# Fall Semester 2017

## EEL4930/ 5270 – Power System Transients
## Undergraduate and Graduate Credit Syllabus

**Undergraduate and Graduate Bulletin Description**:

This course addresses the broad range of transient issues on electrical utility and industrial power systems. The purpose is to teach the student the fundamental principles of this vital subject and equip the student to recognize and solve transient problems in power networks and components. Such problems continue to reappear in different guises with new applications and new equipment. The fundamental ideas are presented first followed by a consistent effort to show how an engineer peels away the superficial differences in transient studies to a point where basic principles can be applied.
The Laplace transform method is the foundation of the formal mathematical analysis. However, many solutions to problems are also reached by a relatively simple process of deduction, which stresses physical insight. Hence, mathematics is used to facilitate understanding.
The material begins with single-phase circuits and progresses to three-phase networks. Circuit complexity proceeds from lumped-parameter modeling to distributed-parameter modeling. Computer solution techniques based on time-domain analysis are introduced throughout the material. Component and system modeling are presented for circuit breakers, machines, transmission lines, and other apparatus. Modeling and analyzing lightning strikes on electrical systems climaxes the course material. Introduction to Electromagnetic Transient Programs (EMTP) will discussed with respect to both offline and real-time simulation strategy.

**Class Meeting Schedule**:
Mondays and Wednesdays from 3:30 to 4:45 pm
Room A 305

**Pre-requisites**
EEL 3216 Fundamentals of Power Systems with a C or better grade or graduate student Status

**Instructor**:
Dr. Omar Faruque
Office: B 365
Office Phone: 850 410 6126, 850 645 8971
Email: faruque@caps.fsu.edu
Office hours: Mondays & Thursdays 2:00 pm to 3:15 pm, or by appointment.

**Learning Outcomes**:
By the end of this course, ***undergraduate students*** will be able to:

1. Apply the Laplace transform to solve basic power system transient analysis problems such as opening a circuit breaker under fault conditions and closing a circuit breaker on a capacitor bank.
2. Model power system apparatus and sources for transient analysis. Know models for lightning and circuit breaker switching operations.
3. Demonstrate techniques for solving traveling wave problems on transmission lines.
4. Extend solution techniques to solve coupled three-phase power system problems.
5. Apply computer analysis tools to solving large-scale transient problems.
6. Understand algorithms behind the computer simulation of power system transients

By the end of this course, ***graduate students*** will additionally be able to:

6. Use off-line and real-time Computer Simulation programs to understand some specific transient related issue through additional simulation project.

**Required text(s) and suggested readings**:

***Text book:***
Lou Van der Sluis, *Transients in Power System*, 1st edition, Wiley.

***Reference book/Suggested readings***
*Electrical Transients in Power System*s, Second Edition by Allan Greenwood
*Power System Analysis and Design*, Fifth Edition 5th Edition
by J. Duncan Glover (Author), Mulukutla S. Sarma (Author), Thomas Overbye (Author)

Selected readings from the journal and conference papers

**Instructional Delivery**:
This course will be 80% lecture, 20% seminar/discussion.

**Course Requirements**: (All students)

**In-class quizzes** (30 points). At least four quizzes will take place and the best three will be counted

**Homework/Assignments** (30 points). Three assignments will be conducted during the semester.

**Final Project/Exam** (40 points). The final exam/project will be administered in the university final exam schedule for this course. The projects will be announced in the first two weeks of class. Students can themselves also propose projects.

***GRADUATE STUDENTS ONLY***

In addition to all of the above, Graduate Students will also be required to do a case study where a transient case will be studied through modeling and simulation but without using any commercial tool. They will require to derive the necessary differential equations and solve them using any numerical method for observing the transient response.

**Software Required:**
PSCAD/EMTDC or equivalent software and/or Matlab

**Grading Scheme**:

| Grading | | Letter | |
|---|---|---|---|
| Homework | 30 % | 90% and above | A |
| Quiz | 30 % | 80% - 89% | B |
| Final Project and Report | 40 % | 70% -79% | C |
| | | 60% -69% | D |
| **Total** | **100** | | F |

**Grade announcement**
Quiz and homework grade will be published in the blackboard and Final grade will be submitted in the roaster.

