Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Outline (W2019)

EES612: Electrical Machines and Actuators

Instructor(s)	Rafael Oliveira [Coordinator] Office: ENG 324 Phone: TBA Email: rafael.oliveira@ryerson.ca Office Hours: 11AM - 12PM
Calendar Description	The single-phase transformer and its applications. DC and AC motor characteristics, and their application in mechanical drives. Power electronic circuits, H bridges, PWM control, interfacing, power amplifiers. DC servo and stepper motors, AC synchronous and induction motors. Transformers. Introduction to typical speed and torque control techniques of motors.
Prerequisites	CEN 199 and (EES 512 or ELE 202)
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. Electrical Engineering: Principles & Applications, Student Value Edition Plus Mastering Engineering with Pearson eText Access Card Package, 7/E, Allan R. Hambley, 2017, PearsonISBN-10: 0134702190, ISBN-13: 9780134702193
Reference Text(s):	1. Electric Machines and Drives, Gordon R. Slemon, 1992,Addison Wesley: ISBN 0201578859 2. Power Electronics, N. Mohan, T. Undeland, and W. Robbins, 3rd Edition, 2006, John Wiley & Sons: ISBN 9788126510900
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Develop further knowledge of electricity and magnetism in support of applications to electric machinery problems (**1c**) 2. Use models to solve electric machinery problems and understand limitations of the Models. (**2b**) 3. Compare theoretical values with experimental values, to characterize the accuracy of the models and understand their limitations. (**3a**) 4. Calculate the parameters of the electric machines studied and their behavior under load. (**4b**) 5. Verify and validate experimental results, using established theories and laws of physics (**5b**) **NOTE:** *Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*
Course Organization	3.0 hours of lecture per week for 13 weeks 2.0 hours of lab/tutorial per week for 12 weeks
Teaching Assistants	TBA

Course Evaluation	<table><tr><th>Theory</th><th></th></tr><tr><td>Mid Term Exam</td><td>30 %</td></tr><tr><td>Final Exam</td><td>40 %</td></tr><tr><th>Laboratory</th><th></th></tr><tr><td>4 Labs</td><td>30 %</td></tr><tr><td>TOTAL:</td><td>100 %</td></tr></table> Note: In order for a student to pass a course with **"Theory and Laboratory"** components, in addition to earning a minimum overall course mark of 50%, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the **"Course Evaluation"** section for details on the Theory and Laboratory components.
Examinations	Midterm exam: Closed book and 2 hours in duration - 30% Final exam: Closed book and 3 hours in duration - 40%
Other Evaluation Information	None
Other Information	None

Course Content

Week	Hours	Chapters / Section	Topic, description
1 and 2	6	14	Fundamentals of Magnetism and Actuators - Conventions and notations - Field strength flux density and B-H curve - Ampere's law and magnetomotive force (mmf) - Induction flux and Faraday's law - Lorentz's force on a conductor - Hysteresis loop and loss - Eddy currents and eddy current losses - Reluctance and magnetic circuits
3 and 4	6	15	DC Machines - Construction and principles of operation - EMF commutation and torque - Mathematical and circuit models - Types: separately excited motors permanent-magnet motors shunt motors and series motors - Torque-speed characteristics of different motors - Speed control techniques

5 and 6	6	14	Single-Phase Transformers - Construction and principles of operation - Ideal transformer and polarity dots - Impedance transformation property - Practical (real) transformers - Circuit model of a real transformer and approximate models - Open-circuit and short-circuit tests for determination of circuit model parameters - Voltage regulation and efficiency
7 and 8	6	16	Induction Machines - Construction and principles of operation: - Types: squirrel-cage and wound rotors - Review of three-phase power - The concepts of rotating field and synchronous speed - The concepts of slip and slip frequency - Circuit model and approximate models - Mathematical model and torque-speed curve (characteristic) - Effects of rotor resistance and excitation frequency - Power flow within the induction machine - Classes and various load conditions - Speed control techniques
9, 10 and 11	7	Lecture Notes	Power Electronics Control of DC and AC Machines - The concepts of switched-mode power processing Pulse-Width Modulation (PWM) and averaging - Power semiconductor switches: the diode BJT MOSFET and IGBT - Two-quadrant chopper and four-quadrant chopper (H Bridge) - DC-to-AC converters and sinusoidal PWM - Single-phase and three-phase diode rectifiers
12	2	16	Synchronous Machines - Construction and principles of operation - Types: round-rotor and salient-rotor - Circuit model and parameters - Brushless DC motors

Laboratory/Tutorials/Activity Schedule

Week	Lab	Description
5 - 02/04	1	Lab 1: DC Machines
9 - 03/04	2	Lab 2: Transformers
11 - 03/18	3	Lab 3: Induction Machines
13 - 04/01	4	Lab 4: Power Electronics

Policies & Important Information:

1. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;
3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Refer to our **Departmental FAQ** page for information on common questions and issues at the following link: https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html.

Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. ***Health certificates*** - If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component for health reasons, they should notify their instructor as soon as possible, and submit a Ryerson Student Health Certificate AND an Academic Consideration Request form within 3 working days of the missed date. Both documents are available at https://www.ryerson.ca/senate/forms/medical.pdf.. **If you are a full-time or part-time degree student, then you submit your forms to your own program department or school;**
2. ***Religious, Aboriginal and Spiritual observance*** - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at www.ryerson.ca/senate/forms/relobservforminstr.pdf. **If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;**
3. ***Academic Accommodation Support*** - Before the first graded work is due, students registered with theAcademic Accommodation Support office (AAS - www.ryerson.ca/studentlearningsupport/academic-accommodation-support) should provide their instructors with an Academic Accommodation letter that describes their academic accommodation plan.

Academic Integrity

Ryerson's Policy 60 (the Academic Integrity policy) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspicions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to an including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the work. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes
3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to theAcademic Integrity policy(https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website (https://www.ryerson.ca/academicintegrity/).

Important Resources Available at Ryerson

1. The Library (https://library.ryerson.ca/) provides research workshops and individual assistance. Inquire at the Reference Desk on the second floor of the library, or go to library.ryerson.ca/guides/workshops
2. Student Learning Support(https://www.ryerson.ca/studentlearningsupport) offers group-based and individual help with writing, math, study skills and transition support, and other issues.