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

IGEE 418 - ELE8461 – ECSE 463 – Electric Power Generation
(Production de l'énergie électrique)

Course Outline
Winter 2025

Instructors: Professor François Bouffard, P.Eng.
E-mail: francois.bouffard@mcgill.ca
Office Hours: Mondays 14:00-15:00 or by appointment

Equivalences:

ECSE 463	Electrical Power Generation (McGill University)
ELE8461	Production de l'énergie électrique (Polytechnique Montréal)
ELEC 446	Electrical Power Generation (Concordia University)
ELE760	Production de l'énergie électrique (École de technologie supérieure)
GEL-3010	Production de l'énergie électrique (Université Laval)
6GEI715	Production de l'énergie électrique (UQAC)
GEN44718	Production de l'énergie électrique (UQAR)
GEN1863	Production de l'énergie électrique (UQO)

Prerequisites: A basic course in power system analysis and electromechanical energy conversion. You should have a basic familiarity with: ac circuit analysis, three-phase systems, basic electromagnetic and electromechanical energy conversion devices.

References:

A. J. Wood & B. F. Wollenberg (1996). *Power Generation Operation and Control,* 2nd ed., New York, NY: Wiley.

G. A. Munoz-Hernandez, S. P. Mansoor & D. I. Jones (2013). *Modelling and Controlling Hydropower Plants*. London: Springer-Verlag

J.-C. Sabonnadière, ed. (2010). *Renewable Energy Technologies*. John Wiley and Sons.

J. Pyrhonen. (2008). *Design of Rotating Electrical Machines*, Wiley-Inter-Science – Blackwell.

G. C. Stone, E. A. Boutler, I. Calbert & H. Dhirani. (2004). *Electrical Insulation for Rotating Machines Design, Evaluation, Aging, Testing, and Repair*. John Wiley and Sons, IEEE Press.

S. Heier. (2006). *Grid Integration of Wind Energy Conversion Systems*. 2nd ed., Wiley Inter-Science.

Lectures: Polytechnique Montréal, Pavillon principal, Room B-543
Mondays: 9:30 – 12:20

Laboratory: Polytechnique Montréal, Pavillon principal, Room A-328
As per the schedule attached: 13:45 – 16:45

Course Website : www.moodle.polymtl.ca; browse for ELE8461, Production de l'énergie électrique

Course Outline: Objectives of the course (with corresponding graduate attributes)

The goal of this course is to introduce the fundamental principles and challenges arising in power generation.
The specific course objectives are:

- Solve problems concerning the operation and planning of electrical power generators – PA, EP
- Analyze the structure and principles of the controls related to electrical power generators and generating stations – KB, PA, IN
- Perform elementary design and sizing of electrical generators, rotating and static – DE
- Apply the principles governing generation dispatch and unit commitment, including management of hydro reservoirs and generating units –PA, EP
- Understand the standards governing the integration and interconnection of electrical power generators to the power grid (grid codes & interconnection standards) – KB
- Develop an understanding of the socioeconomic dimensions of electric power generation – EP

Topics covered

Energy sources – detailed schedule on the following page

- Principles of design, operation and control of synchronous generators
- Principles of operation and control of wind and solar generators
- Generation planning
- Generating station grid interconnection
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Grading Scheme:

Assignments (4)	30%
Laboratory reports (3)	15%
Midterm examination	20%
Final examination	35%
Total	**100%**

Laboratory: Work using computer simulations covers the following topics and applications (Engineering tools used: Matlab Simulink)

- Design procedures for large hydro generators
- Operation and control of synchronous generators – Frequency and voltage controllers
- Wind turbine generators – Operation and controls

Laboratory instructions will be available for download from the course website.
Students are to work in pairs, and each laboratory team will hand in a single 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.
Assignments have to be worked out individually.

IGEE 418 – ELECTRICAL POWER GENRATION
Detailed Schedule –Winter 2025

Wk	Date	Topic	Inst.	Assignments	Laboratories, seminars, ind. visits
1	13 Jan.	Primary energy sources – Conventional and renewable	FB		
2	20 Jan.	Characteristics and operation of hydro generators	FB	**Assignment 1 -** Energy sources and electric power generation	**Seminar 1**- Introduction to hydrogeneration plants **(HQ – Éric Lambert)**
3	27 Jan.	Synchronous generators – Steady state operation & modelling I	FB		
4	3 Feb.	Synchronous generators – Steady state operation & modelling II	FB		**Lab 1 -** Design procedures for large hydro generators
5	10 Feb.	Synchronous generators – Frequency and voltage control	FB	**Assignment 2 -** Synchronous generator operation and control	**Seminar 2** - Advanced synchronous generator controls **(HQ – Éric Lambert)**
6	17 Feb.	Static power converters – Principles of operation as grid-connected generators	FB		**Lab 2** - Operation and control of synchronous generators – Frequency and voltage controllers
7	24 Feb.	Principles of wind energy conversion and systems	FB		
	3 Mar.	**Reading Week**			
8	10 Mar.	**Midterm examination**		**Assignment 3** - Static power converter operation	**Industrial visit 1** – Parc éolien Pierre-De Saurel **(PEPdS – Christian Patenaude)**
9	17 Mar.	Operation and control of grid-connected renewable generation	FB		**Seminar 3** – Solar farm engineering **(CIMA+ – Éric Cantin)**
10	24 Mar.	Energy storage systems and their role in renewable energy integration	FB		**Lab 3** – Control of wind turbine generators
11	31 Mar.	Hydrogeneration operations planning	FB	**Assignment 4** – Hydrogeneration planning and storage management	**Industrial visit 2** - Centrale Beauharnois **(HQ – Éric Lambert)**
12	7 Apr.	Distributed generation interconnection and grid codes			**Seminar 4 -** Integration of bulk generation into the electric grid **(HQ – Yannick Roy)**
13	14 Apr.	Energy system integration	FB		
	TBA	**Final Exam**	Exam on all topics		

Note: *The period for exams will take place from April 22nd to May 6th, 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	30.5	15

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	**KB**	**PA**	**DE**	**IN**	**EP**
Level descriptor	A	A	A	D	D

I = Introduced; D = Developed; A = Applied

Knowledge base for engineering (KB): Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

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.

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 and smart watches 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.

Copyright statement

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