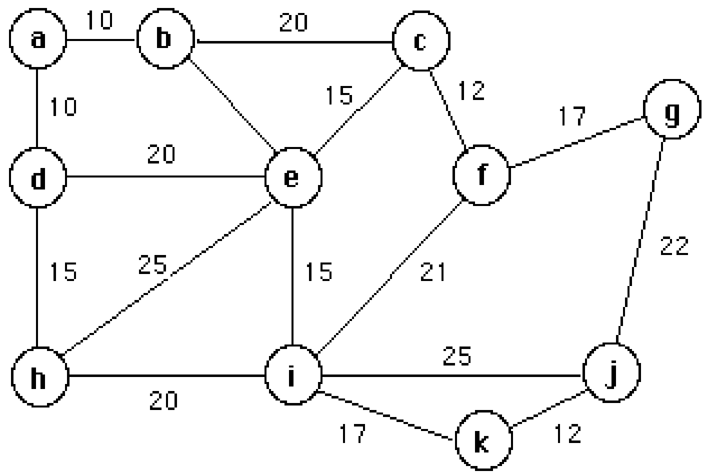
Name ____________________________

56:272 Integer Programming & Network Flows
Quiz #7 – Fall 2003

1. ***Chinese Postman Problem*** Consider the **un**directed street network below:



a. Indicate the degree of every node (intersection).
The postman wishes to find the shortest tour of the network which travels each street *at least once*.
e. By inspection ("eye-balling it"), select the streets which should be traveled more than once.

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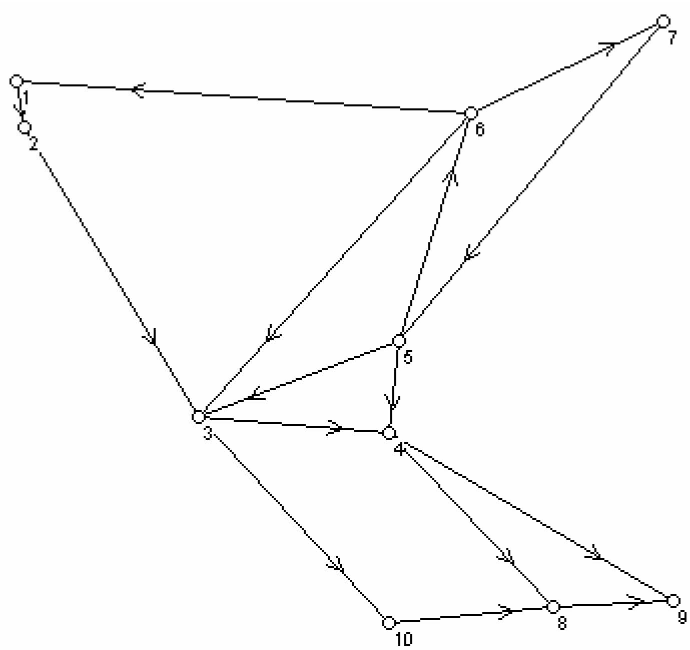
2. Consider the street network show below, where the streets are one-way as indicated:



You are to find the shortest route for a garbage truck which is to leave the city garage at the intersection #1, travel each street in the direction indicated in order to collect garbage, and deliver its load to the landfill at the intersection #9, and then return to the garage. (The truck may travel *either* way on the streets when "dead-heading", i.e., not picking up the garbage.)

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a. If non-zero, write the polarity of each intersection 1 through 10 on the map.
b. Assuming distances are drawn to scale, indicate on which streets you would "dead-head" in order to travel the shortest distance.

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3. Pipes of length 19 feet are kept in stock for use in manufacturing. Today's production schedule requires 2 pieces of length 3 feet, 9 of length 8 feet, and 4 of length 10 feet.

```
                                 Stock Pieces
                                  i  L  C
                                  1 19 40

                                 Requirements
                                  j  L R
                                  1  3 2
                                  2  8 9
                                  3 10 4
(L = length, R = required number of pieces)

The following patterns were initially suggested for cutting the pipes:
     Pattern no.   Cost  ---Pattern---
      1              40     0 1 1
      2              40     6 0 0
      3              40     1 2 0
```

a. Let Xi be the number of pipes cut using pattern #i. Then the LP which could be used to fill the requirements at lowest cost has the tableau:

X1	X2	X3		RHS
				(MIN)

Indicate the coefficients and, in the shaded column, "=", "≤", or "≥".

The LP solution, ignoring the integer restriction on Xi, is:

```
                                  LP Solution
Cost= 373.33333

              Pattern #   Stock #   ---Pattern---   Times Used
               1           1          0 1 1          9
               2           1          6 0 0          0.33333333

Simplex Multipliers PI (Dual Variables):

                             i      PI[i] S[i]
                             1  6.6666667    0
                             2 40.0000000    0
                             3  0.0000000    5
PI= shadow price, S=surplus
```

c. Write the knapsack problem which might be used to generate a new pattern which would allow a savings:

Minimize ___ a1 + ___ a2 + ___ a3
s.t. ___ a1 + ___ a2 + ___ a3 (circle: ≤, =, ≥) ____

The optimal solution of this knapsack problem is

```
                     i  l a
                     1  3 1
                     2  8 2
                     3 10 0
          l = req'd length, a = # pieces to be cut

This is pattern #3
3 patterns have now been defined.
```

d. The new LP which allows this new pattern to be used, is

X1	X2	X3	X4		RHS
					(MIN)