ECE 418 (419) - Power Systems Analysis (with Laboratory)

Credits: 3 (4), **Contact Hours:** Two 75-minute lecture session per week, (one 160-minute laboratory session per week).

Coordinator: Hassan Shanechi, Senior Lecturer of ECE
Textbook: J. Glover, M. Sarma, and Overbye Power System Analysis and Design, Sixth Edition, Cengage Learning, 2017

2019 Catalog Data: ECE 419: Power Systems Analysis with Laboratory. Credit 4.
Transmission systems analysis and design, network analysis using Newton-Raphson load flow. Unsymmetrical short-circuit studies. Detailed consideration of the swing equation and the equal-area criterion for power system stability studies. Use of commercial power system analysis tool to enhance understanding in the laboratory.
Prerequisite(s): [(ECE 319)]
(3-3-4) (C)(P)

Enrollment: Elective course for CPE and EE majors.

Specific outcomes of instruction:

After completing this course, the student should be able to do the following:

1. Construct the power transformer equivalent models, calculate the transformer performance indices and use the short circuit test and open circuit test data to derive the transformer models.
2. Derive and calculate the resistance, inductance, and capacitance for single-phase and three-phase transmission lines.
3. Derive the models for short, medium, and long transmission lines and calculate the line performance indices.
4. Apply Gauss-Seidel method or Newton-Raphson method to obtain a power flow solution of small power systems (2 or 3 bus system).
5. Utilize the generator steady state and transient models in fault analysis and stability analysis.
6. Describe the three-phase symmetrical fault and use Thevenin's equivalent and Z bus matrix to calculate the three-phase faults applied to small power systems (2 or 3 bus system).
7. Apply the concept of the symmetrical components (currents, voltages, impedances) in the calculation of the unsymmetrical faults (line-to-ground, line-to-line, and line-to-line-to-ground-faults).
8. Derive the swing and power equations for a single machine connected to infinite bus system and use them in the transient stability calculation. Use the Equal-Area Criterion in calculating the critical clearing time to clear a fault and to determine if the machine will remain stable following a disturbance such as three-phase fault or an increase in the machine mechanical power input.
9. Use *Matlab* in solving questions related to the above eight objectives.
10. Use commercial grade software (PSS/E) to analyze and design real power systems.

Relationship of ECE 419 specific outcomes of instruction to student outcomes:

	Student Outcomes	**Course Goals**
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1,2,3,4,5,6,7, 8
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	3,4,5,6,7,8
3	An ability to communicate effectively with a range of audiences	9,10
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	10
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	10
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Topics:

- Introduction and review of power networks (1 week)
- Power system components modeling, transformers, transmission lines, per unit systems (1 week)
- Transmission line models and performance. (1.5 weeks)
- Power flow analysis (3weeks)
- Fault analysis (3 weeks)
- Steady state stability analysis (2 weeks)
- Transient stability analysis (2 weeks)
- Tests and review (1.5 weeks)

Computer usage: Students write programs in MATLAB and use the software included in the textbook and PSS/E.

Laboratory topics:

- Introduction to PSS/E (1 week)
- Transmission line parameter calculation (1 week)
- Transmission line design (1 week)
- Power flow analysis (2 week)
- Control of power flow (1 week)
- Symmetrical short circuit analysis (1 week)
- Unsymmetrical short circuit analysis (1 week)
- Application of short circuit analysis in design (1 weeks)
- Stability analysis (1 week)
- Major design experiment (4 weeks)
- Tests (1 week)

Prepared by: Hassan Shanechi **Date:** March 1, 2020