MATH 7390 SYLLABUS SPRING 2014

Course Title, Time, Location, and Web Page. Control Theory, 7:30-8:50AM Tuesdays and Thursdays, 113 Lockett Hall at Louisiana State University (LSU) in Baton Rouge, `http://www.math.lsu.edu/~malisoff/7390/`.

Professor, Contact Information, and Office Hours. My name is Prof. Malisoff (`malisoff@lsu.edu`, 578-6714). My office hours are Tuesdays and Thursdays 10:30-11:40AM in 392 Lockett and by appointment. Feel free to come to my office hours to ask me about the course, or about any other issues that may be related to your school work.

Prerequisites. MATHs 2090 and 4032, or their equivalents. Please contact the instructor to confirm that you have the prerequisites if you have not taken MATHs 2090 and 4032. In general, students who have done well in advanced calculus and linear algebra and who are familiar with methods of proofs have enough background to take this course. Although the course will cover nonlinear control theory, you do not need to have taken a linear control systems course.

Course Description and Coverage. Control theory is a central area at the interface of applied mathematics and engineering. The field studies mathematical methods that influence the behavior of complicated dynamical systems, by finding feedbacks. Feedback refers to automatic adjustments in actions of a system in response to information about the system's own state and its environment. Feedback is essential for robust performance of self-regulated dynamical systems in many biological and engineering applications. This course will involve control theory for time-varying ordinary differential equations. The first part of the course will review the necessary background on nonlinear ordinary differential equations, including existence and uniqueness of solutions and continuous dependence of trajectories on initial conditions. The second part will cover key foundational topics on control theory, including Lyapunov functions and robustness properties of nonlinear dynamics. The final part of the course will cover feedback design, which involves choosing state dependent parameters for the equations in order to ensure that certain control objectives are met, and will include robustness of feedback controlled systems under the influence of control or modeling uncertainty. This is an important course that should be taken by all PhD students interested in specializing in applied mathematics, and it can be taken as a substitute for MATH 7320. The course is also suitable for undergraduates and engineering majors who satisfied the prerequisites. It will include examples from engineering and therefore can be taken instead of ME 7673.

Text and Assigned Readings. Students will not need to purchase any text for this course. Lecture notes or online readings will be assigned by the instructor. Some references that include all of the course topics are:

1. M. Hirsch, S. Smale, and R. Devaney, *Differential Equations, Dynamical Systems, and an Introduction to Chaos, Second Edition*, Elsevier, New York, 2004.
2. H. Khalil, *Nonlinear Systems, Third Edition*, Prentice Hall, Upper Saddle River, NJ, 2002.
3. H.J. Marquez, *Nonlinear Control Systems: Analysis and Design*, John Wiley and Sons, Hoboken, NJ, 2003.
4. S. Sastry, *Nonlinear Systems: Analysis, Stability, and Control*, Springer-Verlag, New York, 1999.
5. J.-J. Slotine and W. Li, *Applied Nonlinear Control*, Prentice Hall, Englewood Cliffs, NJ, 1991.
6. E. Sontag, *Mathematical Control Theory: Deterministic Finite Dimensional Systems*, Springer, New York, 1998.

However, there is much more material in these references than we will cover in this course, so students are not expected to read everything in all of these references. Instead, the instructor will ask LSU to put these references on reserve in the Middleton Library and may assign specific readings from the references, depending on the progress of the class.

Grading. Course grades will be based completely on your homework grades. However, hints for the homework may be given in class, so it behooves all students to try to attend all of our class meetings. Homework will be assigned at least every other week. Homework is due one week after being assigned, unless noted otherwise. Late homework will not be accepted. However, I drop your two lowest homework grades when computing your course grade, so you can miss turning in two homeworks and have your course grade be based on the other homeworks you turn in. Homework solutions will be posted on the class web site. You are allowed to discuss the homeworks with classmates before and after submitting them, and you can use electronic devices to help with the homework such as computer programs or calculators. However, you must write your homework solutions on your own, and you may only turn in your own work for grading. You must put all of your homework on 8.5 by 11 inch loose leaf paper and write neatly. You may not write your homework in red ink. Slovenly homework will not be welcomed and may result in your losing credit.

Student Conduct. Although questions are always welcomed, disruptive behavior will not be welcomed. You must follow the LSU Code of Student Conduct, a statement of which is available from the Office of the Dean of Students; violators may be referred to a University administrator. You should not talk during class without first raising one of your hands for permission to speak. You may not whisper or eat or drink or smoke or curse during class. If you will need to leave early, then please sit near an exit. Please be considerate to students with multiple chemical sensitivity syndrome in your choice of any perfumes or colognes. You may not use boom boxes, calculators, cell phones, pagers, walkmen, or similar devices during class. Cell phones must be off in class unless I tell you otherwise. These classroom rules are designed to help everyone rise to a high level of academic performance and do their best in the course.