INTRODUCTION

• This course is an introduction to the basics of electrical circuit analysis. It is a precursor to learning about integrated circuit design.

• Nowadays most chip design is done automatically using packages like PSpice, Cadence etc. Sadly you still have to know about how circuit components operate since attempting to use those packages without a knowledge of components is a bit like trying to learn programming without knowing what addition and subtraction is.

• It would be super to end these lectures with enough knowledge so you can understand how a .mp3 chip (codec) is designed. Sadly, although you could probably get a handle on how .mp3 codecs work, the chip design itself is a bit tuff to get your mind around in 16 lectures.

• These are the course targets

  1. Review of Kirchoff’s current, voltage laws. Ohm’s law.
  2. DC Circuit analysis: Thevenin and Norton equivalent circuits
  3. Linearity and superposition
  4. Nonlinear Circuits (load line analysis)
  5. Active components (capacitor and inductor) and simple AC Circuits.

• You will find that the handouts from the PSpice course (part of 1E7) that took place in the Trinity Term of your first year contain much valuable information for this course.
1 Course Timetable and Structure

Lectures: 10-11 am Monday (Hamilton 4) and 3-4 pm Wednesday (Hamilton 3)

Lecturer: Dr. Anil Kokaram, www.mee.tcd.ie/~sigmedia

2E7 contains components taught by the Mech. Eng. Dept (Prof. Henry Rice) and EEE Dept (Dr. Anil Kokaram) so tutorials

*Tutorials are therefore split between two subjects.*

The first Electrical Tutorial will be this Wed at 2-3 pm, the next will be on the following Monday at 9-10 am. This cycle repeats every OTHER week.

Tutorials: Two sites for two sets of groups on each of 2 days

9-10 am Monday groups 21-30 [Geography Lecture Theatre]
groups 31-40 AP2.03 [2nd floor AP]

2-3 pm Wednesday groups 1-10 LTEE1 [LT 1, Panoz Institute]
groups 11-20 AP0.09 [Ground Floor, AP]

Try not to get lost. Use www.tcd.ie for maps to find the Panoz Institute.
2 HINTS

2 Hints

- Here is an interesting web site containing demos that could be useful for this course.

  http://www.clarkson.edu/~svoboda/eta/Circuit_Design_Lab/circuit_design_lab.html

- http://www.howstuffworks.com/ is surprisingly good at helping when you get lost in a course. Try “How a capacitor works” for example.

- Course Text: Principles and Applications of Electrical Engineering 3rd ed, Giorgio Rizzoni. Page refs will be given where possible.
3 Basics: Component descriptions

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistor $\Omega$</td>
<td>![Resistor Symbol]</td>
</tr>
<tr>
<td>Capacitor $F$</td>
<td>![Capacitor Symbol]</td>
</tr>
<tr>
<td>Inductor $H$</td>
<td>![Inductor Symbol]</td>
</tr>
</tbody>
</table>

Voltmeter (measures voltage Volts)

Ammeter (measures current Amperes)

Voltage Source

(Conceptual device that provides enough current to maintain a particular voltage)

Current Source

(Conceptual device that provides enough voltage to maintain a particular current)
4 Basics: Some rules

Ohm’s Law: \( V = IR \) Volts = Amperes \( \times \) Ohms
Power: \( P = VI = I^2R = V^2/R \) Watts

Kirchoff’s Current Law:

Kirchoff’s Voltage Law:
5 Simple Stuff: Example 1
6 Simple Stuff: Example 2
7 Network Analysis: Nodal Analysis

[Chapter 3, Section 3.1, Page 73, 3rd ed.]

- One of the methodologies for consistently analysing circuits. Solves for cct voltages.

- Idea is to identify nodes in the circuit, assign voltages as independent variables, then apply KCL.

1. Select reference node (ground if possible)
2. Define the remaining n-1 nodes as the independent variables
3. Express current in terms of voltages, apply KCL
4. Solve resulting system of equations
7 NETWORK ANALYSIS: NODAL ANALYSIS

- 1mA
- 1K
- 2mA
- 4.7K
- 2.2K
- 500

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www.mee.tcd.ie/~sigmedia
8 Network Analysis: Mesh Current Method

[Chapter 3, Section 3.2, Page 78, 3rd ed]

- Alternate methodology for consistently analysing circuits. Solves for cct currents.

- Idea is to identify meshes in circuit, assign \textbf{current} as independent variables, then apply KVL.

1. Identify meshes, define mesh current consistently as independent variables
2. Express voltages in terms of mesh currents, apply KVL
3. Solve resulting system of equations for the mesh currents
8 NETWORK ANALYSIS: MESH CURRENT METHOD

![Network Diagram]

- 10V
- 9V
- 1V
- 10
- 5
- 5

11 www.mee.tcd.ie/~sigmedia