MATH 245, Spring 2013
Practice Problems
in preparation for Exam 2 on Wednesday, May 8, 2013.

The exam covers:

- *Concepts of Mathematical Modeling*, Sections 1.5, 1.7, 2.1, 4.1, 4.2, 4.4, 5.1, 5.3A, and pp. 108–110.
- All topics since the first exam, including and not limited to: sources of error, probability, Leslie matrices, Markov chains, random walks, Monte Carlo models, computer simulations, linear optimization, and sensitivity analysis.
- The topics in Mathematica tutorials 5–6; **be sure to completely understand the waiting room simulation** and the following commands: `RandomInteger`, `RandomReal`, `If`, `For`, `Histogram`, `Maximize`, `Minimize`

Below are some questions that practice concepts from the class.

– Book questions: 1.5.2, 4.2.1, 4.2.2, 4.2.3, 4.2.7 (setup only)

Q1. Create the linear program that will answer question 4.2.13 (p. 262). If you feel inspired, use Mathematica to solve the linear program once you have found it.

Q2. Perform a sensitivity analysis on the fertilizer example on page 253 of the book and page 112 of the notes. That is, determine the equilibrium cost of both a unit of phosphate and a unit of nitrate. (Hint: Increase the amount of phosphates available and see how much the profit increases.)

Q3. Give the definitions of *state space* and *random variable*.

Q4. Read the story below. First, set up a transition matrix for the Markov Chain applying to the above situation. Next, determine the equilibrium distribution of students. Last, determine the probability that a grandson of a Harvard graduate goes to Harvard.

> In the Dark Ages, Harvard and Yale admitted only male students. Assume that, at that time, 80 percent of the sons of Harvard men went to Harvard and the rest went to Yale, and 60 percent of the sons of Yale men went to Yale and the rest went to Harvard.

Q5. Determine the system reliability of the following communication system. There are two different methods of communicating; at least one method must succeed in order for the system to succeed. The first method is by an FM radio, which has reliability 75%. The second method is by a satellite radio; both a physical transmitter must transmit the signal (with 90% reliability) AND the satellite dish must retransmit the signal (with 95% reliability) in order for the satellite radio to succeed.

Q6. Determine and justify the category of error involved in each of the two Sidelight stories in Section 2.1 (page 76 and then page 77). After this, write a paragraph discussing the difference between the two errors encountered. Last, write a few sentences explaining the morals of these errors and how it relates in general to the modeling process in real-life.

Here are some *Mathematica* questions that test concepts for this exam:

M1. Write an `If` statement that outputs "Heads" with probabilty one third, and "Tails" with probability two thirds.

M2. How would you generate a list of 100 trials of Heads and Tails?

M3. What does `%` represent in Mathematica? What would happen if you evaluated it by itself?

M4. Give a pseudocode description of how you might use a computer to simulate the situation in Question **Q5** in order to calculate the expected reliability of the system.