MATH 616 FINAL PROJECT
DUE 5/7/2018 (EXTENSIONS AVAILABLE UPON REQUEST)

Assignment: Analyze a situation that can be modeled using linear algebra. Possible specific topics and/or techniques include, but are not limited to: systems of linear differential equations (e.g. mixture problems), Markov chains, or orthogonal projections (e.g. least squares problems, Fourier series). While different situations may have similarities, each person should construct and analyze their own *unique scenario*.

The entire assignment should be completed in **Mathematica**. The suggested format is as follows:

(1) Consider a concrete single problem (e.g. a homework problem from the book).
(2) Use Mathematica to solve this specific problem.
(3) Investigate what happens when you begin generalizing the specific problem. For example: What happens if you change parameters? What if the number of variables involved increases? Can you determine anything qualitatively about how the solution(s) depend on the parameters?
(4) Attempt to interpret/explain what these calculations mean. Why might you expect or not expect these results? Can you come up with a mathematical argument to explain or support your empirical observations?

Notes: This is an open-ended assignment. This means there is no set parameters or guidelines for what you must include or should not include. You must decide what will make the assignment interesting. Use the `Manipulate` command in Mathematica to facilitate your explorations. Be sure to use the Text environment in Mathematica where appropriate. You can also use `(* comment text *)` to make brief comments within the regular mathematical environment.

Possible Ideas: The *Topic: Markov Chains* chapter in the textbook analyzes several different situations. You are encouraged to take one of those situations as a *starting point*, and then expand upon it by modifying the scenario.

Another possibility is to investigate Fourier series in greater detail. You could use a problem from Dr. Zeinalian's class as a starting point.

I am including a Mathematica .nb file I made investigating a sample tank flow problem with three tanks.

Tips: Because you can work with Mathematica, you shouldn't be too concerned about the sizes of your matrices. In order to construct and work with the matrices, it will probably be easiest to define matrices directly as we have already done. If, however, you are interested in working with very large matrices, there are a few commands you may find useful. You can get details in the Wolfram Documentation Center.

It is possible to work with individual entries in a matrix. If you have a matrix m, you can obtain the element in the i-th row, j-th column by using the command $m[[i, j]]$. The i-th row can be accessed via $m[[i]]$, and the j-th column accessed by $m[[All, j]]$. Finally, you can change an entry by $m[[i, j]] = v$. For example, you could make the $(3, 2)$-entry equal to 14 by $m[[3, 2]] = 14$.

The SparseArray command allows you to create a matrix by stating the matrix entries at specific positions, and the remaining positions will all be 0.

How this counts towards your grade: As almost everyone did well on Test 2 and seems to understand the material, I will let this project serve as the Final Exam. For our final meeting on Monday, May 7, I would like for as many people as possible to *briefly* show the class their calculations. If you are concerned about your grade and want a separate final exam, please contact me. If you have another idea for a final project, you can talk with me about that too.