Lecture 1

EE101 Winter 2014

Instructor

• Joel Kubby (that would be me)
• Office: BE-249
• Office Hours: Tu,W, 4-5 PM
• Phone: (831) 459-1073
• E-mail: jkubby@soe.ucsc.edu
Teaching Assistants

• Dan O’Leary
  – E-mail: dan@soe.ucsc.edu
• Mohammad Hossein Daraei
  – E-mail: daraei@soe.ucsc.edu
• TA office hours to be determined at first lab

Grader

• James Ridgers
  – E-mail: jridgers@ucsc.edu
EE101 Labs

- Location: Baskin Engr 150
- Lab Sections:
  - EE 101L - 01 Tu 8:00AM - 10:00AM (16)
  - EE 101L - 02 Tu 4:00PM - 6:00PM (19)
  - EE 101L - 03 We 10:00AM - 12:00PM (09)
  - EE 101L - 04 We 4:00PM - 6:00PM (13)
  - EE 101L - 05 Th 2:00PM - 4:00PM (05)

### Class & Lab Schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 AM</td>
<td></td>
<td></td>
<td>EE101L-01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:30 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:30 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td></td>
<td></td>
<td>EE101L-03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30 AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00 PM</td>
<td>EE101 Class</td>
<td>EE101 Class</td>
<td>EE101L-05</td>
<td>EE101L-03</td>
<td>EE101 Class</td>
</tr>
<tr>
<td>2:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:00 PM</td>
<td>EE101L-02</td>
<td>EE101L-04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7:00 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Course Details

- Course website:
  - [https://courses.soe.ucsc.edu/courses/ee101/Winter14/01](https://courses.soe.ucsc.edu/courses/ee101/Winter14/01)
  - Lecture slides and homework will be posted on the website
- Classroom: Physical Sciences 110
- Time: MWF 2:00 PM-3:10 PM
- Must enroll concurrently in course 101L, even if you have taken it before
- Prerequisites:
  - Physics 5C/N or 6C/N
  - Applied Mathematics and Statistics 20 or 20A (or Math 24)
Text

• Required Text
  – I have had a custom edition made that only has the chapters we will be studying to reduce the cost.

• Supplemental Texts
  – The Art of Electronics by Paul Horowitz, Winfield Hill, 2nd edition (1989); Cambridge Univ Press (Short); ISBN: 0521370957

Syllabus

1. Fundamentals of Electrical Engineering (Current, Voltage, Resistance, Conductance, Ohm’s Law)
2. Circuit Analysis (Kirkoff’s Voltage & Current Laws, Voltage & Current Dividers, Node/Loop Analysis)
3. Equivalent Circuits (Thevenin, Norton, Source Transformations, Superposition)
4. Amplifiers (Single Stage, Cascaded, Power Supplies)
5. Operational Amplifiers (Summing Point Constraint, Feedback, Inverting, Non-Inverting, Summing, Voltage/Current)
6. First Order Transient Response (Inductance (L), Capacitance (C), RC/RL Circuits)
7. Second Order Transient Response (Series, Parallel, Step Response)
8. AC Analysis (Sinusoidal Signals, Complex Numbers, Phasors, Phasor Circuits, AC Power, AC Thevenin)
9. Filters (Fourier Analysis, Low-Pass, High-Pass, Decibels, Bode Plot)
10. Magnetic Circuits (Materials, Self-Inductance, Mutual-Inductance, Transformers)
# Syllabus

