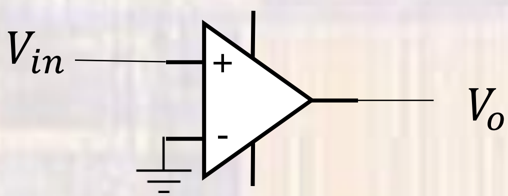
OpAmp Circuits II

Last updated 4/20/22

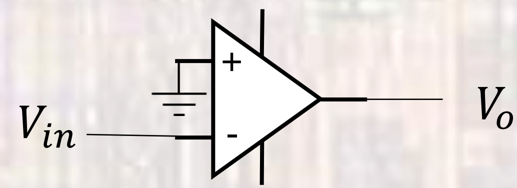
OpAmp Circuits II

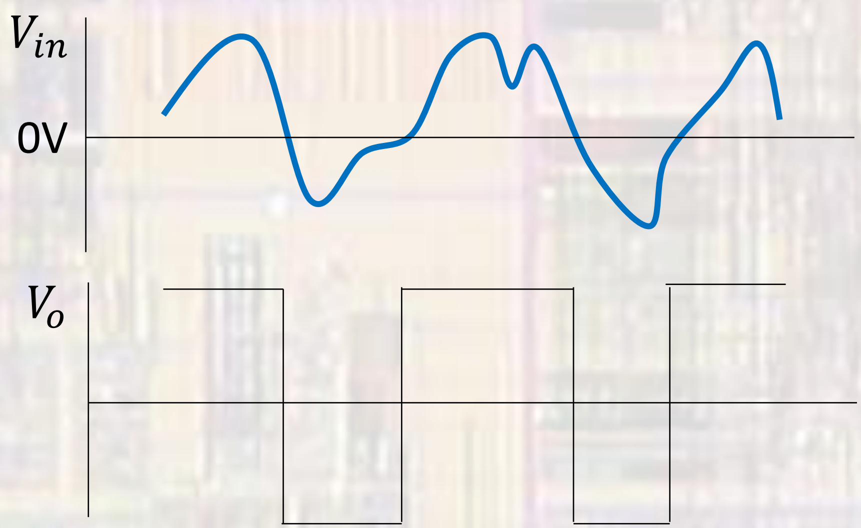
- Zero Crossing Detector
  - Open Loop opamp

Non-Inverting



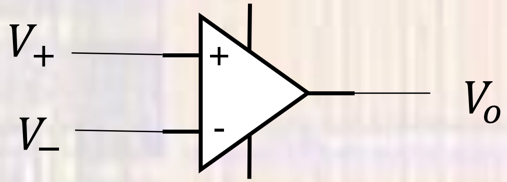
Inverting





OpAmp Circuits II

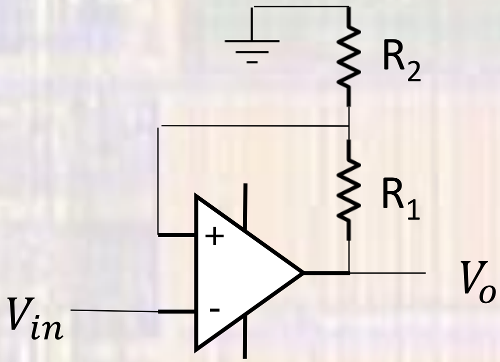
- Comparator
  - Special opamp with non-saturating outputs
    - Reduced delay in switching rail-to-rail



