BUDT 758P: Decision Analytics
Assignment 3, due on 10/8 at 9:30 AM

Problem 1. Return to Problem 2.22 from Assignment 1 (make/buy planning, CammTex Fabric Mill). Use the Excel spreadsheet in the homework solutions to answer the following questions. You can write your answers in a Word document, but carefully explain the justification:

a) What is more valuable, 100 extra machine-hours for the general looms, or 100 extra machine-hours for the regular looms?

b) Which fabric type is the biggest driver of cost? That is, if you could reduce the demand for one of the 15 types by 1 yard, which should it be? Which types are the second- and third-biggest drivers?

c) Explain why some of the shadow prices are positive, while some are negative.

d) In the optimal solution, fabric type 9 is not outsourced. What needs to happen before it becomes cost-effective to outsource this fabric?

Problem 2. Recall the Unity Recycling case from an earlier class (see the handout on the website if you need a reminder). In the second part of this case, we set up the following LP:

$$
\begin{array}{lrcrcrcrcrl}
\min & 10x_R & + & 8x_F & & & & & & & \\
s.t. & 6x_R & + & 2x_F & - & x_{H1} & & & \geq & 12 & \\
 & 2x_R & + & 2x_F & + & x_{H1} & - & x_{H2} & \geq & 8 & \\
 & 4x_R & + & 12x_F & & & + & x_{H2} & \geq & 24 & \\
 & & & & & & & x_i & \geq & 0 & \text{for all } i
\end{array}
$$

(In class, we also had the constraints $x_R, x_F \leq 5$, but let's omit them here for simplicity.) The decision variables x_R, x_F represent the number of hours to run two processing plants in Rockville and Frederick, and the three constraints represent requirements for high-, medium-, and low-grade paper that you have contracted to supply. You also have the ability to re-classify high-grade paper as medium, and medium-grade paper as low; the decision variables x_{H1}, x_{H2} are the amounts of high- and medium-grade paper thus reclassified.

In a Word document, formulate the dual LP and give an economic interpretation. You should clearly explain the meaning of all the dual variables and dual constraints.

Problem 3. Consider the following financial planning problem. Suppose that you start the year with \$3,800 in cash, and your expected liabilities throughout the year are as follows:

Suppose also that your salary (after taxes and benefits) is \$2450 per month. For simplicity, assume that you are always paid on the 1st of each month, and that bills are due sometime before the end of the month.

You have decided that you will invest any money that you don't use to meet your liabilities each month in either 1-month, 3-month, or 7-month short-term investment vehicles. The yield on 1-month investments is 6% per year nominal (thus, you get \$0.005 for each dollar invested after one month); for 3- and 7-month investments, the yields are 8% and 12% per year nominal. Your investment strategy has the following characteristics:

Month	Bills	Month	Bills
January	$2750	July	$3050
February	$2860	August	$2300
March	$2335	September	$1975
April	$2120	October	$1670
May	$1205	November	$2710
June	$1600	December	$2980

- Every time one of your short-term investments matures, you will use the principal as part of your budget (i.e., you will continue investing it and using it for expenses), but you transfer any interest earned to another long-term account, which is not available for your budgeting process. (For example, if you invest $100 in 3-month securities at the beginning of January, you get back $102 at the beginning of April; the principal of $100 can be reinvested, but the yield of $2 is transferred to the other account. Thus, the interest is *not* compounded over the course of the year.)

- You do not want to confine yourself to investments that will all mature by the end of the year. Every type of investment is available in every month, even if it does not mature until the following year: in that case, the return still counts for your objective, but you won't be able to use the principal again for the rest of the year. For simplicity, suppose that the full return is always counted toward the objective, e.g., a 7-month investment made in December is still treated as earning 12% per year.

Now, do the following:

a) Formulate, and solve in Excel, a linear programming model that will help you meet your monthly obligations while maximizing your total investment return through the entire year.

b) What is the minimum amount of starting capital that you need to meet your monthly obligations? (Hint: use the sensitivity report.)

c) In a Word document, formulate the dual LP of the problem in part a) and give an economic interpretation.