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

IGEE 402 – Power Systems Analysis (Réseaux électriques)

Course Outline Fall 2025

Instructors:
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Equivalencies:

ELEC 431	Electrical Power Systems (Concordia University)
ELE653	Transport de l'énergie (ÉTS)
ECSE 464	Power Systems Analysis (McGill University)
ELE8452	Réseaux électriques (Polytechnique Montréal)
GEL-4150	Réseaux électriques (Université Laval)
GEI 145	Génération et transport (Université de Sherbrooke)
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)
GEI1047	Réseaux de transport d'énergie (UQTR)

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: Polytechnique Montréal, Pavillon Lassonde M-2004
Wednesday: 9:30 – 12:20

Laboratory: Polytechnique Montréal, Pavillon Principal – M-5505
Groups 1 & 2 – Every other Wednesday: 13:45 – 16:40
Assistant: Ms. Chenyi Xu
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Course Website: moodle.polymtl.ca; browse for ELE8452 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.

Learning outcomes (and corresponding graduate attributes (GA) developed)

By the end of this course, students will be able to

- Formulate and analyze ac power systems models by selecting adequate component models and analysis methods (PA)
- Conduct standard ac power system analysis studies from which they can draw relevant conclusions and make recommendations (PA)
- Perform ac power system design consisting of adequate component selection and sizing (DE)
- Perform ac power system studies using simulation tools while demonstrating an understanding their limitations (ET, IN)
- Demonstrate an appreciation of how power system operation and planning have significant socioeconomic dimensions (EP)

Topics covered

- Power system fundamentals: Principal objectives; structure and building blocks; transmission versus distribution; operating criteria; economical aspects.
- AC three-phase network analysis: Review of 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 and its variants; 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: Voltage, small-disturbance and 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	20 %
Final examination	45 %
Total	**100 %**

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

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 due as indicated on Moodle.

Assignments

Assignments will be made available for download about every fortnight.

Collaboration is expected, but each student must work out solutions on their own. Offenders will be penalized.
Assignments deadlines will be indicated on Moodle.

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Detailed Schedule – Fall 2025

Wk	Date	Topic	Chapter/ Sections	Assignments	Laboratory TBC
1	27 Aug.	Power system fundamentals, ac power, three-phase circuits	1.1–1.4, 2.4–2.6, 14.1–14.3		
2	3 Sept.	Transformer equivalent circuit, operation, per-unit system	3.1–3.5, 3.7, 3.8	**Assignment 1**	Industrial power system – Intro lab – Group 2
3	10 Sept.	Transmission line characteristics & parameters	4.1–4.10		Industrial power system – Intro lab – Group 1
4	17 Sept.	Transmission line models	5.1–5.3		**Industrial Seminar – HQTÉÉ André Dagenais**
5	24 Sept.	Transmission line models	5.4–5.7	**Assignment 2**	Operation of radial transmission lines – Group 1
6	1 Oct.	Power flow modelling, calculations & control	6.4, 6.6		Operation of radial transmission lines – Group 2
7	8 Oct.	Power flow modelling, calculations & control	6.7, 6.9, 6.10		
	15 Oct.	**Fall reading week**			
8	22 Oct.	**Midterm examination (all topics weeks 1–6)** Symmetrical faults	7.2–7.4	**Assignment 3**	Power flow in meshed systems – Group 2
9	29 Oct.	Symmetrical components	8.1–8.6, 8.8		Power flow in meshed systems – Group 1
10	5 Nov.	Asymmetrical faults	9.1–9.4		Fault analysis – Group 2
11	12 Nov.	Transient stability	11.1–11.4	**Assignment 4**	Fault analysis – Group 1
12	19 Nov.	Power system control	12.1–12.3		Transient stability – Group 2
13	26 Nov.	Power system economic operation	12.4, 12.5		Transient stability – Group 1
	8 Dec.	**Final Exam**	Exam on all topics		

Note: The period for final exams will take place from December 5th to 20th, 2025 inclusive.

Canadian Engineering Accreditation Board (CEAB) Curriculum Content

This course contributes the following curriculum category content:

CEAB curriculum category content (AUs)	**Math**	**Natural science**	**Complementary studies**	**Engineering science**	**Engineering design**
	0	0	0	26	26

Accreditation units (AU) are defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time: one hour of lecture (corresponding to 50 minutes of activity) = 1 AU; one hour of laboratory or scheduled tutorial = 0.5 AU. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the time assigned to determine the AU of various components of the curriculum, the actual instruction time exclusive of final examinations is used.

Mathematics include appropriate elements of linear algebra, differential and integral calculus, differential equations, probability, statistics, numerical analysis, and discrete mathematics.

Complementary studies include humanities, social sciences, arts, management, engineering economics and communications to complement the technical content of the curriculum

Natural science includes elements of physics and chemistry, as well as life sciences and earth sciences. The subjects are intended to impart an understanding of natural phenomena and relationships through the use of analytical and/or experimental techniques.

Engineering science involves the application of mathematics and natural science to practical problems. They may involve the development of mathematical or numerical techniques, modeling, simulation, and experimental procedures. Such subjects include, among others, applied aspects of strength of materials, fluid mechanics, thermodynamics, electrical and electronic circuits, soil mechanics, automatic control, aerodynamics, transport phenomena, elements of materials science, geoscience, computer science, and environmental science

Engineering design integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.

This course contributes to the attainment of the following graduate attributes:

Graduate attribute	**PA**	**DE**	**IN**	**ET**	**EP**
Level descriptor	A	A	D	D	D

I = Introduced; D = Developed; A = Applied

Problem analysis (PA): An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

Design (DE): An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.

Investigation (IN): An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.

Use of Engineering Tools (ET): An ability to create, select, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.

Economics and Project Management (EP): An ability to appropriately incorporate economics and business practices including project, risk and change management into the practice of engineering, and to understand their limitations.

Administrative Aspects

Language of submission for coursework

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

Use of calculators

The instructor recognizes that different calculator models are used across member institutions of the IGEE. To that effect, there are no restrictions on calculator models used by students during examinations. Note, however, that calculators should not be able to connect to the internet. Therefore, mobile phones cannot be used as calculators during examinations.

Academic integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures.

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