This course is structured to introduce the graduate students the fundamental concepts of structural stability, Lyapunov-Schmidt reduction, Morse lemma, bifurcations of fixed points (saddle-node, simple, and Hopf), Symmetry breaking, center manifold, Normal form theory, Co-dimension two bifurcations, Global bifurcation and Chaos. This course will demonstrate that these concepts can be applied to the study of response, stability and bifurcation behavior of engineering systems.

This course covers what constitutes the modern theory of Nonlinear Dynamical Systems. The mathematical background that is required of the students is a working knowledge of linear algebra and differential equations. The dynamics and control (AE 454) concepts or equivalent courses are required.

All students will be required to complete a course project during the semester. These projects will be selected by the students with approval of the instructor before the spring break (March 17–25, 2012). There will be bi-weekly homework assignments over the course of the semester. There will be one midterm exam which is tentatively scheduled for March 13th.

The final grade for the course will be based on

- 25% homework scores, 25% midterm exam 25% project and 25% final examination.

### 3-weeks 01/17 – 02/07  Concepts of Dynamical Systems

- State variable description, Flow, $\omega$ and $\alpha$ - limit sets
- Poincare-Bendixon theorem, Bendixon criterion
- Topological equivalence, Structural Stability

### 5-weeks 02/09 – 03/13  Functional Analytic Methods

- Generalized Implicit Function theorem, Lyapunov-Schmidt Reduction
- Saddle-Node bifurcation
- Morse lemma, Simple bifurcation
- Symmetry, The equivariant branching lemma
- Hopf bifurcation

### 3-weeks 03/25 – 04/17  Geometric Methods

- Stable and unstable manifold
- Center manifold
- Normal forms, Averaging

### 2-weeks 04/22 – 05/01  Global Bifurcations

- Smale Horse shoe, Smale-Birkhoff homoclinic theorem
- Melnikov integrals, Homoclinic tangle
- Higher dimensional Melnikov methods (Not Covered)

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1To be offered in Spring 2015