COURSE OUTLINE

ENEL 519.54 – High-Voltage Engineering

Group Study in Switzerland
Spring 2024

1. Calendar Information

High Voltage Engineering

This course covers the fundamental phenomena and principles related to the occurrence of extensive electric field strengths. This knowledge is applied to the dimensioning and use of electrical power system equipment. The course includes practical training in the high-voltage laboratory regarding the generation and measurement of high voltages, component testing and safety aspects.

Course Hours: H(3-2)

Prerequisites: Electrical Engineering 487 (Electrical Engineering Energy Systems) or consent of the department.

2. Learning Outcomes

At the end of the module, students will be able to understand:

- the principles used to generate high voltages,
- the methods to calculate and grade electrostatic fields and the mechanisms of partial discharges and breakdown of dielectrics,
- high-voltage related aspects of electric power system equipment (functionality, safety, normative aspects, testing, diagnosis, maintenance)

At the end of this course, students will be able to:

- design simple insulation systems using solids, liquids or gases as the insulation medium,
- use different kinds of high voltage sources (Marx, Cockcroft–Walton, RLC resonator, AC),
- build test circuits and perform measurement and testing on high-voltage equipment (dielectric test, TG delta, partial discharge)

3. Timetable

TBA

4. Course Instructors

Course Instructor

Section	Name	Phone	Office	Email
L01	Dominique Rolle	+41(0)26 429 67 36	C20.09	Dominique.rolle@hefr.ch

5. Examinations

The following examinations will be held in this course:

- One midterm examinations *(2 hours duration, closed book, 10 pages manuscript document allowed)*
- Final exam *(2 hours duration, closed book, 20 pages manuscript document allowed)*

6. Use of Calculators in Examinations

Non-programmable scientific calculators *(without formulae storage and /or text display features) may* be used during examinations.

7. Final Grade Determination

The final grade in this course will be based on the following components:

Component	**Weight**
Laboratory work *(Pre-lab + Lab work + Report)*	10 %
One Midterm Examinations	40 %
Final Examination	50 %
TOTAL	100 %

Notes:

a) It is necessary to earn a passing grade on the final exam in order to pass the course as a whole.

b) Conversion from a score out of 100 to a letter grade will be done using a scale determined after the final examination has been marked. This allows the creation of a scale appropriate to the relative difficulty/easiness of the term work and the final exam. As a rough guideline, the following table shows the scale used in this course in the recent past. Please note that the scale used this year will be similar but probably not identical to scales from other years.

Letter	Grade Total Mark (T)
A+	$T \geq 90.5\%$
A	$86.0\% \leq T < 90.5\%$
A-	$81.5\% \leq T < 86.0\%$
B+	$77.0\% \leq T < 81.5\%$
B	$72.5\% \leq T < 77.0\%$
B-	$81.5\% \leq T < 72.5\%$
C+	$68.0\% \leq T < 86.0\%$
C	$63.5\% \leq T < 68.0\%$
C-	$59.0\% \leq T < 63.5\%$
D+	$54.5\% \leq T < 59.0\%$
D	$45.5\% \leq T < 54.5\%$
F	$T < 45.5\%$

8. Textbook

No textbook required, handouts will be distributed.

9. Course Policies

Advising Syllabus

All Schulich School of Engineering students and instructors have a responsibility to familiarize themselves with the policies described in the Schulich School of Engineering Advising Syllabus available at:

http://schulich.ucalgary.ca/undergraduate/advising

The course policies are in compliance with the general course policies at Haute école d'ingénierie et d'architecture Fribourg (HEIA-FR), Switzerland**.**

10. Additional Course Information

28 hours of lectures (14 X 2 h) and 28 hours of labs (7 X 4).

Major Topics:	**Topic:**	**Hours**
	1. Introduction, use of HV, Maxwell equations, electrical field stresses	2
	2. Conduction and displacement current, dielectric systems, Schwaiger factor	2
	3. AC, DC, current and resonant generator	2
	4. Lightning Phenomenon, Marx generator	2
	5. Overvoltage phenomena and insulation coordination in electric power systems	2
	6. Measurement of high voltages and currents in labs and on the grids	2
	7. Conduction, breakdown, and use of gaseous dielectrics	2
	8. Conduction, breakdown, and use of gaseous dielectrics	2
	9. Conduction, breakdown, and use of liquid dielectrics	2
	10 Conduction, breakdown, and use of solid dielectrics	2
	11 Conduction, breakdown, and use of solid dielectrics	2
	12. HV Cable and line, GIS, breaker	2
	13. Power and measuring transformer, bushing, isolator	2
	14. High voltage testing of electrical apparatus	2
Laboratory Experience:	**Laboratory:**	**Hours**
	1. Safety instruction, practice in high voltage laboratory, breakdown in air, Cockcroft–Walton generator	4
	2. AC generator, Schwaiger factor and Paschen Law	4
	3. Marx generator, lighting and switching impulses	4
	4. Resonant generator, current impulses	4
	5. Partial discharges	4
	6. Dielectric testing and tg delta	4
	7. Breakdown in solids and liquids	4

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