University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

Course Outline

Instructor

- Prof. Athula Rajapakse, P.Eng.
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Office Hours
- Tuesdays, Thursdays
  11:30am–12:30pm
  or by appointment

Teaching Assistant
- Parisa Khodaei
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Contact Hours
- 5 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 8 weeks = 24 hours
- Tutorials
  3 hours x 2 weeks = 6 hours
- Field Trip
  6 hours

Prerequisites:
- ECE 3720 Electric Power and Machines

Course Website:
http://umanitoba.ca/umlearn

Important Dates

- **Term Test**
  Monday, March 8th, 2021
  6:00PM – 8:30PM
- **Voluntary Withdrawal Deadline**
  March 31st, 2021
- **Louis Riel Day**
  February 15th, 2021
  No classes or examinations
- **Spring Break**
  February 16th – 19th, 2021
  No classes or examinations
- **Good Friday**
  April 2nd, 2021
  No classes or examinations

ECE 3650 – Electric Machines

Winter 2021

IMPORTANT NOTICE – In-Person Laboratories

This course will be delivered using online lectures and *in-person laboratories*. ***Students are required to pre-screen themselves*** before travelling to campus for their laboratory and must not attend the campus if they are experiencing any COVID-19 symptoms or if they have been in contact with someone who has tested positive for COVID-19. In addition, ***students must wear a face mask*** while attending the laboratory and in all common indoor spaces on campus, or whenever social distancing can not be maintained. For further information, please visit the *UofM COVID-19 Resources* website (https://umanitoba.ca/coronavirus/recovery).

Course Objectives

Constructional features, analysis, modeling, and applications of three phase transformers, synchronous machines, and single phase induction motors; Principle of operation of special motors.

Course Content

The following topics will be covered:

- Three phase transformers:
  - Three phase transformer connections; Special transformer connections (Open Delta, Scott, and Zigzag); Three-phase transformer analysis; Per unit system; Voltage and frequency ratings; Harmonics and inrush currents.
- Synchronous machines
  - Constructional features; Stator windings; Voltage generation and armature reaction ; Equivalent circuit; Open circuit and short circuit tests; Analysis of a synchronous machine connected to an infinity bus; Steady state stability; Synchronous machine capability curve; Operation as a motor.
- Salient pole synchronous machines
  - d-q currents and reactances; Phasor diagram; Power transfer; Determination of d-q reactances.
- Single phase motors
  - Operating principles, equivalent circuit and analysis of single phase induction motors and universal motors; Starting methods of single phase induction motors.
- Special motors
  - Principle of operation of reluctance, hysteresis, and brushless dc motors.

Textbook

Principles of Electric Machines and Power Electronics, P.C. Sen, 3rd edition, Wiley, 2013.

Other Resources

Electric Machinery and Transformers, Bhag S. Guru and Huseyin R. Hizirogulu, 3rd edition, Oxford University Press, 2000.

Learning Outcomes

1. Analyze electric circuits with three-phase transformers.
2. Develop phaser diagrams to obtain phase relationships of three-phase transformers and special transformers.
3. Analyze performance and operating limits of a grid connected synchronous machine using equivalent circuits.
4. Analyze the performance of salient pole synchronous machines using d-q theory and phasor diagrams.
5. Explain different starting methods and analyze the operating performance of single phase induction motors using equivalent circuits.

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 100%
- Engineering Design: 0%

Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/ environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	4	4	3		4		3					1
2	4	4	3		4		3					1
3	4	4	3		4		3					1
4	4	4	3		4		3					1
5	3	3	1		2		3					1

CEAB Graduate Attributes Assessed

PA.2 – Develops and/or implements a strategy to analyze complex engineering problems.

IN.4 – Understands appropriate safe work procedures during experiments or laboratory exercises.

Evaluation

The final course grade is determined by the student's performance in laboratories, in quizzes, and on examinations. Students must complete all the laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Quizzes & Assignments	15	F, S	1, 2, 3, 4
Laboratories	15	F, S	2, 3, 4, 5
Term Test	25	F, S	1, 2, 3, 4
Final Examination	45	S	1, 2, 3, 4, 5

∗ Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

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* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, smart watches, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Information

Copyright Notice

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.