**Tentative Course Outline**

Please recognize that this is a "best guess" of our progress through content. Revisions may be required as the semester yields weather constraints and/or for other unforeseen issues. Every effort will be made to keep all informed of any changes that occur.

| Topic | Week |
|---|---|
| Fundamental circuit analysis of electrical transients | 1 |
| The Laplace Transform and the Dommels Integral | 2 |
| Switching transients | 3 |
| Damping circuits | 4 |
| Abnormal switching transients | 5 |
| Three-phase circuits and transients | 6 |
| Electromagnetic phenomena during transients | 7 |
| Traveling waves and transmission lines | 8 |
| Frequency response modeling | 9 |

| | | |
|---|---|---|
| Modeling power apparatus | 10 | |
| Computer aids for transient studies | | 11 |
| Parametric studies and modeling | 12 | |
| Modeling of lightning | | 13 |
| Insulation coordination | 14 | |
| Final Exam/project per Due | | 15 |

**Academic Integrity and Honor Code**

The FAMU and FSU Honor Codes shall be observed. Students are bound by the Academic Honor Code of their university as published in the associated University Bulletin and Student Handbook. The Academic Honor System is based on the premise that each student has the responsibility (1) to uphold the highest standards of academic integrity in the student's own work, (2) to refuse to tolerate violations of academic integrity in the university community, and (3) to foster a high sense of integrity and social responsibility on the part of the university community. Although study groups are encouraged, all homework and tests must represent work of individual students. Copying of homework, cheating on tests and all other forms of academic dishonesty will not be tolerated. Violations of the academic honor code will be reported to the appropriate academic official. Penalties include but are not limited to 1) failing grade on an assignment or exam, 2) failing course grade, 3) academic suspension, or 4) academic dismissal.

**Attendance Policy**

Class attendance and participation are very important to learning the material and are required. Class discussions will involve solution techniques, modeling helps, and problem solving. It is strongly recommended that a full scientific calculator be brought to class. A calculator that can perform complex arithmetic and matrix inversion will be most advantageous.

**Disability Services**

Students with disabilities needing academic accommodations should:
1. Register with and provide documentation to the Student Disability Resource Center (SDRC).
2. Bring a letter to the instructor from the SDRC indicating you need academic accommodations. This should be done within the first week of class.
For more information about services available to FAMU & FSU students with disabilities, contact the Assistant Dean of Students at your respective university.

**Submission of Assignments**

Homework assignments are due one week after being assigned unless otherwise mentioned. Homework problems in each assignment may be randomly selected for grading.

As upper-level students, the highest quality of work is expected. Solutions are to be writing only on the front side of the page. Each problem is to begin on a new page. Good penmanship and neatness are required. Each problem solution should be presented in a clear and logical order so that other engineers can follow your solution process without guesswork. Draw a box around the numerical answers asked for by the problem. Remember, the solution method is equally important in determining the grade, as is the final solution. Numerical solutions should be expressed to three digits of precision unless otherwise requested.

**Late Submission of Assignments/Homework**

Late homework will not be accepted. Students with a valid and approved excuse will be awarded 50% for the homework if the solution is 100% correct.

**Grade Disputes**
Disputes in grading of homework and tests must be made within one week after the grade is announced to the student. The student will have the burden of proof to show why her/his solution method is correct.

**Calculation of Course Grade**

A weighted average grade will be calculated as specified on the first page of the syllabus. A weighted grade is guaranteed a course grade as specified on the first page. This course will not have curved grades of the course grade. It is theoretically possible for everyone in the class to get an A (or an F).

**Consultation with the Faculty**

It is strongly encouraged that you discuss academic questions with the course instructor. The instructor is available during office hours or by email for consultation.

**Distance learning related components**
All learning outcomes in this Distributed Learning course are equivalent to face-to-face (F2F) version of this course.

This course is an asynchronous online course. Students will work at different times from different locations and will not be required to attend any face-to-face (F2F) or synchronous meetings at the same time.

All discussion board posts and emails will be responded to within 48 hours. Feedback will be provided on all assignments within 48 hours.

Online lectures will be provided through Adobe Connect Professional. Therefore, students must has access to the Internet to view/hear lectures. No special software is required. Students will also submit all assignments and take all quizzes/tests through Blackboard.

Minimal technical skills are needed in this online course. All work in this course must be completed and submitted online. Therefore, students MUST have consistent and reliable access to a computer and the Internet. Before starting this course, students must feel comfortable doing the following. The minimal technical skills students should have include the ability to:

- organize and save electronic files,
- use email and attached files,
- check email and Blackboard daily, and
- download and upload documents.