EECE 571M: Nonlinear Systems and Control
Syllabus

Dr. Meeko Oishi
http://courses.ece.ubc.ca/571m

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Instructor
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Office hours: Monday 2:30-4:30pm (tentative)

Course Location and Time
FSC 1611 Monday, Wednesday, 1:00pm-2:30pm

Grading

30%	Problem Sets
30%	Midterm
40%	Final Exam

Course Description
This graduate course will cover fundamentals of nonlinear systems analysis and control. It is intended for students who have had a graduate course in linear dynamical systems, but no prior exposure to nonlinear dynamical systems. The first part of the course will focus on analysis of nonlinear systems, driven by a number of real-world examples, and some preliminary mathematical background. The second portion of the course will focus on stability through Lyapunov techniques and input-output analysis. The third portion of the course will focus on control of nonlinear systems, through feedback linearization, sliding mode control, and gain scheduling.

Prerequisites
Students should be familiar with linear dynamical systems, differential equations, and linear algebra.

Course Updates
All course updates will be posted on the course website.

Course Readings/Text
Recommended texts:
S. Sastry, *Nonlinear Systems: Analysis, Stability, and Control*, Springer 1999.
H. Khalil, *Nonlinear Systems*, Prentice Hall, 2002.

Course Outline

1. **Introduction:** Examples – violin strings, heart rhythms, double pendulum, van der Pol oscillator. Existence and uniqueness of solutions.
2. **Analysis:** Linearization through Taylors series, Hartman-Grobmann Theorem, local stability. Multiple equilibria, limit cycles, bifurcations.
3. **Second-order systems:** Phase plane techniques, Poincare-Bendixson Theorem.
4. **Input-output analysis and stability:** Small gain theorem, passivity, describing functions.
5. **Mathematical background:** Contraction mapping theorem, homeomorphisms, norms.
6. **Lyapunov stability theory:** Basic stability and instability theorems. Uniform stability, asymptotic stability, exponential stability. LaSalles Theorem, indirect method.
7. **Feedback linearization:** Input-output linearization, full-state linearization, stabilization, tracking. Zero dynamics, MIMO systems, non-minimum phase systems, singularities.
8. **Sliding mode control:** Sliding surfaces, differential inclusions, solutions in the sense of Filippov.
9. **Gain scheduling:** Controller and scheduling design

Course Due Dates

Problem Set #1	September 27
Problem Set #1	October 6
Midterm	October 20
Problem Set #3	November 10
Problem Set #4	November 24
Final Exam	TBD December 7-21

Course Policies

While collaboration and discussion is encouraged on all problem sets unless otherwise specified, each student must hand in their own individual work. Copying will not be tolerated. Students must inform the instructor as soon as they are aware of conflicts with the course due dates.