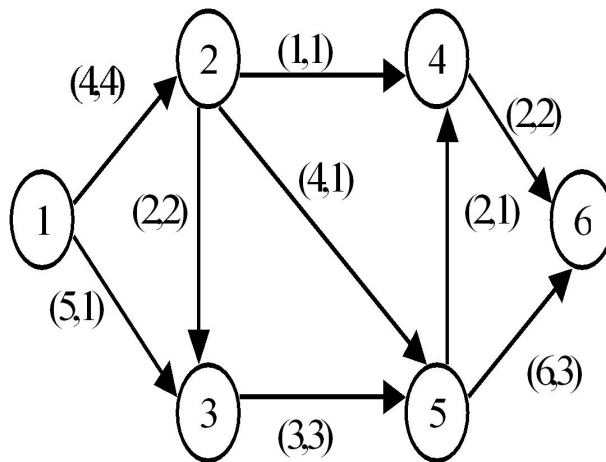


MP305 Practical 2022/2023 - Network Flows I

- The Python notebook `Network_Flows_I` that contains the maximal network flow algorithm can be accessed via any web browser. See the **MP305 Blackboard** web page for details and instructions.
- Solutions to **all** questions with (*) have to be submitted as a pdf document through Blackboard. You must include some text commentary (in Python notebook Markdown cells) to explain your answers to the questions asked.
- This practical is worth 3% of your final grade.

1. Find the maximal flow for minimal capacity for the network below where the capacity $c(i, j)$ and the flow $\phi(i, j)$ is shown on each arc (i, j) :

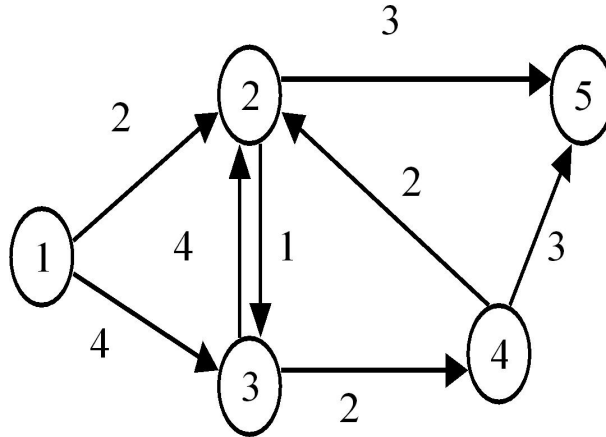


This is the example discussed in the lecture notes. You may read in the data for this example from the Python notebook `Network_Flows_I`. See the **MP305 Blackboard** web page for details and instructions.

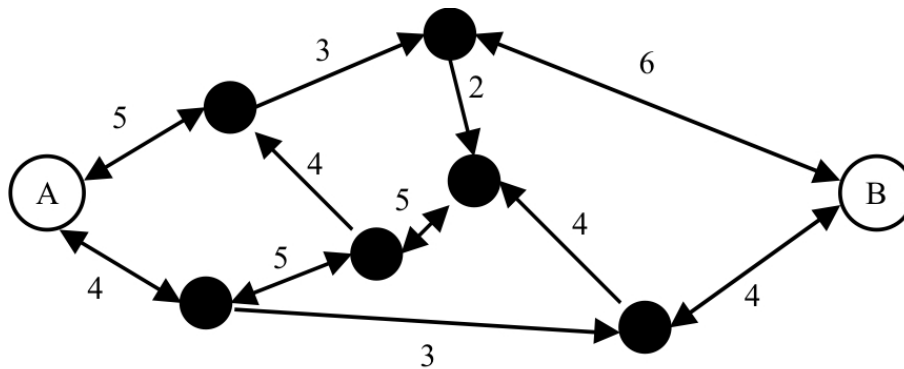
- (a) Find the incremental network and capacities at each iteration of the Ford Fulkerson algorithm.
- (b) In the **last** iteration when the maximal flow is found, identify which arcs are normal and which are inverted in the incremental network.
- (c) Hence find the minimal capacity cut of this network flow model.

In the following two problems, first define the network and its capacities following the template of problem 1 and then run the Python code.

2. (*) Find the maximal flow through the following network with the given capacities:



- Set the initial flow to 0 at each arc and find the incremental network and capacities at each iteration of the Ford-Fulkerson algorithm.
 - In the **last** iteration when the maximal flow is found, identify which arcs are normal and which are inverted in the incremental network.
 - Hence find the minimal capacity cut of this network flow model.
3. (*) A road network is shown below with the capacity on each road indicated. Notice that many roads are two way.



- Find the maximal flow through the network from A to B .
- Compare this to maximal flow from B to A .