Math 137

A. Course Details

COURSE NAME: Applied Analysis (Dynamical Systems)

COURSE DESCRIPTION: This is an introductory course in Dynamical System for undergraduate students of Mathematics. It involves the study of flows in one and two dimensions including linear stability of fixed points, bifurcations, chaos, and applications.

NUMBER OF UNITS: 3 units

PREREQUISITE: Differential Equations

COURSE REQUIREMENTS:

2 Long Examinations . . . .… 50%
Homework, Quiz, Class Participation, Computer Exercise……20%
Project (Use of Software, Presentation, Final Paper)…… ……...30%

PASSING GRADE 60 %

B. Course Outcome and Relationship to Program Outcome

At the end of the course the student should be able to

- Analyze one and two dimensional systems including showing existence and uniqueness of solutions, and local stability of solutions,
- Visualize dynamical systems in one and two-dimensional cases
- Determine the occurrence co-dimension one bifurcations
- Use theorems on existence and non-existence of limit cycles
- Use software to perform computations, and generate graphical representation of the dynamical system (e.g. chaos and co-dimension one and two bifurcations).

C. Course Outline

Week	Topic
1-4	**One-dimensional Flow** **Flows on the Line**. Introduction, Fixed Points and Stability, Population Growth, Linear Stability Analysis, Existence and Unique eness **Bifurcations**. Saddle-Node Bifurcation, Trans-critical Bifurcation, Pitchfork Bifurcation, Examples
5-8	**Two-dimensional Flows**

	Linear Systems. Classification of Linear Systems, Examples. **Phase Plane**. Phase Portraits. Existence, Uniqueness and Topological Consequences, Fixed points and Linearization, Examples.
	FIRST LONG EXAMINATION
9-10	**Hands-on Mathematical Computer Software**
11-15	**Limit Cycles.** Examples, Poincare-Bendixson Theorem, Applications. **Bifurcations Revisited**. Saddle-Node, Trans-critical, and Pitchfork Bifurcations, Hopf Bifurcation, Global Bifurcation of Cycles, Poincare Maps. Co-dimension Two Bifurcations. **Chaos**
	SECOND LONG EXAMINATION
16	**Project Presentations**

D. References (To add more, and recent ones)

- S. Strogatz, Nonlinear Dynamics and Chaos: with Applications to Physics, Biology, Chemistry, and Engineering, Perseus Books, Cambridge, 1994.
- S. Wiggins, Introduction to Applied Nonlinear Dynamical Systems and Chaos (Second Edition), Springer-Verlag, New York, 2003.
- Guckenheimer and P. Holmes, Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields, Springer-Verlag, New York, 1983.
- F. Brauer and C. Castillo Chavez, Mathematical Models in Population Biology and Epidemiology (Second Edition), Springer, 2012.

Computer Software

1. Manual for MATLAB or SCilab
2. Manual for other computer programing package used by the current instructor