ECE 736: Power System Stability and Control

Spring 2016

Lecture Time: Tuesday & Thursday 11:45 am– 1:00 pm
Room: MRC 313

Instructor Information
• Instructor: Dr. Aranya Chakrabortty
• Office: Keystone Science Center, Room 100-26
• Office Hours: Monday 3:00 – 5.00 pm, or by appointment

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Pre-requisite:
ECE 451: Power System Analysis
ECE 308: Elements of Control
ECE 516 and 550 are preferred but not required

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/SPR-2016/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%
Project: 10%
Final Exam: 40%
Homework assignments will be uploaded to the ‘Homework’ section on the course website. 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 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. Chakraborty will help you in choosing the appropriate topics. A 10-minute presentation will be given by each group at the last week of classes. More detailed information will be given on this before Spring holiday.

**Course outline**

01/07 (Th) Review of linear systems, state-space modeling, eigenvalues, linearization  
01/12 (T) Transfer function models, SMIB power system, swing equation, power-angle curves  
01/14 (Th) Angle stability and equal-area criterion  
01/19 (T) Numerical problems on equal-area criterion, critical clearing time  
01/21 (Th) Swing equations for networks  
01/26 (T) Swing equations for networks with algebraic constraints  
01/28 (Th) Synchronous machine response to small-signal perturbation  
02/02 (T) Matlab simulations for small-signal response  
02/04 (Th) Gain margin, phase margin of SMIB systems  
02/09 (T) Excitation systems modeling  
02/11 (Th) Excitation systems (continued) , AVR and PSS  
02/16 (T) AVR and PSS (continued)  
02/18 (Th) Bifurcations in swing models of power systems  
02/23 (T) Simulation examples using Matlab  
02/25 (Th) Synchronous machine modeling  
03/01 (T) Synchronous machine modeling (continued)  
03/03 (Th) Midterm  
03/08 (T) Holiday – Spring break  
03/10 (Th) Holiday – Spring break  
03/15 (T) Power system oscillatory modes  
03/17 (Th) Modal decomposition methods  
03/22 (T) Matlab examples of modal decomposition  
03/24 (Th) Identification of swing models using least squares  
03/29 (T) Damping controller designs using PSS  
03/31 (Th) Damping controller using combined AVR/PSS  
04/05 (T) Damping control design using FACTS controllers  
04/07 (Th) Damping control design using FACTS controllers  
04/12 (T) Voltage oscillation study  
04/14 (Th) Voltage stability, PV curves  
04/19 (T) Nonlinear control designs for PSS  
04/21 (Th) Review and discussions for the final exam, project presentations
Final Exam: 5th May, Thursday, 8 am – 11 am, MRC 313

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.