MAP 4103
Applied Mathematical Modeling
Fall 2018

Instructor: Dr. Necibe Tuncer

Office: SE 202

Office Hours: TBA

Email: ntuncer@fau.edu

Catalog description: This course covers the use of differential and difference equations in scientific modeling. Emphasis is on the modeling cycle using techniques from analysis, computation, and data fitting. Students will develop skills to describe a scientific problem within a mathematical context, to propose methods of analysis, and to formulate questions and summarize results. The course has undergraduate research and inquiry (URI) components which focus on formulating questions and creating mathematical models.

Textbook (required): *A Course in Mathematical Modeling* by D. Mooney and R. Swift.

Broader course description and objectives: This course will cover the use of differential and difference equations in scientific modeling. Techniques for the analysis of such equations both analytically and computationally will be the primary content knowledge. The course will also focus on the modeling cycle: describe a process, propose a model, select tools for analysis, find and analyze solutions, improve the model, and repeat. This will be done in the context of idealized models. This URI portion of the course will include at least one smaller assignment and one larger final project and will address Student Learning Objectives in Knowledge (1), Formulation of Questions (2), and Critical Thinking (4).

A special topics version of this course in Fall 2017 will focus on modeling infectious diseases such as Influenza, Malaria, West Nile virus, HIV, Zika, and Dengue Fever using systems of differential equations. Linear stability analysis and the bifurcation theory will be used to analyze these models. Computational methods such as fitting these models to the data sets will be introduced. In general the focus of the applications that will be used in a given semester will be a the discretion of the instructor and may vary from biological models to applications from physics and engineering.

More background related to the Fall 2017 special topics version this course: Mathematical biology is a very diverse field and with this diversity comes the need to use diverse forms of mathematical analysis to study biological systems. In this course we will focus on how to develop and analyze the mathematical models of infectious diseases. Student will be exposed to variety of models, from a simple SIR (Susceptible-Infected-Recovered) model to more complex epidemiological models, from single species to interacting species. Once the mathematical model is formulated, it can be used in an attempt to gain information about the disease that it describes. Students will learn a selection of mathematical techniques that are useful in modeling and analyzing infectious diseases. Some of these tools are the theory of nonlinear dynamical systems, bifurcation theory, data analysis, and non-linear fitting techniques. Students who complete this course are expected to develop the ability to translate a description of an infectious disease into a mathematical model, use necessary mathematical tools to analyze the model, work with data sets collected from CDC, WHO or the literature to gain insight of the current situation of the disease, enhance their skills in using computer software (MATLAB) to work with data sets and simulation of mathematical models. Each student will be assigned an individual disease as a project where the student will introduce the disease, develop a mathematical model, analyze the model, collect data related to disease, perform parameter estimation, and estimate the efficacy of the current control measures applied to control the disease. This project alone will give the students the foundations needed to conduct research in mathematics. Students from other disciplines will also benefit from this course as well. The following references will be used to prepare the lecture notes.

References:

1. An Introduction to Mathematical Epidemiology, Maia Marthcheva
2. Mathematical Epidemiology of Infectious Diseases, Model Building, Analysis and Interpretation, O.Dieckmann, J.A.P. Heesterbeek
3. Mathematical Models in Population Biology and Epidemiology, Fred Bauer, Carlos Castillo-Chaves.
4. Mathematical Biology, Mark A. Lewis, Mark A. J. Chaplain, James P. Keener, Philip K. Maini.
5. Mathematical Biology I: An Introduction, J.D. Murray.
6. Nonlinear Dynamics and Chaos, Steven H. Strogatz

Prerequisites: (MAP 2302 or MAP 3305) and (MAS 2103 or MAC 2313).

Course grade: Course grades will be determined by

Class Attendance and Participation:	10%
Exam 1:	15%
Exam 2:	15%
Midterm Project:	25%
Final Project:	35%

Grading scale: A/A-: 90-100%, B+/B/B-: 80-89%, C+/C: 70-79%, D: 60-69%

Topical outline:

Week 1 Discrete dynamical systems and difference equations

Week 2 Discrete stochasticity

Week 3 Stages, states, and classes

Week 4 Modeling cycle

Week 5 Exam 1

Week 6 Fitting models to data

Week 7 Midterm project report

Week 8 Fitting models to data 2

Week 9 Exam 2

Week 10 Differential equation models

Week 11 Geometric analysis of differential equations

Week 12 Parameter dependence and bifurcation

Week 13 Final report

Week 14 Final presentations

Incomplete grades:

A grade of I (incomplete) will only be given under certain conditions and in accordance with the academic policies and regulations put forward in FAU's University Catalog. The student has to show exceptional circumstances why requirements cannot be met. A request for an incomplete grade has to be made in writing with supporting documentation, where appropriate.

Classroom etiquette policy:

University policy on the use of electronic devices states: "In order to enhance and maintain a productive atmosphere for education, personal communication devices, such as cellular telephones and pagers, are to be disabled in class sessions."

Disability policy statement:

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodation due to a disability to properly execute coursework must register with the Office of Student Accessibility Service (SAS) – in Boca Raton, SU 133 (561-297-3880) and follow SAS procedures.

Academic integrity:

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty, including cheating and plagiarism, is considered a serious breach of these ethical standards, because it interferes with the University mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the University community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see `http://www.fau.edu/ctl/4.001_Code_of_Academic_Integrity.pdf`