Electric Circuits

ENGG\*2450

Winter Semester 2011

# 1 Instructor

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# 2 Teaching assistants

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Please note that you may also wish to make use of peer helpers:  [engpeers@uoguelph.ca](mailto:engpeers@uoguelph.ca)

# 3 Laboratory technician

Nathaniel Groendyk [groendyk@uoguelph.ca](mailto:groendyk@uoguelph.ca)

# 4 Meetings

**Lectures:** Tuesdays and Thursdays, 14:30 to 15:50, ROZH 101

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| **Tutorials:**  Tuesday, 11:30 to 12:20, MACK 238  Wednesday, 8:30 to 9:20, MACK 238  Wednesday, 10:30 to 11:20, MACK 238  Thursday, 9:30 to 10:20, MACK 238  Thursday, 11:30 to 12:20, MACK 316  Friday, 10:30 to 11:20, MACK 233  Friday, 12:30 to 13:20, MACK 238 | **Laboratories:** THRN 2307  Weeks 4, 5, 9, and 10  Monday, 2:30 to 4:20  Tuesday, 8:30 to 10:20 and 12:30 to 14:20  Wednesday, 15:30 to 17:20  Thursday, 8:30 to 10:20 and 12:30 to 14:20  Friday, 2:30 to 4:20 |

**Midterm:** *Tentatively* scheduled for Thursday Feb. 16th 14:30-15:50

**Final exam:** April 9,8:30-10:30.

# 5 Materials

**Textbook:** C. K. Alexander, M. N. O. Sadiku, Fundamentals of electric circuits, 4th ed.,

McGraw-Hill 2009.

**References:**

1. S. Gregori, Electric circuits in pills, McGraw-Hill 2011.
2. J. G. Tront, PSpice for basic circuit analysis with CD, McGraw-Hill 2007.

The textbook and other reference books are available on Course Reserve in the library.

**Web**: The course will have a web page on courselink.uoguelph.ca (I am still waiting for access)

# 6 Prerequisites

**Topics:** Success in this course requires the fundamentals of engineering mathematics (linear algebra, trigonometry, complex numbers, calculus, and differential equations) and the fundamentals of electromagnetism (electromagnetic quantities and units of measurement, electrostatics, electric and magnetic fields, conservation laws).

**Courses:** As stated in the Undergraduate Calendar.

# 7 Description

The course explores the fundamentals of electric circuit analysis, which are the foundation of micro and nano-scale electronic devices and modern communication, control, and power systems. The course begins with a discussion of the lumped circuit abstraction and simple resistive circuits, followed by the analysis techniques under direct-current conditions. The concept of ideal operational amplifier is presented next and then the course continues with the dynamics of circuits with energy-storage elements. The course concludes with the study of alternate currents, leading to an overview of magnetically coupled circuits.

# 8 Learning objectives

After successfully completing the course you will be able to **analyse and model electric circuits** and to apply the studied concepts to **obtain numerical solutions to engineering problems** **involving electric circuits**. To this purpose you will learn to:

1. Identify terms, quantities, and models used by engineers for describing electric circuits.
2. Analyse the energetic properties of electric and magnetically coupled circuits.
3. Determine the dynamics of linear circuits in transient and at low and high frequency.
4. Analyse alternate-current circuits using the phasor method for sinusoidal steady-state.

# 9 Evaluation

The breakdown for grading the whole course is as follows.

Final exam 50%

Midterm exam 35%

Laboratory reports 10%

Assignments 5%

# 10 Approach

**Lectures** focus on important relationships, clarify concepts, and present examples. As you review the lecture material, I encourage you to go through the **textbook** examples and solve the practice problems. **Tutorials** concentrate on problem solving and are a useful preparation for the exams. Short **assignments** (i.e. problem sets to be completed individually) are issued on a weekly basis. **Laboratories** introduce you to computer-aided design software for electric circuits and help you assimilate and put into practice the subject matter. There are two **laboratory reports** to be completed individually or in small groups. Any student not handing in an assignment or a report receives a grade of zero**. There are no makeup assignments or reports and late submissions are not accepted for marking.**

The **midterm** and the **final exam** (comprehensive) are used to determine the extent to which you have achieved the course learning objectives. The use of notes, books, programmable calculators, or other aids is not permitted at exams. Any student not taking an exam receives a grade of zero for that exam. In case you have a legitimate reason for missing an exam session, I may consider an accommodation upon presentation of a written request and suitable documentation before the time of the exam.

