

## CET 513 Transportation Networks and Optimization

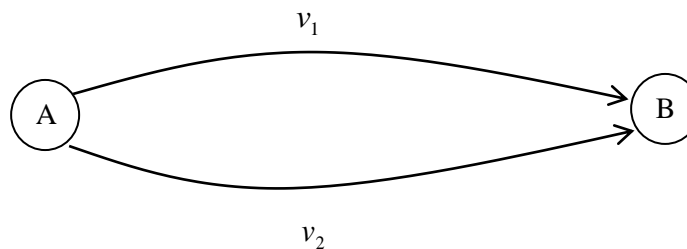
### Homework #1

Out: 10/01/2019

Due: 10/15/2019

#### Problem 1

Two parallel highways connect two cities A and B and their performance functions are  $t_1 = 1 + 0.01v_1$  and  $t_2 = 10 + 0.005v_2$  respectively, where  $t_1$  and  $t_2$  are travel times (in minutes) and  $v_1$  and  $v_2$  are traffic flows (in vehicles). The total demand between two cities is 3900 vehicles.



Assume that there is a route guidance system and every driver follows the route-choice advices from the system. Formulate an optimization problem to determine the optimal routing strategy for the system (i.e., the flow distribution  $v_1$  and  $v_2$ ) to minimize the total system travel time. Solve the problem using Python (preferred). Excel or Matlab may also be used.

#### Problem 2

A logistics company is interested in maximizing its weekly profits. A total of 160 hours of labor are available each week at \$15/hour. Additional labor can be purchased at \$25/hour. Capital (trucks) can be leased (in unlimited quantities) at a cost of \$5/hour. If  $K$  units of capital and  $L$  units of labor are available during a week, then the quantity of goods transported is:

$$Q = L^{1/2} K^{1/3}$$

where  $Q$  is in units of items per week. Each item is transported for a price of \$80. Formulate an optimization problem to determine the quantities of  $K$  and  $L$  needed to maximize the company's weekly profits. Solve the problem using Python (preferred). Excel or Matlab may also be used.

#### Problem 3

For the problem below, identify the following problem components:

- (a) decision variables;

- (b) parameters;
- (c) the objective function in words; and
- (d) constraints in words.

A singly reinforced rectangular concrete beam must carry a known imposed moment and shear. The span length is also known, and the deflection of the beam must not exceed a certain value. The width and depth of the beam are to be determined, as is the area of steel to be placed in the bottom of the beam. The cost of concrete per-cubic yard and the cost of steel per-pound is known, as is the compressive strength of the concrete and yield strength of the steel. The designer wants to design the least-cost beam. The code for such beams states that a certain minimum amount of steel, as a percent of the total effective cross sectional area, must be present in order to avoid excessive cracking on the bottom of the beam due to temperature fluctuations. The code also gives a limit on the maximum amount of steel, again expressed as a percentage of the total effective cross sectional area of the beam, that can be present to avoid sudden compressive failure in the concrete at the top of the beam.

#### Problem 4

List three personal decisions you have made in the last 24 hours that could be specified within the framework of optimization (e.g., selecting what to wear today). List the objectives and constraints you considered in identifying alternatives and making your decisions.