McMaster University | ENGINEERING
W Booth School of Engineering Practice and Technology

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2023	
Course Name	Electric Powertrain Components Design	
Course Code	SEP 711	
Date and Time of lectures	Thursday, 1:30 – 4:20 p.m., CHN 233	
Program Name	Master of Engineering	
Calendar Description	Electric machines: operational principles, materials, specification for traction motors. Electric motor control: DC motor control, AC motor control, switched reluctance machine control. Electric energy storage systems: requirements, batteries, ultracapacitors, battery management systems, hybrid energy storage systems. Low voltage electrification. Electric and hybrid electric powertrains: architectures, powertrain sizing, packaging	
Instructor	Dr. Dan Centea	E-Mail: Avenue Email Office Hours & Location: virtual, by appointment

2. COURSE SPECIFICS

Course Description

Instruction Type

	Type	Total Hours
C	Classroom instruction	33
L	Self-study work	6
T	Tutorial	
DE	Distance education	
TOTAL HOURS		39

Resources

ISBN	Textbook Title & Edition	Author & Publisher
978-1-4665-9769-3	Advanced Electric Drive Vehicles	[1] Emadi, A. CRC Press (Taylor & Francis) https://doi-org.libaccess.lib.mcmaster.ca/10.1201/9781315215570
3rd Ed: 978-1-4987-6177-2; 2nd: 978-1-4200-5398-2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 3rd or 2nd Ed.	[2] Ehsani, M. et al. CRC Press (Taylor & Francis Group), 2nd Edition: read online McMaster Library

Prerequisite(s)	
Corequisite(s)	
Antiquisite(s)	
Course Specific Policies	
Departmental Policies	Where group work is indicated in the course outline, such collaborative work is mandatory. The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception. Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class. The instructor has the right to submit the work submitted by students to software packages that identify plagiarism.

3. SUB TOPIC(S)		Reference and Chapter
Sept. 14, 2023	Fundamentals of vehicle propulsion - Vehicle resistance - Vehicle speed - Dynamic equation - Powertrain tractive effort - Vehicle performance - Energy consumption	[2] Ch. 2.2, 2.3, 2.5–2.7
Sept. 21, 2023	Electric machines - Operational principles of electric machines - Permanent magnet synchronous machines (PM) - Induction machines (IM) - Switched reluctance machines (SRM) - Specifications for traction motors	[1] Ch. 5.6, 5.7
Sept. 28, 2023	Electric motor control - Brush DC motors control - AC motor control - Switched reluctance machine control - Speed control in electric machines	[1] Ch. 6
Oct. 5, 2023	Electric energy storage systems - Energy systems requirements for electrified vehicles - Electrochemical cells - Ultracapacitor cells - Packs and management systems - Hybrid energy storage systems - Sizing (power, torque, rpm, current) the powertrain components of an electric vehicle (problems)	[1] Ch. 7.2-7.4, 7.8, 8.1
Oct. 12, 2023	Electric powertrain sizing (Problems). ***Self study – No class***	
Oct. 19, 2023	***Term test #1 (1:30 hours)*** Belt-driven starter generator systems - Low voltage electrification - Belt-driven starter generator system overview - Belt-driven starter generator requirements and implementation - Key belt-driven starter generator subsystem components	[1] Ch. 10
Oct. 26, 2023	Hybrid electric powertrains - Electric powertrain - Hybrid electric powertrain architectures: series hybrid, parallel hybrid, power-split hybrid - Hybrid powertrain components - Regenerative braking systems - Hybrid powertrain controls	[1] Ch. 11
Nov. 2, 2023	Design principles and control strategies of series hybrid electric drivetrain - Operation patterns - Control strategies - Design principles	[2] Ch. 7 (2nd Ed) / 8 (3rd Ed)

	Design principles and control strategies of parallel hybrid electric drivetrain - Drivetrain configurations - Control strategies - Design principles	[2] Ch. 8 (2nd Ed) / 9 (3rd Ed)
Nov. 9, 2023	Design principles and control methodology of series-parallel hybrid electric drivetrain - Drivetrain configurations - Control methodology - Design principles	[2] Ch. 9 (2nd Ed) / 10 (3rd Ed)
Nov. 16, 2023	Design and control principles of plug-in hybrid electric vehicles - Statistics of daily driving distance - Energy management strategy - Energy storage design - Sizing (power, torque, rpm, current) the powertrain components of a hybrid electric vehicle (problems)	[2] Ch. 10 (2nd Ed) / 11 (3rd Ed)
Nov. 23, 2023	Design and control of mild hybrid electric vehicles - Energy consumed in braking and transmission - Parallel mild hybrid electric drivetrain - Series-parallel mild hybrid electric drivetrain - Powertrain sizing (problems)	[2] Ch. 11 (2nd Ed) / 12 (3rd Ed)
Nov. 30, 2023	***Term test #2 (1:30 hours)*** Final project	
Dec. 7, 2023	*Project consultations (online)*	
Dec. 14, 2023	*Project submission deadline*	

Note: this structure represents a plan and is subject to adjustment term by term. The instructor and the university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING* including dates*	**Weight**
Term test #1 (October 19, 2023)	**30**
Term test #2 (November 30, 2023)	**30**
Project report – due December 14, 2023	**40**
TOTAL	**100**

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. Calculate the propulsion parameters of a vehicular powertrain
2. Summarize the operational principles and control strategies of the motors used in electric drive vehicles
3. Analyze the operating principles of electric energy power systems used in electric and hybrid electric vehicles
4. Compare hybrid electric powertrains used in vehicles
5. Evaluate various architectures for electric drive vehicles that match given technical specifications
6. Design the architectures and adopt control strategies for different architectures of fully electric or hybrid electric powertrains
7. Analyse hybrid electric vehicles in term of energy consumption
8. Calculate the parameters of an electrified powertrain based on the technical specifications of vehicles

6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible. https://secretariat.mcmaster.ca/app/uploads/Discrimination-and-Harassment-Policy.pdf

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-procedures-guidelines/

The following illustrates only three forms of academic dishonesty: 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.

Students are not permitted to use generative AI in this course. In alignment with McMaster academic integrity policy, it "shall be an offence knowingly to … submit academic work for assessment that was purchased or acquired from another source". This includes work created by generative AI tools. Also state in the policy is the following, "Contract Cheating is the act of "outsourcing of student work to third parties" (Lancaster & Clarke, 2016, p. 639) with or without payment." Using Generative AI tools is a form of contract cheating. Charges of academic dishonesty will be brought forward to the Office of Academic Integrity.

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, 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.

ONLINE PROCTORING

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.

COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

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 ACCOMMODATION OF STUDENTS WITH DISABILITIES

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 https://secretariat.mcmaster.ca/app/uploads/Academic-Accommodations-Policy.pdf

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

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.
https://secretariat.mcmaster.ca/app/uploads/2019/02/Academic-Accommodation-for-Religious-Indigenous-and-Spiritual-Observances-Policy-on.pdf

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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
A 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.

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.