AE-554 DYNAMICAL SYSTEMS $\mathscr{E}$ BIFURCATION THEORY [1]

by

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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**

3-hours of lectures   • *State variable description, Flow, ω and α - limit sets*
3-hours of lectures   • *Poincare-Bendixon theorem, Bendixon criterion*
3-hours of lectures   • *Topological equivalence, Structural Stability*

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

3-hours of lectures   • *Generalized Implicit Function theorem, Lyapunov-Schmidt Reduction*
3-hours of lectures   • *Saddle-Node bifurcation*
3-hours of lectures   • *Morse lemma, Simple bifurcation*
3-hours of lectures   • *Symmetry, The equivariant branching lemma*
3-hours of lectures   • *Hopf bifurcation*

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

3-hours of lectures   • *Stable and unstable manifold*
3-hours of lectures   • *Center manifold*
3-hours of lectures   • *Normal forms, Averaging*

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

3-hours of lectures   • *Smale Horse shoe, Smale-Birkhoff homoclinic theorem*
3-hours of lectures   • *Melnikov integrals, Homoclinic tangle*
3-hours of lectures   • *Higher dimensional Melnikov methods (*Not Covered)

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[1]To be offered in Spring 2015