# ELE746: Power Systems Analysis

## Instructor(s)
Apparao Dekka [Coordinator]
Office: ENG 327
Phone: TBA
Email: adekka@ryerson.ca
Office Hours: Fri 2 - 4 PM

## Calendar Description
Overview of the power system; Power Generator and Transformer modeling and operation; Per Unit system of calculations; Transmission line parameters, resistance, inductance and capacitance; Steady State operation of transmission line, short, medium and long lines; Load Flow study, Gauss-Seidel and Newton-Raphson iterative methods; Symmetrical fault analysis, symmetrical components, unsymmetrical fault analysis; introduction of protection relays and Circuit Breakers. Introduction to ETAP for load flow and fault analysis.

## Prerequisites
ELE 637 and ELE 639

## Antirequisites
None

## Corequisites
None

## Compulsory Text(s):

## Reference Text(s):

## Learning Objectives (Indicators)
At the end of this course, the successful student will be able to:

1. Use specialized core knowledge of electric circuits, electromagnetism, and electromechanical energy conversion devices to predict and understand behavior of a power system. (**1d**)
2. Use judgment in solving problems that have information uncertainties, and check for alternative models and solution techniques (**2a**)
3. Evaluate results through manual calculations and use of general-purpose and specialized software, to predict the performance and to determine the prediction closest to the reality. (**5a**)

**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>
<thead>
<tr>
<th>Component</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory: Mid-term Examination</td>
<td>20%</td>
</tr>
<tr>
<td>Theory: Final Examination</td>
<td>40%</td>
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<tr>
<td>Theory: Quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>Lab: Two-bus single-phase network</td>
<td>15%</td>
</tr>
<tr>
<td>Lab: Multi-bus three-phase network</td>
<td>15%</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>100%</strong></td>
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### Examinations
Midterm exam in approximately Week 7 during regular class hours, two hours, closed-book. Final exam, during exam period, three hours, closed-book. Details will be announced in D2L.

### Other Evaluation Information
Two 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.

### Other Information
None

### Course Content

<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
<th>Chapters / Section</th>
<th>Topic, description</th>
</tr>
</thead>
</table>
| 1-2  | 6     | Intro. fundamentals and conventions (Chapter 2) | - Structure and components of the power system  
- Power in single-phase circuits  
- Real power, reactive power, and complex power  
- Power factor correction  
- Complex power flow and complex power balance  
- Balanced three-phase circuits  
- Per-phase analysis and graphical conventions  
- Delta-Y transformations  
- Power in three-phase circuits |
| 3-4  | 6     | Models for short transmission lines generators and transformers (Chapters 3 and 4) | - Short transmission line model  
- Synchronous generator construction and model  
- Single-phase transformer model (equivalent circuit)  
- Transformer performance  
- Three-phase transformers  
- Per-unit system of calculations and change of base |
| 5-6  | 6     | Transmission line models and performance (Chapter 5) | - Short-line model (review)  
- Medium-line model  
- Long-line model  
- ABCD parameters  
- Transmission line performance |
| 7-8  | 6     | Power-flow analysis (Chapter 6) | - Bus admittance matrix and network calculations  
- Power-flow problem and equations  
- Gauss-Seidel method for solving power-flow equations  
- Newton-Raphson method for solving power-flow equations |
Analysis of balanced faults (Chapter 9)
- Balanced three-phase fault
- Short-circuit capacity
- Bus impedance matrix
- Fault analysis using bus impedance matrix

Transmission line parameters (Chapter 4)
- Transmission line resistance
- Transmission line inductance
- Transmission line capacitance

Symmetrical components and unbalanced faults (Chapter 10)
- Fundamental of symmetrical components
- Sequence impedances
- Fault analysis using sequence components

Laboratory/Tutorials/Activity Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Lab</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Tutorial 1 (Chapter 2)</td>
<td>Quiz 1 (fundamentals)</td>
</tr>
<tr>
<td>3</td>
<td>Tutorial 2 (Chapter 2)</td>
<td>Quiz 2 (Chapter 2)</td>
</tr>
<tr>
<td>4</td>
<td>Tutorial 3 (Chapter 3)</td>
<td>Quiz 3 (Chapter 2)</td>
</tr>
<tr>
<td>5</td>
<td>Tutorial 4 (Chapter 3)</td>
<td>Quiz 4 (Chapter 3)</td>
</tr>
<tr>
<td>6</td>
<td>Tutorial 5 (Chapter 3)</td>
<td>Quiz 5 (Chapter 3)</td>
</tr>
<tr>
<td>8-9</td>
<td>Lab 1</td>
<td>Lab 1: Two-bus single-phase network</td>
</tr>
<tr>
<td>10-11</td>
<td>Lab 2</td>
<td>Lab 2: Multi-bus three-phase network (Lab 1 Report Due on Week 10)</td>
</tr>
<tr>
<td>12</td>
<td>Tutorial 6: Review</td>
<td>(Lab 2 Report Due on Week 12)</td>
</tr>
</tbody>
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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. If you have taken the course previously and are currently looking to get a laboratory exemption, then you must fill out this form: http://www.ee.ryerson.ca/guides/ECE-LabExemptionForm.pdf
5. Refer to our Departmental FAQ page for information on common questions and issues at the following link:
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](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](http://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 the Academic Accommodation Support office (AAS - [www.ryerson.ca/studentlearningsupport/academic-accommodation-support](http://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.

Suspicion 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 the [Academic Integrity policy](https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website ([https://www.ryerson.ca/academicintegrity/](http://www.ryerson.ca/academicintegrity/)).

Important Resources Available at Ryerson

1. **The Library** ([https://library.ryerson.ca/](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](http://library.ryerson.ca/guides/workshops)
2. **Student Learning Support**([https://www.ryerson.ca/studentlearningsupport](http://www.ryerson.ca/studentlearningsupport)) offers group-based and individual help with writing, math, study skills and transition support, and other issues.

Approved by: _______________________________                Date ________________________________

Course Instructor