ECE 3650 – Electric Machines  
Winter 2020

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

Other Resources

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.
Expected Competency Levels

<table>
<thead>
<tr>
<th>Outcome</th>
<th>KB</th>
<th>PA</th>
<th>IN</th>
<th>DE</th>
<th>ET</th>
<th>IT</th>
<th>CS</th>
<th>PR</th>
<th>IE</th>
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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. Attendance to a daylong field trip to McArthur Falls generating station is compulsory. The trip will be scheduled on a Saturday. The exact date will be announced well in advance.

<table>
<thead>
<tr>
<th>Component</th>
<th>Value (%)</th>
<th>Method of Feedback</th>
<th>Learning Outcomes Evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes &amp; Assignments</td>
<td>10</td>
<td>F, S</td>
<td>1, 2, 3, 4</td>
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<tr>
<td>Laboratories + Field Trip</td>
<td>18</td>
<td>F, S</td>
<td>2, 3, 4, 5</td>
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<tr>
<td>Term Test</td>
<td>22</td>
<td>F, S</td>
<td>1, 2, 3, 4</td>
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<tr>
<td>Final Examination</td>
<td>50</td>
<td>S</td>
<td>1, 2, 3, 4, 5</td>
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</tbody>
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* 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 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.

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

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Grading Scale

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<td>95–100</td>
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<tr>
<td>A</td>
<td>85–94</td>
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<tr>
<td>B+</td>
<td>80–84</td>
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<tr>
<td>B</td>
<td>70–79</td>
</tr>
<tr>
<td>C+</td>
<td>65–69</td>
</tr>
<tr>
<td>C</td>
<td>55–64</td>
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<tr>
<td>D</td>
<td>45–54</td>
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<tr>
<td>F</td>
<td>&lt;45</td>
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</tbody>
</table>

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.
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.