Math 139A, Fall 2019
Applications of Mathematics

Instructor  John E. MCarthy
Class  Tu 10.00-11.00 in Cupples I, Rm 218

JM Office  105 Cupples I
JM Office Hours  M 4.00-5.00, Tu 11.00-12.00, Th. 3.00-3.4, and by appointment
Phone  935-6753

Prerequisites
Math 131, taken concurrently

Description
Mathematics can often seem intimidatingly abstract. "Why do we need to know this?" and "What is this good for?" are common questions, which sometimes are not adequately answered. It is all very well to say that mathematics is needed for cell-phone design, or to make ultrasound images, or for Google to calculate page-rank; but explaining exactly how it is used in any of these applications takes a great deal of time.

The purpose of this course is to give examples of how mathematics can be used to understand real world problems. It is aimed at students who are also enrolled in Calculus I, Math 131, so we will start with problems that only need pre-calculus to solve, and work up to ones that use calculus.

Do I need to be a math wiz to take this course?
No. The course is for students who are curious about how mathematics is used, and want some inkling of its scope.

Content
Here is a tentative schedule. The first seven do not use calculus, the next six do. We may change some of these topics.

1. Dimensional Analysis. How to guess plausible formulas.
2. The mathematics of convoys. Are they a good idea? What are the pros and cons? Reading for class on Sep 4
3. Fibonacci Numbers. See this site for pictures
4. The golden ratio
5. Fractals I: Coastlines
6. Fractals II: what is dimension?
7. Linear regression I. Application: the Gutenberg-Richter law of earthquake magnitudes. How can we speak of a twenty thousand year event? Earthquakes
8. Linear Regression II: How to find the best line. Regression to the mean Application: Metabolic rate versus animal size Metabolic Rates
11. Should we all have the same mitochondrial DNA? Galton's approach to surnames.
12. How genes spread through populations.
13. Sigmoid curves for populations, and the logistic equation.
14. SIR model of infectious diseases.

**Basis for Grading**

Grading will be based on classroom participation, and a term paper. The topic of the term paper should be chosen in consultation with the Instructor. A preliminary draft should be handed in October 30th. This will be graded and returned, and a final version should be handed in December 4th.

Classroom Participation (contribution to discussion): 20%
Term Paper - first draft: 30%
Term Paper - final draft: 50%

**Class**

I do expect you to come to class every day, and to participate in class discussions. I expect you to read the corresponding section in Korner's book. I may call on you at any time to answer a question.
Texts  

This is a lovely book. If you get bogged down in some section, it is okay to move on.