# 11 Obtaining help

You can obtain help from me during my office hours (posted on the course web page) and after lectures, from the teaching assistants during their office hours and after tutorials and laboratories, and from the laboratory technician during the laboratory time slots.

Please contact us if you need help or you have fallen behind in your work. We are willing to put in as much effort to help you as you are willing to put in to help yourself. We are happy to work with you on difficult concepts and hear your suggestions for improving the course. If you are busy during our office hours, then email us with some days and times you are free, and we will set an appointment that works for both you and us.

If you are ill, call the Student Health Services or a medical doctor. If you have emotional, family, or living environment problems that affect your ability to study, visit the Counselling Services or your academic advisor. If you have a disability or a temporary disability, refer to the Centre for Students with Disabilities and you are welcome to discuss with us your specific learning needs at the earliest possible time. I have made every effort to avoid conflicts with religious obligations. If there is a discrepancy, please contact me as soon as possible.

# 12 Scholastic integrity

The value of an academic degree depends on the integrity of the work done to earn that degree. It is imperative that you keep a high level of honour in your work. The policies on scholastic dishonesty reported in the Undergraduate Calendar will be enforced.

Academic misconduct, such as plagiarism, is a serious offence at the University of Guelph. Please consult the Undergraduate Calendar 2010-2011 and School of Engineering programs guide, for offences, penalties and procedures relating to academic misconduct.

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

I recommend that you review the tutorial on academicintegrity.uoguelph.ca and that you discuss any questions that you may have with me or the teaching assistants.

# 13 Communication

Communication is through announcements in class. Some information will be posted on the course web page or sent via email messages to your University address. It is your responsibility to keep yourself informed. Please do not expect instant reply to your emails; because of the large enrolment, we usually go through students' messages twice a week.

# 14 Copyright

The instructor reserves the right to all materials made available for this course and all interpretations presented in class, which may not be reproduced or transmitted to others without the written consent of the instructor. The electronic recording of classes is only allowed with prior consent of the instructor and solely for the use of the authorized student.

# 15 Disclaimer

I reserve the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph academic regulations.

# 16 Topics

**Basic concepts:** Electrical quantities and units of measurement; two terminal elements and lumped circuits; passive sign convention and conservation of energy; independent and dependent voltage and current sources; open and short circuits

**Basic laws:** Resistor and Ohm's law; branches, nodes, loops, and meshes; Kirchhoff's current law and Kirchhoff's voltage law; series and parallel connection of resistors; R 2R ladders and bridge circuits; wye delta transformations

**Methods of analysis:** Circuit graphs; planar and nonplanar circuits; hinged and unhinged circuits; node branch and mesh branch matrixes; nodal analysis of linear circuits; mesh analysis of linear circuits

**Circuit theorems:** Linearity property and principle of superposition; source transformation; Thevenin's and Norton's theorems; maximum power transfer

**Operational amplifiers:** Ideal op amp; positive and negative feedback; inverting and noninverting configurations; summing and difference amplifiers; op amp circuits

**Energy-storage elements:** Capacitor and inductor; capacitors and inductors combinations; integrator and differentiator

**First-order circuits:** Singularity functions; linear first order circuits; steady state and transient analysis; natural, forced, and complete response

**Second-order circuits:** Linear second order circuits; steady state and transient analysis; natural, forced, and complete response; over-damped, critically damped, under-damped, and lossless cases

**Alternate-current circuits:** Sinusoids and phasors; impedance and admittance; Kirchhoff's laws; impedance combinations Sinusoidal steady-state analysis nodal and mesh analysis; superposition; source transformation; Thevenin and Norton equivalent circuits

**AC power analysis:** Average and root mean square values; maximum power transfer; complex power and conservation of the complex power

**Magnetically coupled circuits:** Coupled circuits; mutual inductance; transformer and ideal transformer