Toronto Metropolitan University

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

Course Outline (F2023)

ELE747: Advanced Electric Drives

Instructor(s)	Surinder Jassar [Coordinator] Office: Online Phone: TBA Email: sjassar@torontomu.ca Office Hours: Monday 7 - 8 pm
Calendar Description	A course on modeling, analysis and design of electric drive systems. The main topics include: modelling of dc/ac motors, dynamic and steady performance, reference frame, small signal (linearized) analysis, solid-state converters, motor speed/position control schemes, simulation and digital control techniques. The modeling, simulation and digital controller will be developed in this course to analysis and design advanced electric drive systems. Important concepts are illustrated with laboratory experiments.
Prerequisites	(ELE 637 and ELE 639) or ELE 654
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. P.C. Krause, O. Wasynczuk, etc, Analysis of Electric Machinery and Drive Systems, 3rd edition Wiley-IEEE Press, 2013, ISBN 9781118024294
Reference Text(s):	1. N. Mohan, T. Undeland and W. Robbins, "Power Electronics - Converters, Applications and Design 3rd edition", Wiley-IEEE Press, 2002, ISBN: 9780471226932 2. B. Wu, High Power Converters and AC Drives, Wiley-IEEE Press, 2006, ISBN: 0471731714 3. R. Krishnan, Electric Motor Drives, Modeling, Analysis and Control, Prentice Hall, 2001, ISBN: 0130910147
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. To analysis the drive system performance using concept of various engineering knowledge. (**1c**) 2. To develop system models and perform simulation. (**2b**) 3. To design the drive system based on the engineering requirements. (**4a**) 4. To conduct drive system experiment and data analysis. (**5b**) 5. To develop power converters and digital control techniques for electric drives. (**5a**) 6. The lab components have presentations scheduled upon the completion of project components. The teamwork is very well evaluated to gauge teamwork and collaboration among peers and marked appropriately. (**8a**) 7. The drive systems are evaluated for efficiency, power and torque variables and appropriate ac/dc drives systems are evaluated for environmental and social factors in choosing appropriate motors for case studies. (**9a**)

	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 per week for 12 weeks 0.0 hours of tutorial per week for 12 weeks
Teaching Assistants	Shirin Hosseini Email: shirin.hosseini@torontomu.ca Mohammad Khoobani Email: mohammad.khoobani@torontomu.ca
Course Evaluation	

Theory	
Theoretical: Midterm Exam	25 %
Theoretical: Final Exam	45 %
Laboratory	
Laboratory: DC motor drives and digital control platform	15 %
Laboratory: Induction motor drives	15 %
TOTAL:	100 %

Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both **"Theory and Laboratory"** components, 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 above for details on the Theory and Laboratory components (if applicable).

Examinations	Midterm exam is in Week 7 on Wednesday Oct 18, 2023, two hours, closed-book. Final exam, during exam period, three hours, closed-book. Details will be announced in D2L.
Other Evaluation Information	Two formal reports are required for the labs. In order to achieve a passing grade, the student must achieve an average of at least 50% in both theoretical and laboratory components.
Teaching Methods	The lectures and labs will be in person. Please check your schedule for the room numbers.
Other Information	None

Course Content

Week	Hours	Chapters / Section	Topic, description
1	2		Introduction of Electric Drives 1.1 Introduction

			1.2 Torque-Speed Convention 1.3 Configuration of DC drives 1.4 Configuration of AC drives 1.5 Applications
1-3	6		Modeling and Analysis DC Drives 2.1 Introduction 2.2 Steady-State Models 2.3 Speed Control Methods 2.4 Braking and Starting Methods 2.5 Dynamic Models and Transfer functions 2.6 Computer Simulation Techniques
3-4	5		Chopper-Fed DC Drives 3.1 Introduction 3.2 Single Quadrant Choppers 3.3 Multi Quadrant Choppers 3.4 Steady-State and Dynamic Models 3.5 Closed Loop Control Schemes
5-6	5		Rectifier-Fed DC Drives 4.1 Introduction 4.2 Uncontrolled Rectifiers 4.3 Controlled Rectifiers 4.4 Dual Converter 4.5 Steady-State and Dynamic Analysis
8	2		Reference Frame Theory 5.1 Introduction 5.2 Equations of Transformation 5.3 Stationary and Arbitrary Reference Frames 5.4 Analysis of Resistive and Inductive Circuits
8-10	7		Modeling and Analysis of Induction Motor Drives 6.1 Introduction 6.2 Dynamic Models and Analysis 6.3 Computer Simulation Techniques 6.4 Steady State Models and Analysis 6.5 Variable Voltage Operation 6.6 Variable Frequency Operation

11-12	5		Power Converters for Induction Motor Drives 7.1 Introduction 7.2 Voltage Source Converters 7.3 Square Wave and Pulse Width Modulated Operation 7.4 Converter Modeling and Simulation 7.5 V/F Control Scheme 7.6 Field Oriented Control Scheme
12-13	4		Analysis of Synchronous Machines 8.1 Introduction 8.2 Modeling of Synchronous Machines 8.3 Dynamic and Steady State Analysis 8.4 Permanent Magnet Synchronous Machines

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
2	1	DC motor drives and digital control platform Part A: DC motor parameter test
3	2	DC motor drives and digital control platform Part B: DC motor dynamic simulation
4	3	DC motor drives and digital control platform Part C: Power converter with digital control platform
5-7	4	DC motor drives and digital control platform Part D: Digital control of DC motor drives
8-9	5	Induction motor drives: Part A: Induction motor dynamic performance
10-11	6	Induction motor drives: Part B: Pulse width modulated (PWM) inverter
12-13	7	Induction motor drives: Part C: Digital control of induction motor

University Policies

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the Senate website

Important Resources Available at Toronto Metropolitan University

- The Library provides research workshops and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the Library's virtual research help service to speak with a librarian.
- Student Life and Learning Support offers group-based and individual help with writing, math, study skills, and transition support, as well as resources and checklists to support students as online learners.

- You can submit an Academic Consideration Request when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the Senate website and select the blue radio button on the top right hand side entitled: Academic Consideration Request (ACR) to submit this request.

  For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate Policy 167: Academic Consideration.

- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The Remote Learning Guide for students includes guides to completing quizzes or exams in D2L Brightspace, with or without Respondus LockDown Browser and Monitor, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for Faculty and students.

Accessibility

- Similar to an accessibility statement, use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about Academic Accommodation Support.
- Learn how to register with AAS.

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about Academic Accommodations versus Academic Consideration and how to access each.

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:**24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:**24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via My SSP app or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the Toronto Metropolitan University Mental Health and Wellbeing website.