$V_o = vdd\ or\ vss$

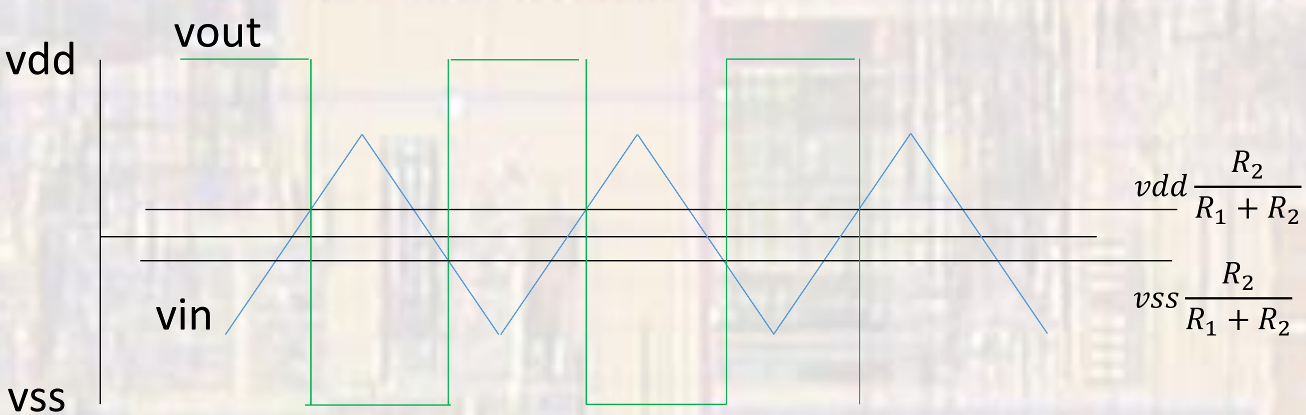
OpAmp Circuits II

- Schmitt Trigger
  - Positive feedback
  - Non-overlapping switching points



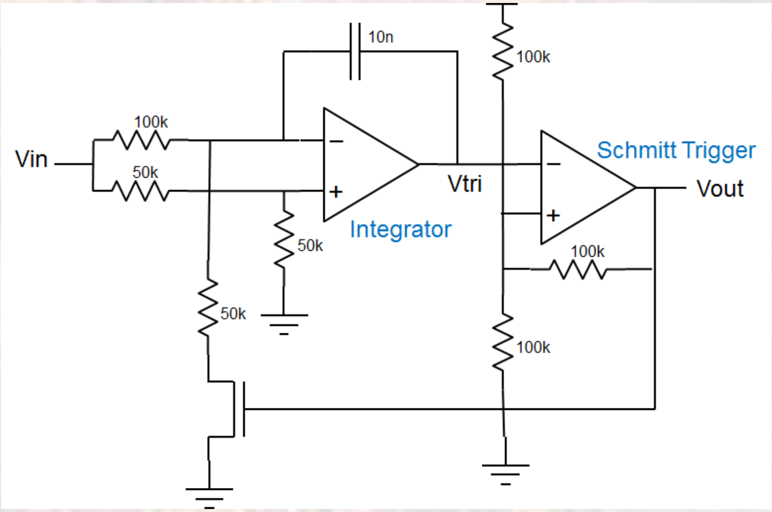
$$when\ V_o = vdd, then\ v_+ = vdd\frac{R_2}{R_1 + R_2}$$

$$when\ V_o = vss, then\ v_+ = vss\frac{R_2}{R_1 + R_2}$$

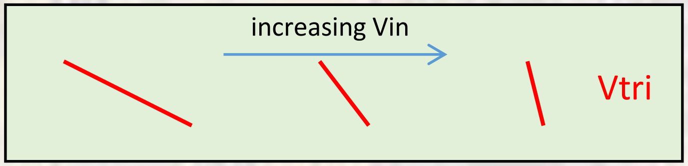


OpAmp Circuits II

- Voltage Controlled Oscillator (VCO)

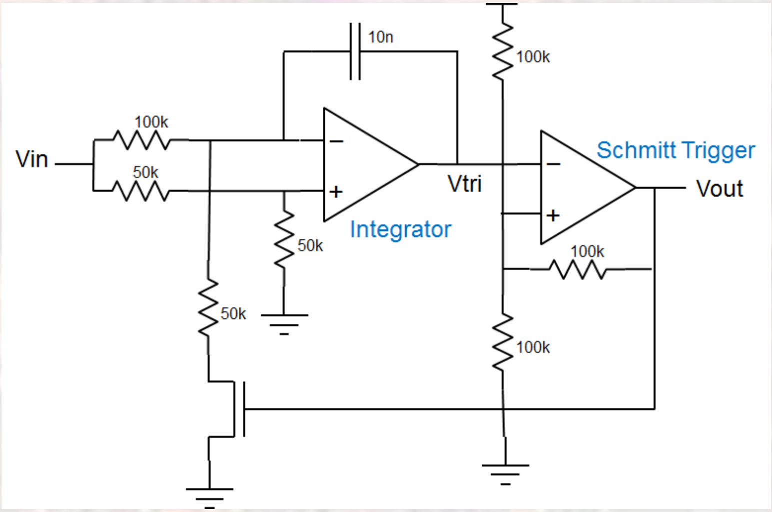


  - Integrator
    - Opamp wants v+input = v-input
    - When the MOSFET is off
      - + input is Vin/2 (minus input wants to be Vin/2)
      - current through 100K resistor must go through C
      - current through C Ic = -Cdv/dt
      - -dv/dt is proportional to Vin → the opamp slews down