<table>
<thead>
<tr>
<th>Class</th>
<th>Lecture</th>
<th>Date</th>
<th>Topic</th>
<th>Sections</th>
<th>Homework</th>
<th>Quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>01/06/14</td>
<td>Introduction</td>
<td>1.1-1.3, 1.4, 1.7</td>
<td>Pre-Rae</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>01/08/14</td>
<td>Fundamentals of Electrical Engineering</td>
<td>1.4, 1.5, 2.1, 2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>01/10/14</td>
<td>Basic Laws, Voltage &amp; Current Dividers</td>
<td>2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>01/13/14</td>
<td>Node/Loop Analysis</td>
<td>2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>01/15/14</td>
<td>Node/Loop Analysis</td>
<td>2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>01/17/14</td>
<td>Thévenin Equivalent Circuits</td>
<td>2.6-2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>01/22/14</td>
<td>Norton Equivalent Circuits</td>
<td>2.6-2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>01/24/14</td>
<td>Amplifiers</td>
<td>11.1-1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>01/27/14</td>
<td>Review for Midterm 1</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10a</td>
<td>02/03/14</td>
<td>Op-Amp Circuits</td>
<td>14.2-14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>10b</td>
<td>02/05/14</td>
<td>Op-Amp Circuits</td>
<td>14.2-14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>11</td>
<td>02/07/14</td>
<td>Inductance and Capacitance</td>
<td>3.1-3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>12</td>
<td>02/10/14</td>
<td>First Order Transient Response</td>
<td>4.1-4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>13</td>
<td>02/14/14</td>
<td>Second Order Transient Response</td>
<td>4.1-4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>14</td>
<td>02/19/14</td>
<td>Review for Midterm 2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>15</td>
<td>02/21/14</td>
<td>Midterm 2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>16</td>
<td>02/24/14</td>
<td>Sinusoidal Signals, Complex Numbers, Power</td>
<td>5.1-5.3, Appendix A</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>17</td>
<td>02/26/14</td>
<td>Bode Plot, High-Pass Filter, Series Resonant</td>
<td>6.4-6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>18</td>
<td>02/28/14</td>
<td>RC/RL Circuits, High-Pass Filters, Active</td>
<td>6.5-10.4, 10.5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>03/03/14</td>
<td>Voltage Sources, Transformers</td>
<td>6.5-10.4, 10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>20</td>
<td>03/05/14</td>
<td>Inductance and Capacitance</td>
<td>3.1-3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>21</td>
<td>03/07/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>22</td>
<td>03/10/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>23</td>
<td>03/12/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>24</td>
<td>03/14/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>25</td>
<td>03/17/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>26</td>
<td>03/19/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>27</td>
<td>03/21/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>28</td>
<td>03/23/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>29</td>
<td>03/25/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>30</td>
<td>03/27/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>31</td>
<td>03/29/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>32</td>
<td>03/31/14</td>
<td>Magnetic Circuits</td>
<td>15.1-15.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Grading**

- **Midterm 1** 15% (1/27/14)
- **Midterm 2** 15% (2/21/14)
- **Final Exam** 30% (3/21/14)
- **Homework** 20% (see schedule)
- **Quizzes** 20% (see schedule)

If you are not going to be able to take the midterms and the final exam on these dates you should take this class at a later date!

You have to pass the final exam to pass the class!
Homework

• Will be posted weekly on the course website
• The due date is listed on the course schedule.
• No late home work will be accepted!
• Solutions will be posted after class

Quizzes

• The quizzes will cover the topics covered in the previous lectures and the topics from the reading assignments
• The quizzes will be given at the beginning of class so please be on-time!
• e-Waste substitute for missed or low scoring quiz
• We will have a pre-req evaluation next class to assess your preparation for EE101
Evaluation Quiz

- Solution of simultaneous equations
- Determinants
- Differential equations
- Electricity and Magnetism
- Complex numbers

Midterms and Final

- You will be provided with a sheet of key formulas that you can use on the midterms and final exam.
- These sheets will be posted on the class website before the tests so that you can familiarize yourself with them.
- No additional information will be allowed.
- iPhones, iPads, laptops,… will not be allowed.
How to pass this course

• Read each section of the text before class
• Work out each example as you read through the text (before class)
  – We will work through some examples in class
  – Sit next to someone you enjoy working with
• Do the homework by yourself
• Be sure to understand any example or homework problem you got wrong
  – Bring questions to your TA’s section

