ME 6444 Syllabus (Fall 2021)

1. **Introduction:** Welcome to ME 6444, Nonlinear Systems! My email address and office location are shown below:

Dr. Michael J. Leamy
Room 132, Erskine Love Building
E-mail: michael.leamy@me.gatech.edu

Office Hours:

By appointment (virtual or in-person). I will be very accommodating.

2. **Students with special needs:** Please see me as soon as possible so that we can make appropriate arrangements.

3. **Topics:**

Unit I: Introduction to Dynamical Systems

1. Introduction to nonlinear behavior
2. Analysis of dynamical systems using symbolic and numeric computation - MAPLE®
3. Modeling of physical systems (accounting for nonlinearity)
   a. Hamilton's Principle
   b. Discretization techniques

Unit II: Classical Analysis Techniques for Autonomous Systems

4. Properties of linear systems
5. Phase plane analysis
6. Local stability analysis of (nonlinear) equilibria (fixed points)
7. Bifurcation analysis of fixed points

Unit III: Weakly Nonlinear Analysis Techniques - SDOF

8. Weakly nonlinear oscillations and perturbation analysis
   a. Conservative systems
   b. Nonconservative systems – damped and forced
9. Parametrically excited systems

Approximation methods: Averaging, Lindstedt-Poincaré, Multiple Scales, Harmonic Balance, Floquet Theory, Homotopy Techniques

Unit IV: Modern Nonlinear Analysis Techniques

10. Quasiperiodic solutions
11. Poincaré sections and maps
12. Introduction to chaos and fractals
13. Classical routes to chaos

4. **Exams:** There will be a midterm exam. The final project will replace a traditional final exam.

5. **Term Project:** A final project will be assigned near the end of the semester. You may work in a group of two or on your own. The topic will be chosen by you (or your group).

6. **Grading Policy:**

Midterm:	35%
Problem Sets:	30%
Term Project:	35%

7. **References (No Required Textbook)**

Primary

1. Nayfeh and Mook, 2004, *Nonlinear Oscillations*
2. Nayfeh and Balachandran, 2004, *Applied Nonlinear Dynamics*
3. Stephen Lynch, 2001, *Dynamical Systems with Applications Using MAPLE*

Secondary

1. Jordan and Smith, 1987, *Nonlinear Ordinary Differential Equations, 2nd ed.*
2. Stephen Wiggins, 1990, *Introduction to Applied Nonlinear Dynamical Systems and Chaos*
3. Guckenheimer and Holmes, 1983, *Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields*
4. Ali Nayfeh, 1981, *Introduction to Perturbation Techniques*
5. Francis Moon, 2004, *Chaotic Vibrations: An Introduction for Applied Scientists and Engineers*
6. James Gleick, 1987, *Chaos: Making a New Science*