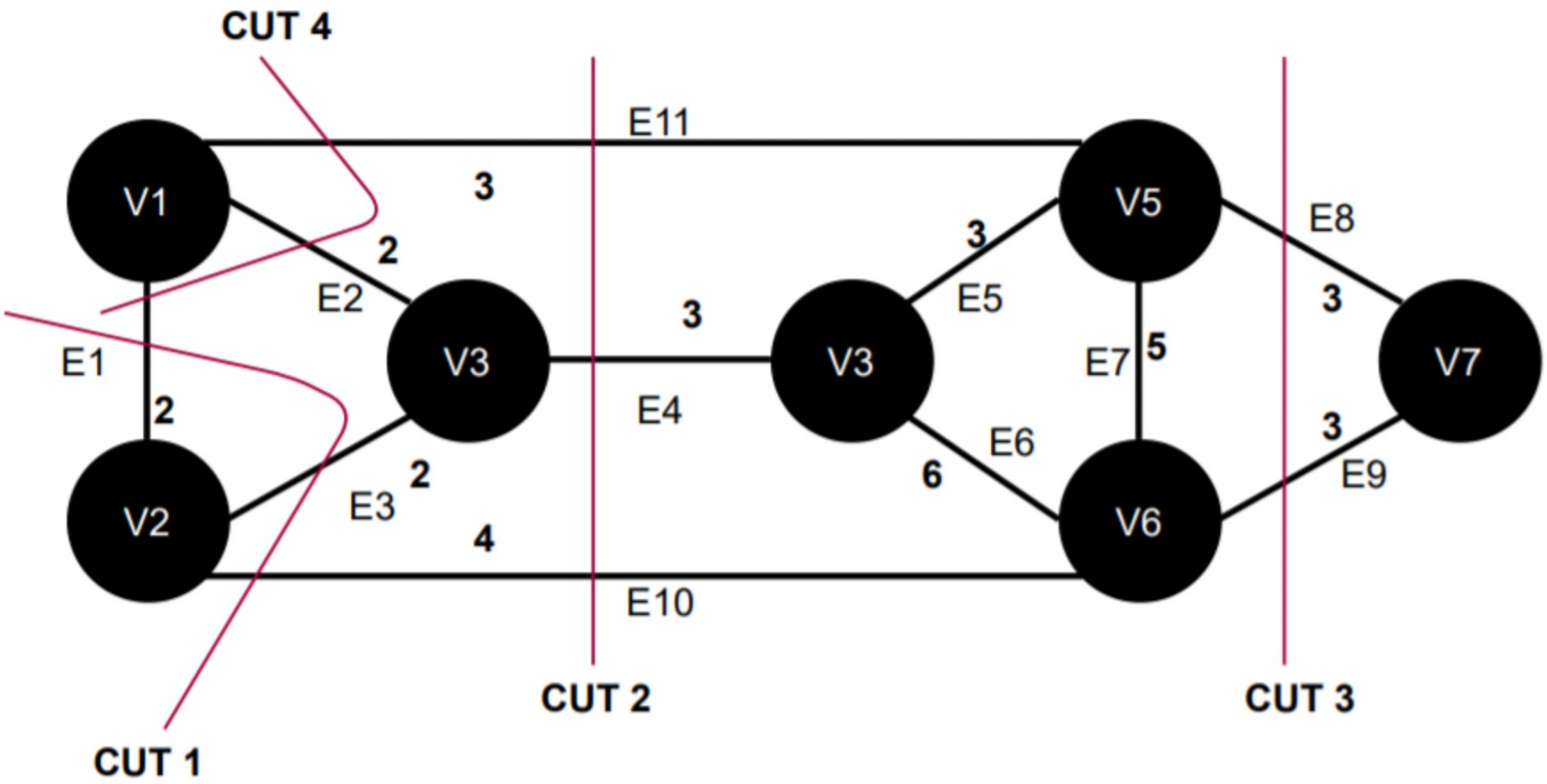
- Maximum flow :
  - maximum amount of flow that the graph or network would allow to flow from the source node to its sink node

- Minimum cut of a weighted graph:
  - minimum sum of weights of edges that, when removed from the graph, divide the graph into two sets.

# Max-Flow Min-Cut theorem

- CS and optimization theory
- In a flow network, **the maximum amount of flow passing from the source to the sink is equal to the total weight of the edges in a minimum cut**
  - i.e., the smallest total weight of the edges which if removed would disconnect the source from the sink
- This theorem can be verified using the Ford-Fulkerson algorithm. This algorithm finds the maximum flow of a network or graph.

# Example


CUT 4
E11
V1
3
V5
E8
2
3
E2
E5
3
V3
3
V3
E7
5
V7
E1
E4
2
E6
3
6
E9
2
E3
V2
4
V6
E10
CUT 2
CUT 3
CUT 1

# Ford-Fulkerson algorithm

- Based on three important concepts:
  - the residual network
  - augmented path
  - Min-cut.
- Main idea:
  - starts with a workable flow through the graph, and the flow is improved iteratively.
  - If this flow is maximum, it makes it possible to determine
    - the flow function satisfying this value
    - as well as the minimum cut.
  - If the flow is not maximum, its objective is to highlight an improving path corresponding to this flow.
  - Initially, the algorithm starts by setting the flow value between the source and sink node to 0.
  - **At each iteration, we find an augmented path and increase the flow value.**
  - We'll terminate the algorithm and return the flow value when no more augmented paths can be found