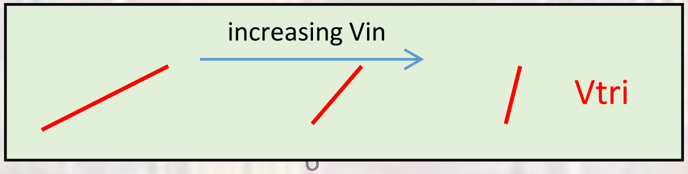


OpAmp Circuits II

- Voltage Controlled Oscillator (VCO)

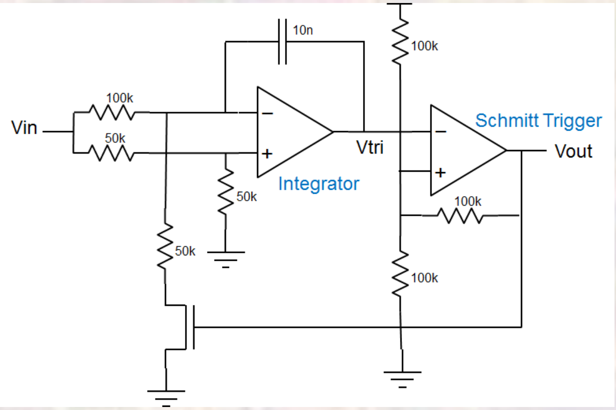


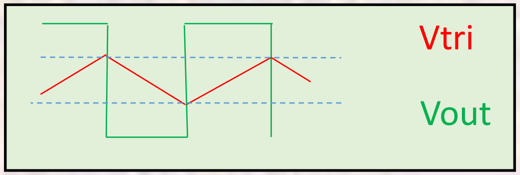
  - Integrator
    - Opamp wants v+input = v-input
    - When the MOSFET is on
      - + input is Vin/2 (minus input wants to be Vin/2)
      - current through the 100K resistor is ½ the current through 50K and MOSFET
      - the other half the current through the MOSFET must come from the C
      - current through C   Ic = Cdv/dt
      - dv/dt is proportional to Vin → the opamp slews up

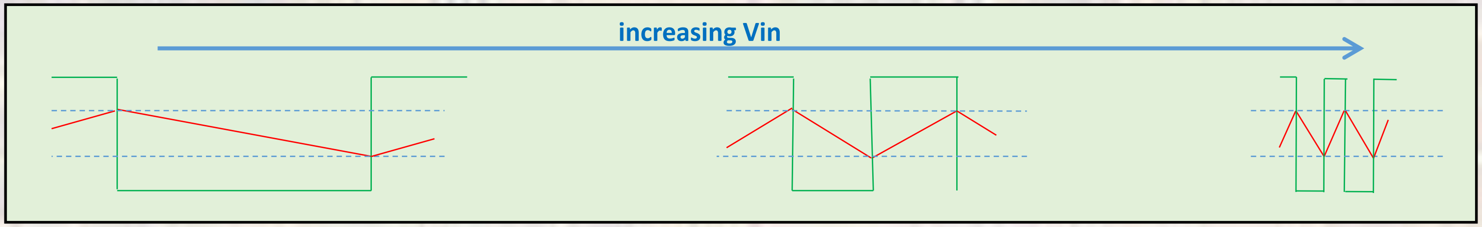


OpAmp Circuits II

- Voltage Controlled Oscillator (VCO)
  - Schmitt Trigger
    - When Vout is high
      - Mosfet is on → Vtri is slewing up
      - + input is Vdd*2/3
      - When Vtri goes above Vdd*2/3 the opamp switches to Vout = 0
      - mosfet turns off → Vtri slews down
    - When Vout is low
      - Mosfet is off → Vtri is slewing down
      - + input is Vdd*1/3
      - When Vtri goes below Vdd*1/3 the opamp switches to Vout = high
      - mosfet turns on → Vtri slews up



