ECE 736: Power System Stability and Control

Lecture Time: Tuesday & Thursday 9:35 – 10:50 am
Room: MRC 313

Instructor Information

• Instructor: Dr. Aranya Chakrabortty
• Office: Keystone Science Center, Room 100-26
• Office Hours: Monday 4:00 – 6.00 pm, or by appointment

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Pre-requisite:
ECE 451: Power System Analysis
ECE 435: Elements of Control

Course Objectives:
Upon completion of this course, students will be able to:

1. Develop linear and nonlinear models of multi-machine power systems
2. Analyze various types of stability properties of power systems
3. Model and simulate excitation mechanisms in synchronous machines
4. Perform modal analysis on power system signals
5. Identify power system models from dynamic data
6. Design controllers for transient/angle stabilization and voltage regulation.

Textbook:

Course website:
http://engineeringonline.ncsu.edu/onlinecourses/coursehomepages/FALL2011/ECE736.html

Matlab Primer: Has been uploaded to the ‘Resources’ section on the course website.

Grading Policy:
There will be 7 or 8 homework assignments throughout the semester, a midterm, a final exam and a research project. The weight for each is as follows:

Homeworks: 20%
Midterm: 30%
Final Exam: 40%
Course project: 10%

Homework assignments will be uploaded to the ‘Assignment’ section on the course website. Paper copies of the homework will also be handed out in class. All homework will be due in a week from the day the
assignment is handed out. There will be 20% penalty for each session late. Submission will not be accepted if more than two sessions late.

Distance learning students are requested to scan their completed homeworks and email it to the instructor at achakra2@ncsu.edu by the submission deadlines stated on the homework.

Solutions:
Solutions to homework and tests will be uploaded to the Assignment section of the course website.

Course Research Project:
Students (divided in groups) will choose a technical paper on power system dynamic modeling and simulation, study it and modify it accordingly to come up with their own new simulations, derivations, study, etc. Dr. Chakrabortty will help you in choosing the appropriate topics. A brief presentation will be given by each group at the last week of classes. More detailed information will be given on this before Thanksgiving break.

Course outline

08/18 (Th) Review of linear systems, state-space modeling, eigenvalues, linearization
08/23 (T) Transfer function models, SMIB power system, swing equation, power-angle curves
08/25 (Th) Review of pole-placement and state-feedback controller design
08/30 (T) Power system stabilizers, lead-lag design
09/01 (Th) Angle stability and equal-area criterion
09/06 (T) Numerical problems on equal-area criterion, critical clearing time
09/08 (Th) Synchronous machine response to small-signal perturbation
09/13 (T) Small-signal response of machines with voltage regulator
09/15 (Th) Gain margin, phase margin of SMIB systems
09/20 (T) Transient stability study of synchronous machines
09/22 (Th) Transient stability study of synchronous machines (continued)
09/27 (T) Discrete-time models of SMIB power system, Kron reduction
09/29 (Th) Bifurcations in swing models of power systems
10/04 (T) Midterm Exam
10/06 (Th) Holiday
10/11 (T) Synchronous machine modeling – classical models
10/13 (Th) Synchronous machine modeling (continued)
10/18 (T) Synchronous machine modeling (continued) – detailed models
10/20 (Th) Simulations using Matlab/Simulink
10/25 (T) Power system oscillatory modes
10/27 (Th) Modal analysis of test-cases
11/01 (T) Modal participation factors, local/interarea modes
11/03 (Th) Excitation systems
11/08 (T) Effect of excitation on transient stability
11/10 (Th) Sensitivity analysis
11/15 (T) Simulation of excitation models in Matlab/Simulink
11/17 (Th) Parameter identification in swing models
11/22 (T) Parameter identification (continued)
11/24 (Th) Thanksgiving Holiday
11/29 (T) Wide-area monitoring of oscillations using PMUs, test cases
12/01 (Th) Project presentation/Review of topics before final exams
**Software needed:** Matlab and Simulink
Other related simulation packages will be provided by the instructor.

**Academic integrity**

It is the aim of the faculty of NCSU to foster a spirit of complete honesty and a high standard of integrity. The attempt of students to present as their own any work that they have not honestly performed is regarded by the faculty and administration as a serious offense and renders the offenders liable to serious consequences, possibly suspension.

**Students with disabilities**

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided.

**Civility in the classroom**

Students are expected to assist in maintaining a classroom environment that is conducive to learning. Inappropriate behavior in the classroom that leads to the distraction of others shall not be tolerated under any circumstances.