56:171 Operations Research
Quiz #3 Solutoins -- 20 September 2002

Part I. For each statement, indicate "+"=**true** or "o"=**false**.

__o__ a. When you enter an LP formulation into LINDO, you must first convert all inequalities to equations.

__o__ b. Unlike the ordinary simplex method, the "Revised Simplex Method" never requires the use of artificial variables.

__+__ c. Whether an LP is a minimization or a maximization problem, the first phase of the two-phase method is exactly the same.

__o__ d. At the beginning of the *first* phase of the two-phase simplex method, the phase-one objective function will have the value 0.

__+__ e. At the end of the *first* phase of the two-phase simplex method, the phase-one objective function must be zero if the LP is feasible.

__o__ f. If a zero appears on the right-hand-side of row i of an LP tableau, then at the next iteration you *must* pivot in row i.

__+__g. If an LP model has constraints of the form $Ax \leq b$, $x \geq 0$, and b is nonnegative, then there is no need for artificial variables.

__o__ h. If a zero appears on the right-hand-side of row *i* of an LP tableau, then at the next iteration you *cannot* pivot in row *i*.

__o__ i. Every variable in the “primal” problem has a corresponding dual variable.

__o__ j. The *primal* LP is a *minimization* problem, whereas the *dual* problem is a *maximization* problem.

__+__k. If the slack or surplus variable in a constraint is positive, then the corresponding dual variable must be zero.

__+__ l. If the right-hand-side of constraint *i* in the LP problem “Minimize cx st $Ax \leq b$, $x \geq 0$” increases, then the optimal value must either decrease or remain unchanged.

__o__ m. If the right-hand-side of constraint *i* in the LP problem “Maximize cx st $A \leq b$, $x \geq 0$” increases, then the optimal value must either decrease or remain unchanged.

__o__ n. The revised simplex method usually requires fewer iterations than the ordinary simplex method.

__+__ o. The simplex multipliers at the termination of the revised simplex method are always feasible in the dual LP of the problem being solved.

__+__ p. In the two-phase method, the first phase finds a basic feasible solution to the LP being solved, while the second phase finds the optimal solution.

__+__ q. The original objective function is ignored during phase one of the two-phase method.

__+__ r. If a zero appears in row *i* of the column of substitution rates in the pivot column, then then row *i* cannot be the pivot row.

Part II. Sensitivity analysis using LINDO.

Ken and Larry, Inc., supplies its ice cream parlors with three flavors of ice cream: chocolate, vanilla, and banana. Because of extremely hot weather and a high demand for its products, the company has run short of its supply of ingredients: milk, sugar, & cream. Hence, they will not be able to fill all the orders received from their retail outlets, the ice cream parlors. Owing to these circumstances, the company has decided to choose the amount of each product to produce that will maximize total profit, given the constraints on supply of the basic ingredients.

The chocolate, vanilla, and banana flavors generate, respectively, \$1.00, \$0.90, and \$0.95 per profit per gallon sold. The company has only 200 gallons of milk, 150 pounds of sugar, and 60 gallons of cream left in its inventory. The LP formulation for this problem has variables C, V, and B representing gallons of chocolate, vanilla, and banana ice cream produced, respectively.

```
MAXIMIZE  C+0.9V+0.95B
ST

0.45C + 0.50V + 0.40B <= 200  ! milk resource
0.50C + 0.40V + 0.40B <= 150  ! sugar resource
0.10C + 0.15V + 0.20B <= 60   ! cream resource

END
```

```
        OBJECTIVE FUNCTION VALUE
        1)      341.2500

  VARIABLE        VALUE          REDUCED COST
         C         0.000000          0.037500
         V       300.000000          0.000000
         B        75.000000          0.000000

       ROW   SLACK OR SURPLUS     DUAL PRICES
        2)        20.000000          0.000000
        3)         0.000000          1.875000
        4)         0.000000          1.000000
```

```
RANGES IN WHICH THE BASIS IS UNCHANGED:

                           OBJ COEFFICIENT RANGES
 VARIABLE         CURRENT        ALLOWABLE        ALLOWABLE
                   COEF          INCREASE         DECREASE
        C        1.000000         0.037500         INFINITY
        V        0.900000         0.050000         0.012500
        B        0.950000         0.021429         0.050000

                           RIGHTHAND SIDE RANGES
      ROW         CURRENT        ALLOWABLE        ALLOWABLE
                    RHS          INCREASE         DECREASE
        2      200.000000         INFINITY        20.000000
        3      150.000000        10.000000        30.000000
        4       60.000000        15.000000         3.750000
```

True/False (+ or O):

__+__ 1. If the profit per gallon of chocolate increases to $1.02, the basis and the values of the basic variables will be unchanged.

__o__ 2. If the profit per gallon of vanilla drops to $0.88, the basis and the values of the basic variables will be unchanged.

Multiple choice: *(**NSI** = "not sufficient information")*

_d_ 3. If the amount of cream available were to increase to 65 gallons, the increase in profit will be *(choose nearest value):*

a. $0.00 b. $0.50 c. $1 d. $5 e. $10 f. *NSI*

_a_ 4. If the amount of milk available were to increase to 225 gallons, the increase in profit will be *(choose nearest value):*

a. $0.00 b. $0.50 c. $1 d. $5 e. $10 f. *NSI*

_e_ 5. If the profit per gallon of banana ice cream were to drop to $0.93 per gallon, the loss in total profit would be *(choose nearest value):*

a. $0.00 b. $0.50 c. $1 d. $5 e. $10 *($15)* f. *NSI*