ELK 5350 POWER SYSTEM STABILITY 3(3 0 0)

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Objectives of the Course

The students are subject to learn stability concepts in power systems including those of synchronous machine modeling, load-frequency control modeling of synchronous machines, excitation system types and their dynamic models, single machine dynamic models. multi-machine dynamic models, small-signal models and stability of synchronous machines, computer-based simulations of developed models, transient stability and stability margin enhancement.

Contents

The course covers the basic concepts of power system stability. Transients, dynamics, and steady-state stability concepts are covered. Nonlinearity of synchronous machine parameters is shown. Park's transformation and two-axis d-q modeling of synchronous machines is given. Besides the synchronous machine model, turbine, load, and excitation system models are also obtained and combined to yield a power system model. Different types of excitation systems are studied and modeled. IEEE type excitation systems are studied. Small-signal dynamic models are obtained and represented by block diagrams in conjunction with the dynamic models of stabilizer models. Therefore, the power system models are simulated with and without stabilizers. A direct solution method of transient stability is studied. A power system stability program combined with a power flow solution program is described and operated to show the results and importance of transient stability.

In this course, the above described modelings are used in load-frequency control, bus voltage regulation, power factor correction, and stability margin enhancement problems of power systems.

Learning Outcomes

Upon successfully completion of the course, the students will be able to :

LO - 1 : Have sufficient knowledge on the operation of synchronous generators
LO - 2 : Have sufficient information on governor (prime) control of synchronous generators
LO - 3 : Have sufficient knowledge on excitation control of synchronous generators
LO - 4 : Develop small signal model of power systems
LO - 5 : Model, analyze and control single and multi-area power systems
LO - 6 :.Model and analyze voltage and stability issues in power systems
LO - 7 : Use equal area criterion to analyze power system stability (PSS)
LO - 8 : Analyze and control voltage and frequency oscillations in PSS

Teaching Plan

Week 1 Transient, sub-transient and steady state stability definitions in power systems
Week 2 Understanding governor and excitation control
Week 3 Modelling power system for governor control
Week 4 Developing controllers for governor control
Week 5 Modelling power system for excitation control
Week 6 Developing controllers for excitation control
Week 7 Modelling single machine infinite bus system
Week 8 Modelling multi machine systems
Week 9 Midterm exam
Week 10 Voltage and frequency control of single area power systems
Week 11 Voltage and frequency control of multi-area power systems
Week 12 Equal area criterion and its use for power system stability
Week 13 Simulation examples for power system stabilities
Week 14 Evaluating term projects
Week 15 Evaluating term projects
Week 16 Final exam

Text book / Course materyals

1. Ismail H. Altas, unpublished lecture notes
2. Ismail H. Altas, "Fuzzy Logic Control in Energy Systems with design applications in MATLAB/Simulink", The Institution of Engineering and Technology (The IET) Books, 2017.

Aditional resources

3. P.M. Anderson and A.A. Fouad, *Power System Control and Stability*, John Wiley & Sons, Inc, 2003.
4. P. S. Kundur, *Power System Stability and Control*, McGraw-Hill Professional, 1994.
5. E. W. Kimbark, *Power System Stability*, Wiley-IEEE, 1995.
6. J. W. Bialek, J. Machowski, *Power System Dynamics and Stability*, John Wiley, 1997.
7. P. W. Sauer, M. A. Pai, *Power System Dynamics and Stability*, Prentice Hall,1998.
8. K. R. Padiyar, *Power System Dynamics: Stability and Control*, John Wiley, 1996.
9. L. L. Grigsby, *Power System Stability and Control*, Taylor & Francis, 2007
10. H. Saadat, *Power System Analysis*, McGraw Hill Book Company, 1999.

Evaluation Method

Method	Week	Date	Duration (Hour)	Contribution (%)
Midterm	9		2	30
Project 1	5 - 11		12	20
Project 2 (Final)	10 - 15		12	50
Total			26	100

Student Work Load and its Distribution

Type of work	Duration (hours pw)	Number of weeks
Lectures (face to face teaching)	3	14
Extracurricular work	2	10
Preparation for the Midterm Exam	2	8
Midterm	2	1
Homework	0	0
Project	2	6
End of term exam	2	6
Other 1	2	1
Total Work Load	**15**	

ADDITIONAL INFORMATION

Prerequisites

Although there is no official prerequisite for this course; it is highly recommended to have some knowledge on steady-state operation principles of electrical machines and power systems, especially basic operation principles of synchronous machines and power transmission. Being familiar with Matlab/Simulink will also help.

Simulation Examples

There are some special selected problems to be done as design projects by the students. These projects will be described during first 2-3 weeks and will be published in course website at www.altas.org. The followings are some of the titles to be studied in design projects.

1. Excitation Systems in Power Systems
2. Load-frequency control of power systems
3. Transient stability issues in power systems
4. Small signal models and simulation
5. Two-area power system control and generalization to multi machine systems

Course Evaluation, Test/Quiz/Project/Final Exam Schedule

This is a project based graduate course. There will be a sit-down midterm exam and two projects instead of the second midterm and final exams. Students are expected to show very high performance on doing the projects. Every student will have a different problem or physical system to study and simulate for control purposes. The first project must be submitted before the end of the 13^{th} week of the lectures. The due date for the second project is the final exam day of this course. All students must submit their projects not later than the dates described above. Otherwise, the grade will be zero. The weightings for the projects will be as follows:

Midterm 1	Sit-down exam	:	30%	A sit-down written exam.
Project 1	As Midterm 2	:	20%	Must be submitted by the end of the 13^{th} week of this term
Project 2	As Final	:	50%	Must be submitted by the end of the final exam day
	Total	:	100%	

All projects must be written in IEEE paper format and submitted in the forms of both hard copy and computer files. All related files including reports as MS Word .doc files, Matlab .m files, Simulink .mdl files or other file types must be submitted by e-mail to ihaltas@altas.org. An MS Word Template file is available in the Course Resources area of the course web site at www.altas.org.
Good project works will be evaluated as joint conference or journal papers.

E-Mail Group

An e-mail group will be established for communicating with the students who admitted this course. I will create this e-mail group to send some important information and announcements by e-mail.

Additional Requirements

- Attendance in 70% of lectures is compulsory.
- Having lecture notes in classroom during the lectures is required.
- Cell phones must be powered off during the lectures and all exams.
- Since the students have plenty of time to submit their projects, there will not be any deferred exams.