Op Amps
EGR 220, Chapter 5
February 18, 2016

Thevenin Self-Review

- What is a Thevenin Equivalent Circuit?
  - Draw a generic Thevenin equivalent circuit
  - Discuss and write down 3 good uses for a Thevenin equivalent circuit, or for the Thevenin theorem
- How might you find the maximum power that can be delivered to any load from any circuit?
  - Why is this an important question?

Overview

- Equivalent circuits
  - Thevenin equivalent circuit
  - Ideal Op Amp circuit diagram
- Op Amp circuit analysis
- Op Amp wiring diagrams
  - Lab 4

741 Op Amp Circuit Diagram

http://www.uoguelph.ca/~antoon/gadgets/741/741.html
Transistor Analogy

- 3 terminal device
  - 2 terminals – power and ground
  - 3rd terminal – input

Op Amp Circuit Analysis

- The Golden rules apply to the Op Amp input:
  - **Golden rule #1?**
    - Input voltage:
  - **Golden rule #2?**
    - Input current:
- Also of interest:
  - $I_{out} = ?$

Op Amp Circuit Analysis

- Analyze Op Amp circuits
  - Apply Golden Rules
  - KCL for input stage (often)
  - KVL or V-divider for output stage (often)
- Gain
  - Ratio of output:input
- Feedback
  - Connect output to input
  - “Feed” the output “back” to the input

Find voltage gain $v_o/v_s$
Inverting Amplifier
Find voltage gain, $v_o/v_i$

Non-inverting Amplifier
Find voltage gain, $v_o/v_i$

Op Amps Do Math: Difference Amplifier
→ find $v_o$ and $i_o$

Lab: 741 Op Amp On A Chip

741 in 8-pin DIL (Dual In Line) pack

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>offset null</td>
</tr>
<tr>
<td>2</td>
<td>inverting input</td>
</tr>
<tr>
<td>3</td>
<td>non-inverting input</td>
</tr>
<tr>
<td>4</td>
<td>output</td>
</tr>
<tr>
<td>5</td>
<td>offset null</td>
</tr>
<tr>
<td>6</td>
<td>not connected</td>
</tr>
</tbody>
</table>

(viewed from above)
Notice Color Scheme, Layout & Feedback Resistor Across the OpAmp

Powering and Wiring an Op Amp

Power Supply: You will use ±25V and +6V connections

Power Supply Connections

Lab 4 Circuit 1

Your $V_{in}$, $0 < V_{in} < 6V$
To pin ___?

$+V_{cc} = +15V$
To pin ___?

$-V_{cc} = -15V$
To pin ___?

Ground outputs tied together
To pin ___?

Lab 4 Circuit 1

$i_1$ to $i_2$
$R_f$
$0 A$

$v_1$
$0 V$
$v_2$
$+ v_3$

Lab 4 Circuit 2

Lab 4 Pre-Lab

- This is a LONG lab
- You must complete the pre-lab and this week it will be ‘graded’ as correct or incorrect
  - Wiring diagrams
    - *Something possible* that shows you are thinking about this
  - Gain & output expressions – correct or not
  - Sketch of output – correct or not

Summary

- Uses for op amps
  - Amplifying an electrical signal
  - Basic math functions – analog computers
- Analysis with op amps uses:
  - The Golden Rules
  - Often use: KCL and/or Voltage-divider
- Concepts of gain and feedback