

Winter 2022

ECE 8320 – 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 is 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 CONTENT:

The following topics will be discussed:

- 1) Introduction
 - a) Converters in power systems and HVDC systems
 - b) VSC-HVDC vs. LCC-HVDC
 - c) operating limits and capability
 - d) MMC vs. two- and multi-level converters
 - e) 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.

TEXTBOOK:

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

GRADE ANNOUNCEMENTS:

EVALUATION:

Your final course grade is determined by your performance in the components list below in the Evaluation Table (seminar, assignments, project, mid-term, and a final examination. **Students must receive a minimum of 50% on the final examination and must complete and pass all components in the course in order to be eligible to receive a passing grade.**

Each component is weighted as follows:

COMPONENT	NO	VALUE %	TOTAL VALUE	DETAILS / ADDITIONAL INFO
Assignments	TBD		40	
Term test	1		30	
Final examination	1		30	
Total			100	

GRADE SCALE:

LETTER	MARK	LETTER	MARK	LETTER	MARK	LETTER	MARK
A+	95-100	B+	80-84	C+	65-69	D	45-54
A	85-94	B	70-79	C	55-64	F	<45

INSTRUCTOR INFO:

Name:..... Prof. S. Filizadeh
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 Office Hours: By appointment

VOLUNTARY WITHDRAW:

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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