INSTITUT EN GÉNIE DE L'ÉNERGIE ÉLECTRIQUE
INSTITUTE OF ELECTRICAL POWER ENGINEERING

IGEE 402 – Power Systems Analysis (Réseaux électriques)

Course Outline
Fall 2020

Instructors:

Professor François Bouffard, P.Eng.
E-mail: francois.bouffard@mcgill.ca
Office Hours: Virtual, by appointment; information to book appointments will be provided on Moodle.

Equivalences:

ELEC 431	Electrical Power Systems (Concordia University)
ELE653	Transport de l'énergie (ÉTS)
ELE8452	Réseaux électriques (Polytechnique Montréal)
ECSE 464	Power Systems Analysis (McGill University)
GEI 145	Génération et transport (Université de Sherbrooke)
GEL-4150	Réseaux électriques (Université Laval)
GEI1047	Réseaux de transport d'énergie (UQTR)
6GEI700	Transport et exploitation de l'énergie (UQAC)
GEN43216	Réseaux électriques (UQAR)
GEN4335	Conception, analyse et exploitation d'un réseau électrique (UQAT)
GEN1673	Réseaux électriques (UQO)

Textbook:

J.D. Glover, M.S. Sarma & T.J. Overbye. (2016). *Power System Analysis & Design*, 6th ed., Stamford, CT: Cengage Learning.

Alternate Texts:

J.J. Grainger & W.D. Stevenson Jr. (1994). *Power System Analysis*. New York, NY: McGraw-Hill.
A. Gómez-Expósito, A.J. Conejo & C. Cañizares, eds. (2009). *Electric Energy Systems*: Analysis and Operation. Boca Raton, FL: CRC Press.
These books are alternate reference books for the course, covering in more depth the topics addressed in the main text.

Lectures:

Online, using the Zoom online meeting platform; lectures will be live and recorded; links to join the lecture will be provided by the instructor on Moodle
Wednesday: 9:30 – 12:20, Montreal time

Laboratory:

Online, using the Zoom online meeting platform; remote lab access instructions will be provided on Moodle
Groups 1 & 2 – Every other Wednesday: 13:45 – 16:40
Assistant: Mohamed Awadalla
E-mail: mohamed.awadalla@mail.cgill.ca

Course Website:

www.moodle.polymtl.ca; browse for IGEE 402 / ELE 8452 Réseaux électriques.

Course Outline:

Objectives of the Course

The course presents the principles of operation and methods of analysis and design in sufficient depth to give the students the basic tools for investigating basic power system issues. Students will develop a sound understanding of a broad range of topics related to modeling of power system apparatus and analyzing their responses to system disturbances, as well as their deployments in coordinated power network operations.

Topics covered

- Power system fundamentals: Principal objectives; structure and building blocks; transmission versus distribution; operating criteria; economical aspects.
- AC three-phase network analysis: Balanced three-phase networks; three-phase power.
- Transformers: Equivalent circuit models; per-unit calculations; operation.
- Transmission lines: Parameters; models for balanced operation; compensation.
- Power flow analysis: Admittance matrix; problem formulation; solution by the Newton-Raphson method; power flow control.
- Synchronous machines: Basic models for power system studies.
- Symmetrical components: Fortescue transformation and sequence networks.
- Introduction to power system protection: Symmetrical and asymmetrical fault calculations.
- Introduction to power system stability and control: Transient stability; voltage and frequency control.
- Economic operation: Economic dispatch; optimal power flow.

Grading Scheme:

Assignments (4)	20 %
Laboratory reports (4)	15 %
Mid-term examination (take home)	20 %
Final examination (take home)	45 %
Total	**100 %**

Laboratory:

Work using computer simulations covers the following topics and applications:

- Operation of radial lines – transmission line models
- Power flow in meshed systems – control and compensation
- Fault analysis – symmetrical and unsymmetrical short circuit studies
- Power system transient stability – transient operation under faults

Laboratory instructions will be available for download from the course website.
Laboratory experiments will be conducted using *Powerworld Simulator*.
Students are to work in pairs, and each student is required to hand in the same report.
Students in the team will receive the same grade.
Laboratory reports are normally due one week after the scheduled laboratory period.

Assignments

Assignments will be made available for download about every fortnight.
Assignments have to be submitted individually. Collaboration is expected, but individual submissions have to be produced.
Assignments will be due within one week.

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Detailed Schedule – Fall 2020

Wk	Date	Topic	Chapter / Sections	Assignments	Laboratory Virtual A-328
1	2 Sept.	Power system fundamentals, ac power, three-phase circuits	1.1–1.4, 2.4–2.6, 14.1–14.3		
2	9 Sept.	Transformer equivalent circuit, operation, per-unit system	3.1–3.5, 3.7, 3.8	**Assignment 1**	Industrial power system – Intro lab – Group 1
3	16 Sept.	Transmission line characteristics & parameters	4.1–4.10		Industrial power system – Intro lab – Group 2
4	23 Sept.	Transmission line models	5.1–5.3		**Industrial Seminar – André Dagenais HQTÉ**
5	30 Sept.	Transmission line models	5.4–5.7	**Assignment 2**	Operation of radial transmission lines – Group 1
6	7 Oct.	Power flow modelling, calculations & control	6.4, 6.6		Operation of radial transmission lines – Group 2
	14 Oct.	**Fall reading week**			
7	21 Oct.	Power flow modelling, calculations & control	6.7, 6.9, 6.10		
8	28 Oct.	**Take home midterm (all topics from weeks 1–6)** Symmetrical faults	7.2–7.4	**Assignment 3**	Power flow in meshed systems – Group 1
9	4 Nov.	Symmetrical components	8.1–8.6, 8.8		Power flow in meshed systems – Group 2
10	11 Nov.	Asymmetrical faults	9.1–9.4		Fault analysis – Group 1
11	18 Nov.	Transient stability	11.1–11.4	**Assignment 4**	Fault analysis – Group 2
12	25 Nov.	Power system control	12.1–12.3		Transient stability – Group 1
13	2 Dec.	Power system economic operation	12.4, 12.5		Transient stability – Group 2
	Take home	**Final Exam**	Exam on all topics		

Note: The period for final exams will take place from December 10th to 23rd, 2020 inclusive.