



WINTER 2019

## ECE 8370 – Modular Multilevel Converter Systems and Applications

### COURSE DESCRIPTION:

This is an advanced, graduate-level course on the topic of modular multilevel converters. The course delves into details of topologies and operating principles of modular multilevel converters and provides an in-depth coverage of their control systems. Several advanced topics regarding internal operating aspects (e.g., losses and component sizing) and system-wide operating principles (e.g., ac and dc faults and inertia emulation) will be covered.

### COURSE OBJECTIVE:

The objective of the course to present a contemporary coverage of the topic of modular multilevel converters and prepare its audience for the study of advanced topics related to the design, analysis, and operation of these converters.

### PRE-REQUISITES:

Undergraduate background in power systems and power electronics.

### CONTACT HOURS:

3-hours per week

### COURSE CONTENTS:

The following topics will be discussed:

- 1) Introduction
  - a) VSC-HVDC vs. LCC-HVDC
  - b) operating limits and capability
  - c) MMC vs. two- and multi-level converters
  - d) State of the art in PE related to MMC converters (mainly IGBT developments, post-silicon devices and potential impact, etc.)
- 2) MMC converter principles
  - a) Submodule types
  - b) MMC topologies and features
  - c) MMC control system requirements (cap. voltage balancing and regulation, PWM methods, circulating current suppression, etc.)
  - d) High-level control systems (direct vs. decoupled, tuning methods, etc.)
- 3) MMC-HVDC systems and dc grid
  - a) Conventional MMC-based systems
  - b) Systems with dc fault blocking capability
  - c) Control of MMCs in HVDC systems and dc grids and capabilities
- 4) Special topics
  - a) MMC modeling (EMT, detailed equivalent, averaged, etc.)
  - b) MMC system component sizing
  - c) MMC system behavior during ac and dc faults and blocking schemes
  - d) Emulation of synchronous machine
  - e) MMC losses

**HOMEWORK:**

See the evaluation section (below)

**REFERENCE BOOK:**

K. Sharifabadi, L. Harnfors, H. P. Nee, S. Norrga, R. Teodorescu, *Design, Control, and Application of Modular Multilevel Converters for HVDC Transmission Systems*, IEEE-Wiley, 2016.

**EVALUATION:**

Your final course grade is determined by your performance in assignments, a research seminar, a course project, and a final examination. The weighting of each of these components is as follows:

COMPONENT	NO	VALUE %	TOTAL VALUE	DETAILS / ADDITIONAL INFO
Assignments	5	5%	25	
Term Test	1	25%	25	
Final Examination	1	50%	50	
<b>TOTAL</b>			100	

**INSTRUCTOR INFO:**

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Office Hours: ..... By appointment

**VOLUNTARY WITHDRAW:**

**Wednesday, 20 March 2019**

**REQUIREMENTS/REGULATIONS**

**Student Responsibilities:** It is the responsibility of each student to contact the instructor if he/she is uncertain about his/her standing in the course and his/her potential for receiving a failing grade. Students should also familiarize themselves with Sections 4 and 6 of the Regulations dealing with, among others, incomplete term work, deferred examinations, attendance and withdrawal, etc..

**Lectures:** Attendance at lectures is essential for successful completion of this course. Students must satisfy each evaluation component in the course.

## 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 and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism\* or any other form of cheating is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university) regardless of media

- examinations
- assignments
- laboratory reports
- term exams

A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty

Please refer any questions regarding Academic Integrity to your course instructor.

**\*Plagiarism:** to steal and pass off (the ideas or words of another) as one's own; use (another's production) without crediting the source