Academic Dishonesty

Any confirmed academic dishonesty including but not limited to copying homeworks or cheating on exams, will result in a no-pass or failing grade and automatic referral of the case of suspected policy violation to your college for further disciplinary action. You are encouraged to read the campus policies regarding academic integrity. Examples of cheating include (but are not limited to):

• Sharing results or other information during an examination.
• Working on an exam before or after the official time allowed.
• Submitting homework that is not your own work.
• Reading another student’s homework solution before it is due.
• Allowing someone else to read your homework solution before the assignment is due.

If there is any question as to whether a given action might be construed as cheating, see me before you engage in any such action.
Labs
Core lab exercises:
1. Resistive Circuits
2. Equivalent circuits and load matching
3. Transients in circuits
4. AC circuits and filter design
5. Amplifiers and op amp circuit design

Introduction
1. Recognize interrelationships of electrical engineering with other fields of science and engineering
2. List the major subfields of electrical engineering
3. Circuits
4. Current & voltage
5. Waveforms, ac & dc
5. Reference directions
Electrical systems have two main objectives:

- To gather, store, process, transport, and present *information*
- To distribute and convert *energy* between various forms

**Electrical Engineering Subdivisions**

- Communication systems
- Computer systems
- Control systems
- Electromagnetics
- Electronics
- Photonics
- Power systems
- Signal processing
Electrical Circuits

The headlight circuit in a car. (a) The actual layout of the circuit. (b) The circuit diagram

Fluid Analogy
Electrical Current

Electrical current is the time rate of flow of electrical charge through a conductor or circuit element. The units are amperes (A), which are equivalent to coulombs per second (C/s).

What is actually flowing in wire?

André Ampère (1775-1836)

http://www-groups.dcs.st-and.ac.uk/~history/PictDisplay/Ampere.html
Electrical Current

\[ i(t) = \frac{dq(t)}{dt} \]

\[ q(t) = \int_{t_0}^{t} i(t) dt + q(t_0) \]

Circuit Elements

An electrical circuit consists of circuit elements such as voltage sources, resistances, inductances and capacitances that are connected in closed paths by conductors.
Current Variables

In analyzing circuits, we frequently start by assigning current variables such as $i_1$, $i_2$, $i_3$.

Direct Current
Alternating Current

When a current is constant with time, we say that we have **direct current**, abbreviated as dc. On the other hand, a current that varies with time, reversing direction periodically, is called **alternating current**, abbreviated as ac.
Examples of dc and ac currents

(a) Dc current

\[ i_d(t) = 2 \]

(b) Ac current

\[ i_d(t) = 2 \cos 2\pi t \]

Examples of ac waveforms

(a) Triangular waveform

(b) Square waveform
Reference Directions

Reference directions can be indicated by labeling the ends of the circuit elements and using double subscripts on the current variables. The reference direction for $i_{ab}$ points from $a$ to $b$. On the other hand, the reference direction for $i_{ba}$ points from $b$ to $a$.

\[ i_{ab} = -i_{ba} \]

Voltages

The **voltage** associated with a circuit element is the energy transferred per unit of charge that flows through the element. The units of voltage are volts (V), which are equivalent to joules per coulomb (J/C).
Alessandro Volta (1745-1827)

The first battery was made of alternating disks of zinc and copper with each pair separated by brine soaked cloth.

http://www.corrosion-doctors.org/Biographies/VoltaBio.htm

Reference Directions

Energy is transferred when charge flows through an element having a voltage across it.

“uphill: battery”

“downhill: resistor”

Energy supplied by the element

Energy absorbed by the element
Reference Directions

The voltage $v_{ab}$ has a reference polarity that is positive at point $a$ and negative at point $b$.

Reference Directions

The positive reference for $v$ is at the head of the arrow.