MTH 442 Introduction to Difference Equations - Spring 2019

Instructor: Orlando Merino, 200F Lippitt Hall, 8744442, merino@uri.edu
Time/place: MWF 11 a.m., Lippitt Hall 205

Text: You will be given access (through SAKAI) to an electronic version of course notes.

Evaluation: Two Exams (20% ea.), Homework (20%), CAS Projects (20 %),
Final Presentation and Project (20%).

Synopsis: MTH442 is an introduction to the basic concepts and techniques of difference equations for advanced undergraduates and beginning graduate students.

Prerequisites: MTH243 or equivalent **(**Mutivariable calculus)

About Difference Equations (DE): DE appear in situations where the (n+1) generation (or state) of a system depends upon some previous generations (or states). Such equations also appear naturally as discrete analogues of differential equations, and as numerical solutions of differential equations that model various diverse phenomena in biology, ecology, physiology, physics, engineering, economics, and other areas.

About MTH442: In addition to performing mathematical analysis of difference equations, with the aid of a Computer Algebra System you will experiment with difference equations, and discover that such equations possess fascinating properties with a great amount of structure. Some of these computer observations may be cast as theorems that you discover and prove!

Outcomes: At the end of the semester, the student will be able to

1. Classify a given difference equation according to its type.
2. Investigate numerically, graphically and analytically, properties of solutions to difference equations such as convergence to equilibria or periodic points, boundedness, chaotic behavior.
3. Find equilibrium and periodic solutions to autonomous scalar or planar difference equations, and investigate their stability properties.
4. Analyze difference equations models by using computational and analytic tools.
5. Find and classify by type the bifurcation points of difference equations models.
6. Use computer simulations to make conjectures on the properties of solutions to difference equations, and use mathematical analysis and other techniques to prove or disprove conjectures or claims about difference equations.

Topics: Review of Sequences in the real line. Introduction to Difference Equations, First order DEs, linear equations with constant coefficients, variable coefficients, equilibria, periodic points, stability of equilibria, bifurcations, logistic map, baker's map, period doubling bifurcations, chaotic behavior (one dimensional case), two dimensional systems of difference equations, linear theory, nonlinear systems, equilibria and periodic points, stability, basins of attraction, stable and unstable manifolds, area preserving maps, numerical issues in difference equations. If time permits, systems with order higher than 2.

References: There is no official text. Here are some useful references.

1. Discrete Dynamical Systems and Difference Equations with Mathematica, by M. Kulenovic and O. Merino, Chapman & Hall/CRC, 2002, ISBN 1-58488-287-5
2. An Introduction to Difference Equations, Ed. 3, by S. Elaydi, Springer 2010, ISBN-13: 9781441920010
3. Discrete Chaos, S. Elaydi, Chapman/Hall 2007, ISBN 9781584885924

Additional References:

1. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Westview Press 1994, ISBN 0-7382-0453-6. This is a very good book on continuous dynamical systems, has a section on discrete dynamical systems.
2. Chaos, James Gleick, Penguin Books, 1987, ISBN 978-0-14-311345-4. This is an excellent source of historical developments in the field of chaotic dynamical systems.

Other: Class policies, attendance, late work, exam makeups, special needs, expectations, will be discussed during our first class meeting.