ECE 716
SWITCHED RELUCTANCE MACHINES
COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Switched Reluctance Machine (SRM) differs from other electric machines due to its simple construction and lack of coils or permanent magnets on the rotor. These features enable the operation at high speed and harsh environment. SRM is a promising candidate for various motor drive applications. Conventionally, high torque ripple and acoustic noise has been a challenge in SRMs, but they can be addressed by proper design and control.

The simple and low-cost construction of an SRM makes the modelling, analysis, and controls more challenging. In this course, we will explore various characteristics of SRM including modeling, converters, control, materials, and design. Students will utilize the course material to design and analyze an SRM in their course project.

The objective of the course is to develop an understanding of the fundamental operational principles and control of switched reluctance machines (SRM). The student will be provided with the multidisciplinary principles and design aspects of SRM. The topics that will be covered throughout the course include electromagnetic principles, modeling, controls, converters, and materials used in SRMs, and design of an SRM. The course also targets helping the student gain hands-on experience in simulation tools used in electric machine design.

SCHEDULE And MODE OF DELIVERY

The lectures will be delivered in-person format.

Lectures: Friday 10:00am – 1:00pm, McMaster Automotive Resource Center

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INSTRUCTORS

Dr. Berker Bilgin
Email: bilginb@mcmaster.ca
Office: CRL-109
Phone: 905-525-9140 ext. 27080
Office Hours: by appointment

COURSE WEBSITE/S

http://avenue.mcmaster.ca

COURSE OBJECTIVES

Students will go through all relevant topics to understand the operational principles and design of an SRM. Upon the completion of this course, students will be able to complete the following:

- Understand the operational principles of SRM

- Gain an understanding of multidisciplinary design aspects in SRM

- Develop simulation models to analyze the performance of SRM

- Conduct finite element analysis (FEA) simulations to characterize SRM

- Gain an experience in designing an SRM for a selected application

Group Project

Students will complete a course project **due the end of the term**. Students will form groups of their choice. The maximum number of students in each group is **three**. For group work, the students will select an application, calculate the design requirements in the Project Proposal (due in the 7th week of the term) and design a switched reluctance machine for that application.

A Project Report must be submitted on the due date along with the final simulation files. The report should be written in double-column IEEE paper format. The report should not be more than 10 pages including references. Reports are expected to be free of spelling and grammatical mistakes. All references must be included and properly cited.

By the **3rd week of the term**, a Course Project Outline must be submitted. It should present the team members and the selected project.

Project Proposal

For group work, the purpose of this assignment is to identify the specifications of the switched reluctance machine to be designed in the course project. Some of these requirements are:

- Torque-speed envelop (continuous and peak)
- Phase current (continuous and peak)
- Input DC voltage

- Dimensional constraints
- Current density and cooling constraints

The groups are expected to conduct research and report the following details for their application:
- Details of the application, advantages and challenges
- Industry analysis (e.g. number of motors manufactured, major manufacturers, units sold, sample purchasing price, etc.)
- Electric motor types currently used in the application
- Specifications for sample motors

This report should not exceed 5 pages in length (1.5 spacing, 1" margin on all sides, single column, single space, Time New Roman 12 font) inclusive of any exhibits and/or appendices but exclusive of the title page, table of contents, and references. Some of the information in this report can be used in the introduction of the Course Project Report.

Course Project Assessment

The purpose of this assessment is to evaluate the contribution of each member of a group to the project. The Course Project Assessment will be held on the **13th week of the term**. The schedule of the meetings will be announced during the term. In this assessment, the students will be graded for their individual performance and contribution to the group project.

Midterm Test

The midterm test, **written in the 8th week of the term**, may consist of a combination of problems, short-answer questions, and drawings. More details of the format, structure, and content coverage will be provided during the term.

Practices and Assignments

There will be four in-class practices and one assignment. They are scheduled for the **2nd, 3rd, 5th, 6th, and 10th week** of the term.

COURSE MATERIALS

Optional Texts:

B. Bilgin, J. W. Jiang, and A. Emadi, *Switched Reluctance Motor Drives: Fundamentals to Applications*, CRC Press, 2018, ISBN: 9878-1138304598

COURSE OVERVIEW

Week	Date	Topic	Due
1	Sep. 5 2025	Course Overview Electric Motor Industry and SRM	
2	Sep. 12 2025	Electromagnetic Principles of SRM	In-class practice: JMAG Basic Study
3	Sep. 19 2025	Derivation of Pole Configuration in SRM Operational Principles of SRM	In-class practice: 2D Modeling in JMAG Project Outline due Sep. 19, 11:59 PM ET
4	Sep. 26 2025	Modeling of SRM	
5	Oct. 3 2025	SRM Modeling in JMAG SRM in Generating Mode	In-class practice: SRM Static Characteristics in JMAG
6	Oct. 10 2025	Control of SRM Converters in SRM	In-class practice: SRM Dynamic Characteristics in JMAG
7	Oct. 17 2025	Midterm Recess No Lecture	Project Proposal due Oct. 17, 11:59 PM ET
8	Oct. 24 2025	Midterm Exam No Lecture	Take home Posted: Oct. 20 Due: Oct. 30, 11:59 PM ET
9	Oct. 31 2025	Design Considerations in SRM	
10	Nov. 7 2025	SRM Design Example	Coil Calculation Assignment due Nov. 12, 11:59 PM ET
11	Nov. 14 2025	Materials used in SRM	
12	Nov. 21 2025	Manufacturing Techniques for SRM	
13	Nov. 28 2025	Project Assessment No Lecture	Project Report due Dec. 26, 11:59 PM ET

At certain points in the course, it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Components and Weights

Project Proposal	7th week of the term	10%
Practices and Assignments	2nd, 3rd, 5th, 6th, and 10th weeks	15%
Midterm Exam	8th week of the term	25%
Project Assessment	13th week of the term	15%
Project Report	December 26, 2025	35%
Total		100%

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/
The following illustrates only three forms of academic dishonesty:
• plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.
• improper collaboration in group work.
• copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.
Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-

line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors.
The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated.

Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying in research in a university setting are there: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf/.