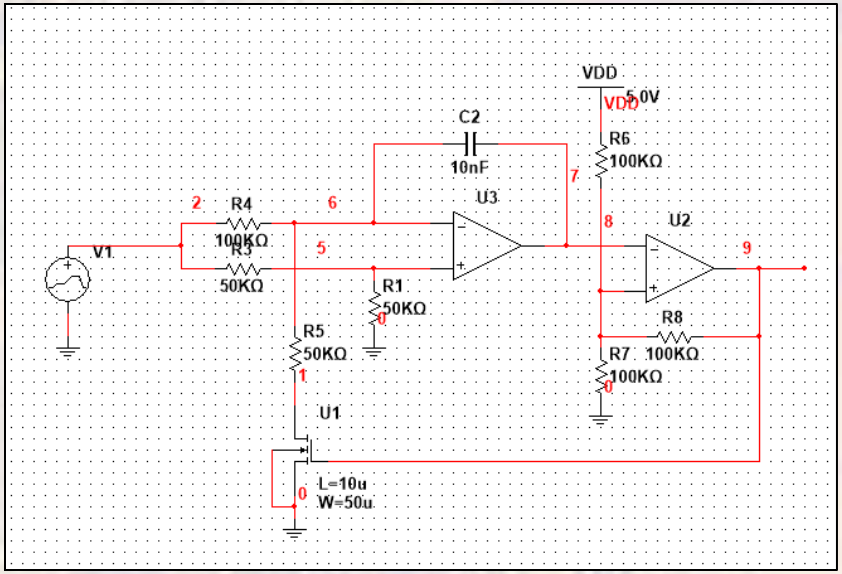


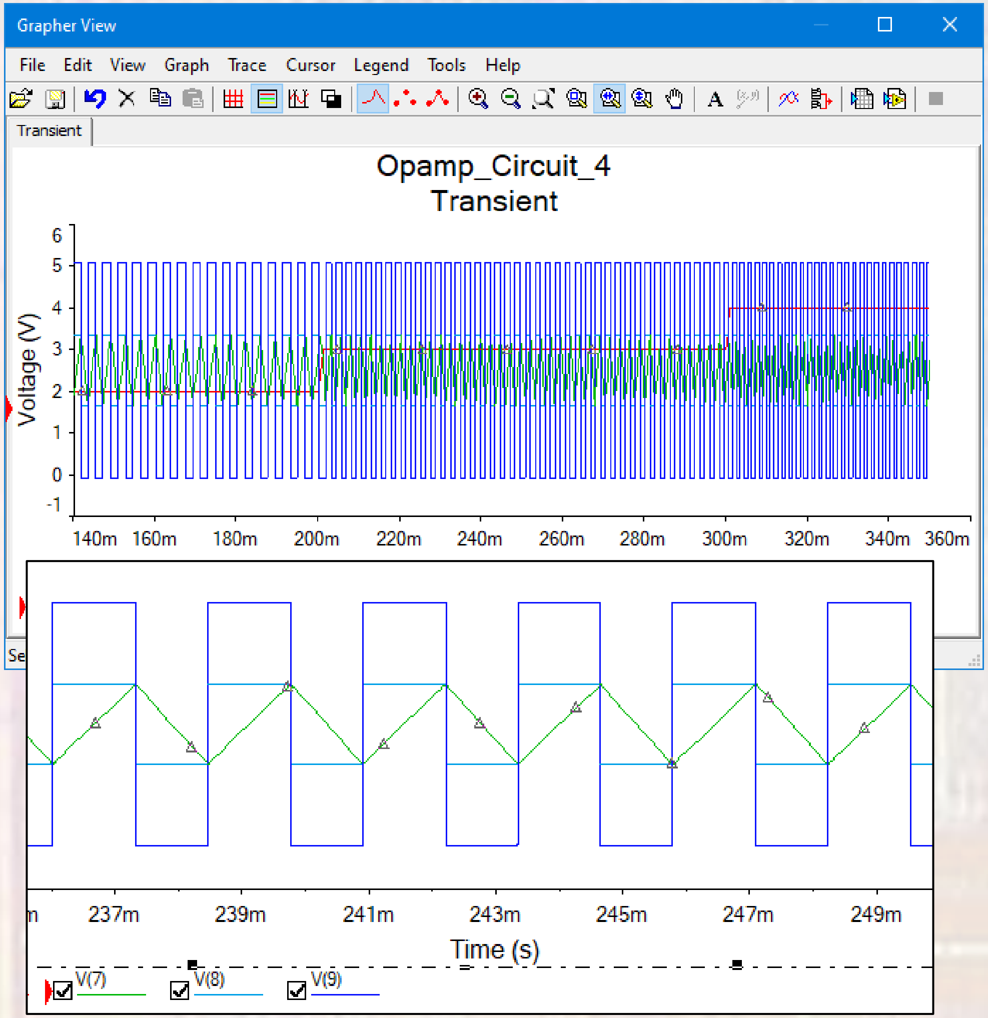


VCO

OpAmp Circuits II

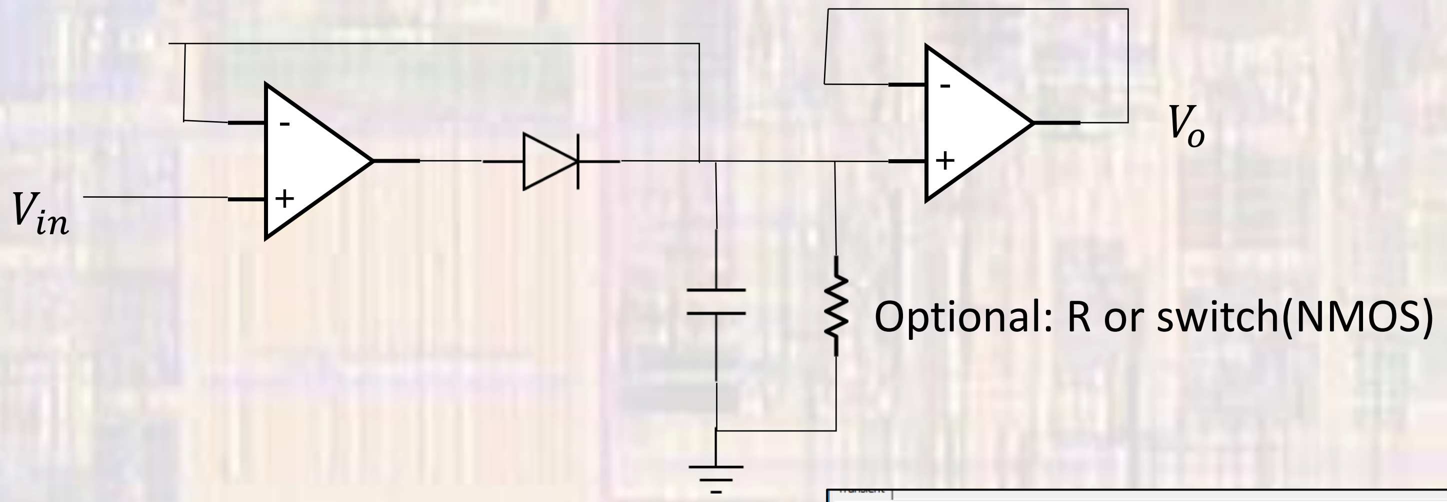
