**Instructions for HW from Chapters 5, 6 and 7 (Taylor):**

1. Formulate Each Problem Correctly as ILP, or LP problem.

2. Solve Each One by LINDO (**L**inear **IN**teractive **D**iscrete **O**ptimization) Software.

3. While Solving click on No to the question “Range Sensitivity Analysis?”

4. Submit your work (parts 1, and 2) together with Managerial Interpretations.

1. Integer LP Models:

Page 185, use (ILP), Page 186, use (Binary LP), Page 187, Use (MILP)

 **B.** Transportation (TP) and Assignment (AP) Models:

 Page 234 (TP), use (LP), Page 247 (AP), use (LP)

 **C.**      Network Models: Formulation and LP Solution:

 Page 291 (Shortest Path), Page 303 (Max Flow), PERT (Ch.8)

**1. How do solve Unrestricted (i.e. non-standard form) LP?**

Suppose you wish to solve the following LP model:

Maximize X*1*

Subject To:

X*1* + X*2* ≥ 0

2X*1* + X*2* ≥ 2

X*1* ≥ 0

X*2* ≤ 0

Notice that the feasible region is in the fourth quadrant of Cartesian system.

The LINDI input is:

*Maximize X1*

*S.T. X1 + X2 > 0*

*2X1 + X2 < 2*

*X1 > 0*

*X2 < 0*

*End*

*free X1*

*free X2*

Solution is (X1 = 2, X2 = -2) with optimal value of 2.

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**2. Solving System of Linear Equation:**

HW: How do you use your LINDO package to solve the following system of equations?

 2X1 + 3X2 + X3 = 4

 X1 + X2 - X3 = 3

 2X1 - 2X2 - X3 =1

Hint create a dummy objective function, say Max X1 + X2 + X3, subject to the all three equation, the run it as LP with Unrestricted Variables (why?)

**3. How to solve Integer LP?**

Suppose in the Carpenter’s Problem ever table needs four chairs; then the LP formulation is:

*Max 5X1+3X2*

*S.T.  2X1+X2 £ 40, X1 + 2X2 £50 , 4X1 - X2 = 0 , X1 ³ 0, X2 ³0*

*End*

*GIN X1*

*GIN X2*

GIN stands for general integer variable. The optimal solution is (X1 = 5, X2 = 20) with optimal value of 85.

Special case of binary variables (X= 0 or 1) is also permitted in LINDO, the command to make the variable X a binary variable is INT X1.

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**4. How to solve Binary (0, 1) LP?**

Suppose there are n items to be considered for inclusion in a Knapsack. Each item has certain per unit value to the traveler who is packing the knapsack. Each item has a per unit weight that contributes to the overall weight of the knapsack. There is a limitation on the total weight that can be carried. The objective is to maximize the total value of what is packed into the knapsack subject to the total weight limitation. We can use Binary LP to solve this problem.

Using the INT command in LINDO restricts a variable to being either 0 or 1. These variables are often referred to as binary variables. In many applications, binary variables can be very useful in modeling all-or-nothing situations. Examples might include such things as taking on a fixed cost, building a new plant, or buying a minimum level of some resource to receive a quantity discount.

Consider the following Knapsack Problem

Maximize 11X*1* + 9X*2* + 8X*3* + 15X*4*

Subject to:

4X*1* + 3X*2* + 2X*3* + 5X*4*  £ 8,

and any X*i* is either 0 or 1.

Since is this very small size problem there are 4 variables each can have either of 2 values, there are 24 = 16 possibilities. Trying all 16 possibilities in order to identify an optimal solution (if it exists) is tedious. Therefore, one must use any one of ILP software packages to solve even this or any larger-scale problem.

Using LINDO, the problem statement is:

*Max 11X1 + 9X2 + 8X3 + 15X4*

*S.T. 4X1 + 3X2 + 2X3 + 5X4 £ 8*

*END*

*INT X1*

*INT X2*

*INT X3*

*INT X4*

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