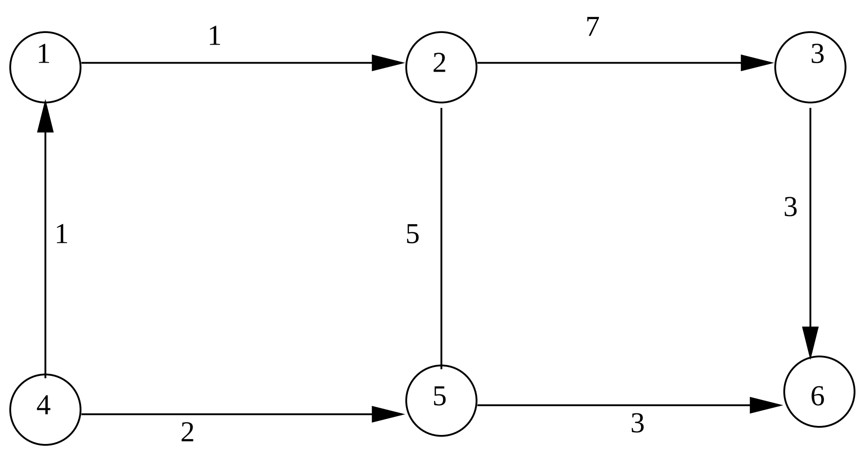
CAD of Digital Circuits — Physical Design

Spring 2014, Homework # 1
Due Date: Friday, Feb 7^{th} (in class)
Late assignments will not be accepted

1) You are asked to write a tutorial paper, in your own words, describing the MinCut/MaxFlow problem. The paper should be no more than 4 pages long, double-column format, 10 pt or larger font (IEEE or ACM conference proceedings style). Feel free to refer to any textbook, class notes, tutorials on the web — no constraints.
   a) You may create your own example to demonstrate the problem.
   b) To obtain a solution to this problem, describe a (MI)LP formulation of the max-flow problem, and then describe the min-cut formulation. [Make sure to describe clearly what each variable and constraint represents, and what is the optimization objective]
   c) Demonstrate the application of each of the (MI)LP formulations (maxflow and mincut) on the network of Fig 1. Vertices 4 and 6 are the source and sink, respectively. The edge $(2, 5) = (5, 2)$ is undirected, so some transformations are necessary to convert the problem to a directed network. Finally, redo the problem for edge capacity $(2, 5) = (5, 2) = 3$.



2) Consider the following transportation problem. Quantities $a_1, \ldots, a_m$ of a product are being shipped from each of m locations and received in amounts $b_1, \ldots, b_n$ at each of n destitations. Associated with the shipping of a unit of a product from origin i to destination j is a unit shipping cost c_{ij}. It is desired to determine the amounts x_{ij} to be shipped between each origin-destination pait $(i, j), i = 1, \ldots, m; j = 1, \ldots, n$, so as to satisfy the shipping requirements and minimize the total cost of transportation of the product.
   a) Formulate the problem as a linear programming problem.
   b) Solve the problem for the following data:

$$\mathbf{a} = [25 \quad 25 \quad 50]^T; \ \mathbf{b} = [15 \quad 20 \quad 30 \quad 35]^T;$$

$$C = \begin{pmatrix} 10 & 5 & 6 & 7 \\ 8 & 2 & 7 & 6 \\ 9 & 3 & 4 & 8 \end{pmatrix}$$

c) Formulate and solve the dual problem for the above primal problem. Compare the primal and dual results.

d) For every integer vector **a, b**, prove that the optimal solution to this problem is always integer.

3) Floorplanning using MILP: Consider 5 modules that are to be floor-placed in *any* orientation on a chip. The chip width cannot exceed 3 units, and the height of the floorplan is to be minimized. The width (W) and height (H) of each module is given (in same units) as:

- Module 1: W = 1, H = 1;
- Module 2: W = 1, H = 1;
- Module 3: W = 2, H = 1;
- Module 4: W = 2, H = 1;
- Module 5: W = 1, H = 3;

Formulate the problem (clearly!) as a MILP, and obtain a feasible solution to the floorplan, and depict the solution using a figure.