Course Syllabus

Dynamical Systems (MATH 320/520)

Description: *Theory and applications of mathematical models of dynamical systems (discrete and continuous). Topics include linear and non-linear equations, linear and non-linear systems of equations, bifurcation, chaos and fractals.*

Credit Hours: 3

Frequency: Usually offered in the fall semester of odd numbered years.

Audience: Elective for math, engineering.

Prerequisites: MATH 132

Format: 3 lectures (50 min) per week

Textbook: *A First Course in Chaotic Dynamical Systems: Theory and Experiment* by Robert L. Devaney (Required). ISBN 0-201-55406-2

Software: Use of *Maple* is recommended (available on campus computers; purchase of student versions is recommended).

Internet: Course material and grades are often maintained in Blackboard, at the discretion of the instructor.

Access & Accommodations: The Access & Accommodations Resource Center (AARC) is the campus office that works with students to provide access and accommodations in cases of diagnosed mental or emotional health issues, attentional or learning disabilities, vision or hearing limitations, chronic diseases, or allergies. You can contact the office at aarc@valpo.edu or 219.464.5206. Students who need, or think they may need, accommodations due to a diagnosis, or who think they have a diagnosis, are invited to contact AARC to arrange a confidential discussion with the AARC office. Further, students who are registered with AARC are required to contact their professor(s) if they wish to exercise the accommodations outlined in their letter from the AARC.

Notice of Cancellation: In the event class is cancelled, you will be notified through your Valparaiso University e-mail account.

Student Learning Objectives:

A. Students understand fundamental concepts related to modeling time dependent phenomena.
B. Students extend their knowledge of calculus to solve problems in difference (and maybe differential) equations.
C. Students improve problem solving skills.
D. Students will cooperate *when appropriate* (see section syllabus for details) to help each other understand the concepts of dynamical systems and to learn how to function in a work group.

E. Students think analytically when creating a mathematical model from a description of the process and analyze it using mathematical and numerical methods, both manually and using technology.

Topics & Performance Requirements Include (but are not limited to):

Preface: *Students will be able to …*

1. Recognize the difference between a difference equation and a differential equation.
2. Express application problems in terms of dynamical systems equations.
3. Iterate functions and find orbits, fixed points, and periods.
4. Use graphical analysis of dynamical systems and understand phase portraits.
5. Understand the ramifications of the Fixed Point Theorem.
6. Determine the stability of fixed points (attracting vs repelling).
7. Recognize bifurcation points and type.
8. Master the ideas of the Cantor middle-thirds set.
9. Recognize when a dynamical system exhibits chaotic behavior (use of Sarkovskii's Theorem, etc.).
10. Generate fractals.
11. Recognize the common examples of fractals.
12. Find the topological dimension of sets and fractal dimensions.
13. Perform basic arithmetic of complex numbers.
14. Work with Julia sets and the Mandelbrot set.
15. identify when certain theorems apply, and if not, identify what hypothesis is violated
16. carry over and apply knowledge from Calculus such as differentiability and integration
17. prove some theorems involving dynamical systems
18. check results (produced both manually and with technology) and recognize those which are obviously false or suboptimal