New York University
Department of Electrical and Computer Engineering
ECE-GY 6633 – Transients, Surges and Faults in Power Systems
Fall 2019

Prof. Francisco de León

Lectures: Tuesdays from 3:20 PM to 5:50 PM at 2 MTC Room 817

Contact information: fdeleon@nyu.edu
Room: Dibner Building (5 MTC) room 200 – G
Phone: 646 997 3961
Cell: 347 385 0601
Office hours: Tuesdays 2:00 to 3:00, or by appointment

Pre-requisites: Graduate status or equivalent knowledge to ECE-GY 5613 (Symmetrical Components)

Description: This course is an introduction to the study of electromagnetic transients in power systems. Its importance stands from the fact that electromagnetic transients determine the design of the insulation of all electrical equipment. The course also serves to gain better understanding of other advanced courses in power such as: ECE-GY 6613 (Transmission and Distribution), and especial topic courses. This course also prepares the participants to start research work in the area of electrical transients.

Objectives: At the end of the term the participants will be able to compute and analyze the most common electrical transients that a power system is subjected. The participants will understand why the study of transients is of paramount importance in the design of an electrical system. They will also be able to use the existing specialized software for the computation of electromagnetic transients in power systems (EMTP-type programs).

Structure: The course is based on lectures, but it heavily relies on the use of an electromagnetic transients simulation program such as the EMTP-RV, ATP, or PSCAD. A great number of application examples will be resolved in class, as assignments, and as projects. We have a partnership with the company that distributes the EMTP-RV, and students can have free of charge access to the full commercial program.

Textbook: The *required* textbook for the course is: Allan Greenwood, "Electrical Transients in Power Systems", Second Edition, John Wiley & Sons, 1991. ISBN: 0-471-62058-0.

Reference Material: The following reference books cover the history and all important aspects of the area of electromagnetic transients and the numerical methods used for the computation:

[1] L. van der Sluis, "*Transients in Power Systems*", John Wiley & Sons, 2001.
[2] H. W. Dommel, "EMTP Theory Book", 1987.
[3] Leuven EMTP Center, "*Alternative Transient Program Rule Book*", 1987.
[4] P. E. Viemeister, "*The Lightning Book*", MIT Press, 1972.
[5] L. O. Chua and P. Lin, "*Computer Aided Analysis of Electronic Circuits*", Prentice-Hall, 1975.
[6] P. Chowdhuri, "*Electromagnetic Transients in Power Systems*", Research Studies Press, 1996.
[7] N. R. Watson and N. Watson, "*Power Systems Electromagnetic Transients Simulation*", IEE Power & Energy Series, 2001.

[8] Juan Martinez-Velasco, "*Power System Transients: Parameter Determination*", CRC Press, 2009.

There are also a good number of papers that are very useful for this course:

[1] H. W. Dommel, "*Digital Computer Solution of Electromagnetic Transients in Single- and Multiphase Networks*", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-88, No. 4, April 1969, pp. 388-399.
[2] H. W. Dommel and W.S. Meyer, "*Computation of Electromagnetic Transients*", Proceedings of the IEEE, Vol. 62, No. 7, July 1974, pp. 983-993.
[3] J. R. Carson, "*Wave Propagation in Overhead Wires with Ground Return*", Bell System Technology Journal, No. 5, 1926, pp. 539-554.

Software requirements: The students need to gain access to one of the specialized commercial software simulation packages (called EMTP-type programs). Note that Matlab Simulink or LTSpice are not recommended for this course, please get one of this:

1) **EMTP-RV**. Access will be given to all students in the class as per partnership with the manufacturer. Our research group has substantial experience with this program.

2) **ATP**. Access to the royalty free ATP will be provided to those who complete the licensing agreement with the Canadian/American EMTP User Group at http://www.emtp.org/. The ATP Draw Users Guide will be provided as a pdf file.

3) **PSCAD**. The manufacturer offers a student version, which is identical to the commercial version, except that is limited to small size systems. In our group we do not have much experience with this program, but it is commonly used in the industry.

