

## HW1

### Network Analytics

Due: 25 Nov 2015

These questions have to be done by yourself without consultation.

*Programming:* You are allowed to consult on the programming part with your colleagues and on the web but the final code has to be written and debugged entirely on your own. You cannot use existing code snippets on the web unless explicitly allowed in the question.

**Submission Instructions:** Submit individual and group parts separately. The file names should be as follows: **LastName\_FirstName\_HW#.xxx** (either .word or .pdf or .xls),

1.

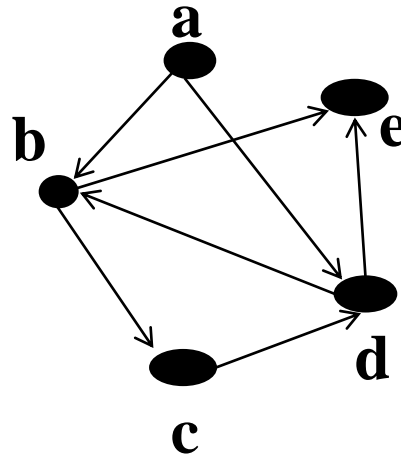
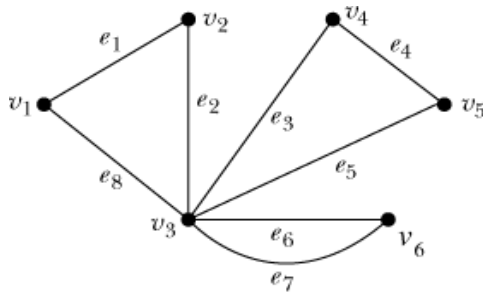
- a. If  $G=(V,E)$  is a graph with  $m$  edges, then show

$$\sum_v \deg(v) = 2m = 2 |E|$$

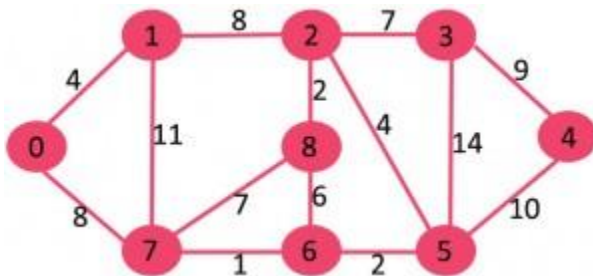
- b. If  $G$  is a digraph then show

$$\sum_v \text{indegree}(v) = \sum_v \text{outdegree}(v) = |E|$$

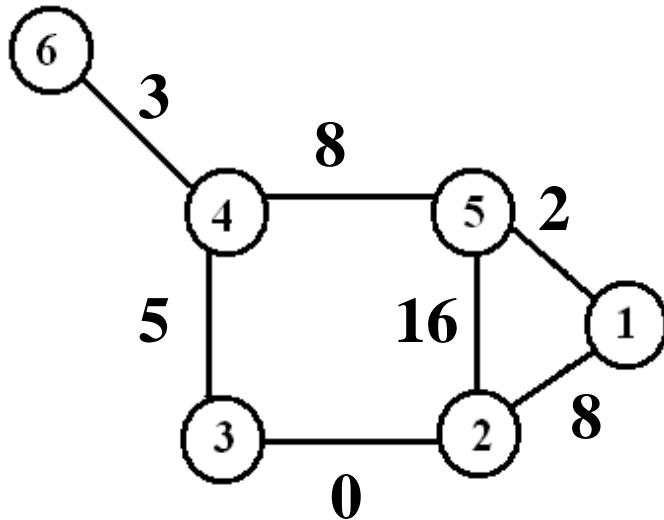
2. Write the incidence matrices of the following graphs:



3. Find the **max**-cost spanning tree in this graph



4. Find the shortest path from node 1 to 6 in this graph using Dijkstra's algorithm



6. Program your algorithms for 3 and 4 in Python.

The network structures are given in the files HW1\_3.txt and HW1\_4.txt with the following format:

```
nodeIndex      nodeIndex  cost on edge
```

7. Solve 3 and 4 calling the spanning tree and shortest path subroutines (Dijkstra as well as the all-pairs shortest path via Floyd-Warshall algorithm) from the NetworkX Python library.

8. Read the handout of excerpts from “Structure and Dynamics of Networks” for class discussion next week:

despite all the progress and focus from various fields (math, statistics, physics, sociology, computer science, operations research, economics) what questions on networks remain both “Interesting” and “challenging” for businesses and why?