E151 Lecture 1 – Intro and Linear Networks Review

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ENGR151

Disclaimer

These are note for Prof. Spencer to give the lecture, they were not intended as a reference for students. Students asked for them anyway, so I’m putting them up as a courtesy. Remember that they are not intended as a substitute for lecture.
Why Take This Class

• Teaching analog circuit design
• “Analog is dead and digital is king” – some strawman
• Used ADC in E80, why not apply to every analog problem? (board list)
  • Speed, noise, dynamic range, power \( \leftarrow \) All tightly linked
  • Expensive, complex to design and use, delicate
  • Why is outside the scope of this class … but true
• What other analog tool do you know (op-amp). Why not? (board list)
  • Low power output
  • Limited bandwidth
  • We WILL learn why here \( \leftarrow \) YOU WILL BUILD ONE

What Makes Up Our Goals?

• Learning goals: you will learn how to build an op-amp (as list)
  • Really good at basics: RC dynamics and KVL/KCL
  • Basic semiconductor physics and intuition for how devices work in circuits
  • Single and multi-stage linear amplifiers
  • Analog building blocks and “talking the talk”
  • Fearless in lab and rational debugging
• Four major types of analysis (as list)
  • Large signal
  • Small signal
  • Dynamic
  • Other (mostly differential)
How Are We Doing This?

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>11:59PM</td>
<td>Turn in Lab Notebook &amp; Problems</td>
</tr>
<tr>
<td>Tue</td>
<td>Lecture</td>
<td>Lab debrief</td>
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<tr>
<td>Wed</td>
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<tr>
<td>Thu</td>
<td>12:01PM</td>
<td>Turn in self-graded problems</td>
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<tr>
<td></td>
<td>Lecture</td>
<td>Quiz on lecture material (ind, + group)</td>
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<td></td>
<td>Afternoon</td>
<td>Lab + problems released</td>
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<tr>
<td>Fri</td>
<td>Lab</td>
<td>Oscpe lesson &amp; work time</td>
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</tbody>
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- Lab deliverable is notebook: next slide
- Problems don’t need to be done before lab, just related
- More later on design project, problems solo, DP + lab partners

Lab Notebook Demo

- My example posted
- Chronological – that helps you reference from boss qs
- Informal and handwritten – clear, but not a writeup, always evidence
- Correct – you need to get right measurements in this class, like 80

- This should help you both in and out of lab
- Lab password
- Break to gather partners, come back to tech work.
E84 was Linear Circuit Theory

- Small groups, find 2 3 different ways for

\[ I = \frac{V - V_2}{R_1} + \frac{V}{R_2} \]

KCL

\[ \begin{align*}
I_1 &= \frac{V - V_2}{R_1} + I \\
I_2 &= \frac{V}{R_2}
\end{align*} \]

KVL

\[ \begin{align*}
V &= I_1 R_1 + I_2 R_2 \\
V &= \frac{V}{R_1} + \frac{V}{R_2}
\end{align*} \]

Split matrix into vectors and turn them off one at a time.

Matrix Picture of Circuit Linearity

- Split matrix into vectors and turn them off one at a time.
Dependent Sources (I solve)

• V source or I source controlled by some other spot in circuit

\[ \begin{align*}
V &= \frac{1}{R_1} + \frac{2}{R_2} \cdot I_2 \quad R_1 \cdot 2 \cdot R_2 \cdot I_2 = I_2 \\
\frac{V}{R_1} &= I_2 \left( \frac{1}{R_1} - \frac{2}{R_2} \right) \\
I_2 &= \frac{V}{R_1} \left( \frac{1}{R_1} - \frac{2}{R_2} \right)
\end{align*} \]