UNIVERSITY OF WATERLOO

Department of Electrical & Computer Engineering

ECE 6613 PD: Power System Analysis
Course Outline
Fall 2012

Instructor:
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Office hours: Tuesdays and Thursdays 5:30-6:30 PM (course chat-room) , TBC

Lectures: Wednesdays 9:30 AM -12:20 PM, with a ~20 min break at ~10:50 AM.

Objectives:
- Understand the basic definitions and concepts associated with short circuit, power flow and stability analysis.
- Discuss in detail techniques and tools for power system analysis, with a practical perspective.

Content:

No. of Weeks	Topics	Sub-Topics
1	Review	• Basic power system elements and models: generators; transmission systems; loads.
1	Power Flow	• System model. • Equations. • Solution techniques: Newton-Raphson; fast decoupled.
1	Short Circuit	• System model. • Faults: 3-phase; single-phase-to-ground; two-phase; two-phase-to-ground. • Matrix analysis.
1	Basic stability concepts	• Nonlinear systems: Ordinary Differential Equations (ODE), Differential Algebraic Equations (DAE) • Equilibrium points: Definition; linearization; eigen analysis. • Stability regions.

3	Voltage Stability and Control	• Definitions. • Voltage collapse: ◊ Basic concepts. ◊ Tools: Continuation power flows; direct methods; indices. ◊ Control and protection: Compensation; secondary voltage regulation; under-voltage relays. ◊ Practical applications: Transmission congestion; a real blackout analysis. • Voltage regulation: ◊ Basic concepts. ◊ Practical applications: A real blackout analysis.
2	Small-perturbation Stability and Control	• Definitions and basic concepts. • Tools: Eigenvalue analysis. • Control and protection: PSSS; FACTS. • Practical applications: A real blackout analysis.
2	Transient Stability and Control	• Definitions and basic concepts. • Tools: time domain simulations; direct methods (energy functions and equal area criterion). • Practical applications: A real blackout analysis.
1	Frequency Stability and Control	• Definitions and basic concepts. • Control and protection: primary and secondary frequency regulation; automatic generation control (AGC); under-frequency relays. • Practical applications: A real blackout analysis.

Recommended Text:
A. Gómez-Expósito, A. J. Conejo and C. A. Cañizares, Editors, *Electric Energy Systems: Analysis and Operation*, CRC Press, July 2008, ISBN 0849373654.

Other References:
1. A. R. Bergen and V. Vittal, *Power systems analysis*, Second Edition, Prentice-Hall, 2000.
2. J. Arrillaga and C. P. Arnold, *Computer analysis of power systems*, John Wiley, 1990.
3. P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1994, ISBN 0-07-035958-X.
4. P. M. Anderson and A. A. Fouad, *Power system control and stability*, IEEE Press, 1994.
5. C. A. Cañizares, Editor, "Voltage stability assessment: concepts, practices and tools," IEEE-PES Power System Stability Subcommittee Special Publication, SP101PSS, May 2003.
6. I. S. Duff, A. M. Erisman and J. K. Reid, *Direct Methods for Sparse Matrices*, Oxford Science Publications, 1986.
7. Journal papers and technical reports (available on-line).
8. Course notes available at course website.

Requisites: Basic knowledge of power systems and modeling is required. Some familiarity with MATLAB is desirable but not required.

Marking:

Projects (2)	→	25 %	
MT Exam	→	25 %	Take home; date and time TBD
Final Exam	→	50 %	Date, time and location TBD

MT Exam: Take home, *individual* test based on problems presented and discussed during lectures regarding the various topics discussed in class. Some problems might require the use of MATLAB, PSAT and/or UWPFLOW.

Projects:

1. Short circuit analysis of the IEEE 14-bus test system using MATLAB.
2. Stability analysis of the IEEE 14-bus test system using PSAT.