University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

## Course Outline

### Instructor

- Prof. Behzad Kordi, P.Eng.
  SPC–308 Stanley Pauley Centre
  (204) 474–7851
  Behzad.Kordi@umanitoba.ca


### Office Hours
- After lectures or by appointment

### Teaching Assistant
- Manuja Gunawardana
  gunawams@myumanitoba.ca

### Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 12 weeks = 36 hours
- Laboratories:
  3 hours x 5 weeks = 15 hours

### Prerequisites:
- ECE 3580 Foundations of Electromagnetics
- ECE 3720 Electric Power and Machines

### Course Website:
http://umanitoba.ca/umlearn

## Important Dates

- **Term Test**
  Tuesday, March 16th, 2021
  (in-class)
- **Voluntary Withdrawal Deadline**
  March 31st, 2021
- **Louis Riel Day**
  February 15th, 2021
  No classes or examinations
- **Spring Break**
  February 16th – 19th, 2021
  No classes or examinations
- **Good Friday**
  April 2nd, 2021
  No classes or examinations

# ECE 4360 – High Voltage Engineering

Winter 2021

## IMPORTANT NOTICE – Mandatory Requirement to Report

This course will be conducted using remote instruction. Students who are accessing the course from outside of Canada or the USA ***must notify the instructor*** and indicate in which country they are located. Access to software may be restricted from some countries and failure to comply with these restrictions may result in criminal prosecution.

## Course Objectives

The course serves as an introduction to high voltage engineering, including basics of electrical breakdown, high voltage generation, high voltage test systems, measurement and analysis techniques as applied to power system apparatus such as cables, insulators, transformers, and generators.

## Course Content

The following topics will be covered:

- Generation of high voltage: AC, DC, and impulse generating equipment.
- High voltage measuring systems.
- Quasi-electrostatic field calculation and simulation models.
- Standard high voltage laboratory test and measurement methods and analysis of results.
- Electrical breakdown fundamentals; electrical breakdown in solids, liquids, and gases.
- Non-destructive tests such as corona testing and partial discharge.
- Insulation coordination as related to equipment ratings and test requirements.
- Review of other industrial applications of high voltage engineering.

## Textbook

*High Voltage Engineering: Fundamentals*, E. Kuffel, W. S. Zaengl, and J. Kuffel, Newnes: Oxford, 2nd edition, 2000.

## Other Resources

*High Voltage Test Techniques*, D. Kind and K. Feser, Newnes: Oxford, 2nd edition, 2001.

## Learning Outcomes

1. Understand fundamental concepts of high voltage AC, DC, and impulse generation.
2. Learn the techniques employed in high voltage measurements.
3. Apply analytical and numerical techniques for electric field calculations in high voltage systems.
4. Learn the fundamental concept of electric breakdown in liquids, gases, and solids.
5. Become familiar with non-destructive test techniques in high voltage engineering.

## Expected Competency Levels

| Outcome | KB | PA | IN | DE | ET | IT | CS | PR | IE | EE | EP | LL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 3 | 4 | 2 | 4 | | 3 | 2 | 2 | | 3 | 3 |
| 2 | 4 | 3 | 4 | 2 | 4 | | 3 | 2 | 2 | | 3 | 3 |
| 3 | 5 | 4 | 4 | 2 | 4 | | 3 | | | | | 3 |
| 4 | 4 | 2 | 3 | | | | 3 | | | | | 3 |
| 5 | 3 | 4 | 3 | | 4 | | 3 | | | | | 3 |

## Accreditation Details

### Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 100%
- Engineering Design: 0%

### Attributes

A1: A knowledge base for engineering
A2: Problem analysis
A3: Investigation
A4: Design
A5: Use of engineering tools
A6: Individual and team work
A7: Communication skills
A8: Professionalism
A9: Impact of engineering on society/ environment
A10: Ethics and equity
A11: Economics and project management
A12: Life-long learning

### Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

### Grading Scale

| Letter | Mark |
|---|---|
| A+ | 95–100 |
| A | 85–94 |
| B+ | 80–84 |
| B | 70–79 |
| C+ | 65–69 |
| C | 55–64 |
| D | 45–54 |
| F | < 45 |

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

## Evaluation

The final course grade is determined by the student's performance on assignments, a project & seminar, in laboratories, and on examinations. Students must complete all components of the course and receive a minimum of 50% on the final examination in order to be eligible to receive a passing grade.

| Component | Value (%) | Method of Feedback | Learning Outcomes Evaluated |
|---|---|---|---|
| Assignments | 15 | F, S | 1, 2, 3, 4, 5 |
| Laboratories | 15 | F, S | 1, 2, 3, 4, 5 |
| Project / Seminar | 10 | F, S | 1, 2, 3, 4, 5 |
| Term Test | 10 | F, S | 1, 2, 3, 4 |
| Final Examination | 50 | S | 1, 2, 3, 4, 5 |

* Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

## CEAB Graduate Attributes Assessed

IN.4 – Understands appropriate safe work procedures during experiments or laboratory exercises.

CS.3 – Delivers effective technical presentations.

## Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

## Copyright Notice



## Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, smart watches, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

*Supplemental Information*

## Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.