Students are invited to bring their laptops to work (hands-on) the class examples. Note, however, that the course is about transients and not about using the simulation software.

Course Evaluation:

All students must take a mid-term exam on March 20, 2018 for 30% of the credit. Also all students need to handle their homework two weeks after it was assigned for 20% of the credit.

Homework includes all the examples worked in class. The report should contain observations and conclusions relating the results to theory.

The remaining 50% of points come from the final exam on May 15. Students may also select to work on a research project. However, for this option to be possible you need to convince me that the selected project has research merit and fulfils the objectives of this course. You should your progress every week in one of the group research meetings.

	Date	Option 1 (Project)	Option 2 (Final)
Homework	Weekly	20%	20%
Mid-term exam	October 29	30%	30%
Project*	December 10	50%	-----
Final exam	December 17	-----	50%
Total		100%	100%

* The project must be written using the IEEE/PES paper template.

Class Schedule (Fall 2019)

Lectures: 9/3, 9/10, 9/17, 9/24, 10/1, 10/8,
Legislative Day: 10/15 No Class (Monday classes meet)
Lecture: 10/22
Midterm: 10/29
Lectures: 11/5, 11/12, 11/19, 11/26, 12/3, 12/10
Project presentations: 12/10
Final: 12/17

Format of the report: IEEE paper template.

1) Presentation of project in Power Point
2) Deliver a project report, with the following:

    a. Title
    b. Abstract
    c. Introduction
        i. Scopes
        ii. Limitations
    d. Results
    e. Conclusions
    f. Recommendations

Detailed Contents

1. **Electric Circuits: A Refresher**
    a. Current and voltage sources
    b. Resistance, inductance (self and mutual) and capacitance
    c. Series and parallel circuits
    d. Classification of electromagnetic transients in power systems
        i. Over-voltages and over-currents
        ii. By device: transmission lines, transformers, capacitors, motors.
    e. Simple transients
        i. RL and RC circuits
        ii. Introduction to solution methods
        iii. Special circuits with mathematical contradictions
        iv. RLC Circuit
    f. ATP examples

2. **Numerical Tools**
    a. Numerical integration
    b. Trapezoidal rule of integration (TRI)
        i. Absolute stability
        ii. Numerical oscillations
    c. Norton equivalent circuits
    d. KCL and KVL

3. **Simulation Tools**
    a. Time-domain solution of the state equations
    b. EMTP/ATP
    c. Special circuits with mathematical contradictions

4. **Modeling of Power Apparatus and Systems**
    a. Transmission lines
    b. Cables
    c. Transformers
    d. Generators
    e. Switchgear
    f. Surge arresters

5. **Switching Transients**
    a. Connection and disconnection of transmission lines
    b. Connection and disconnection of transformers and inductors
    c. Connection and disconnection of capacitors
    d. Symmetrical and asymmetrical faults
    e. Transient recovery voltage

6. **Transients in Three-Phase Systems**
    a. Symmetrical components
    b. Modal transformations
    c. Connection of lines, transformers, capacitors and faults

7. **Lightning**
    a. Description of the problem
    b. Physical phenomena
    c. Effects in the power system
    d. Impulse test

8. **Protection and Reduction of Transients**
    a. Shielding
    b. Arresters
    c. Grounding
    d. Circuit elements
    e. Insulation coordination

9. **Advanced Topics (time permitting)**
    a. Calculation of model parameters
    b. Electric equivalents of magnetic circuits
    c. Frequency dependency
    d. Modeling of non-linear components

Moses Center Statement of Disability

If you are student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 2nd floor.

NYU School of Engineering Policies and Procedures on Academic Misconduct

Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who

A. Breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

B. Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

   1. Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
   2. Fabrication: including but not limited to, falsifying experimental data and/or citations.
   3. Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
   4. Unauthorized collaboration: working together on work that was meant to be done individually.
   5. Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.
   6. Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.