- Voltage Controlled Oscillator (VCO)

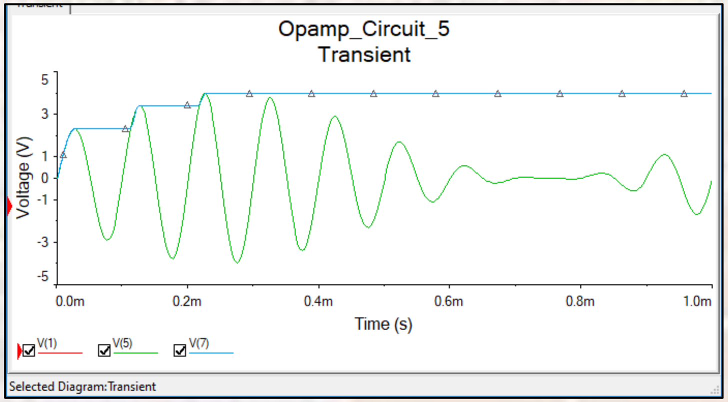




OpAmp Circuits II

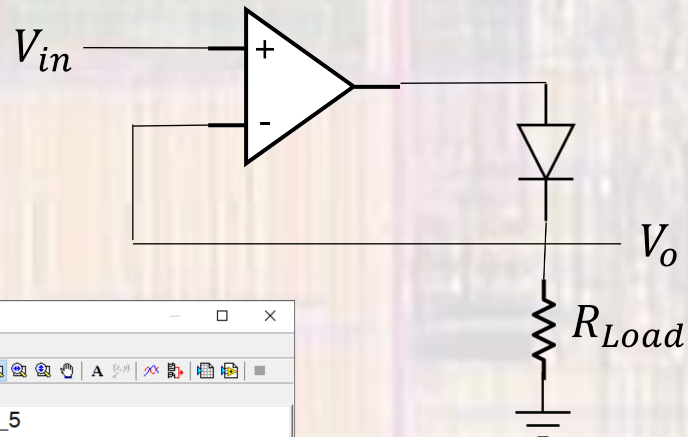
- Peak Detector

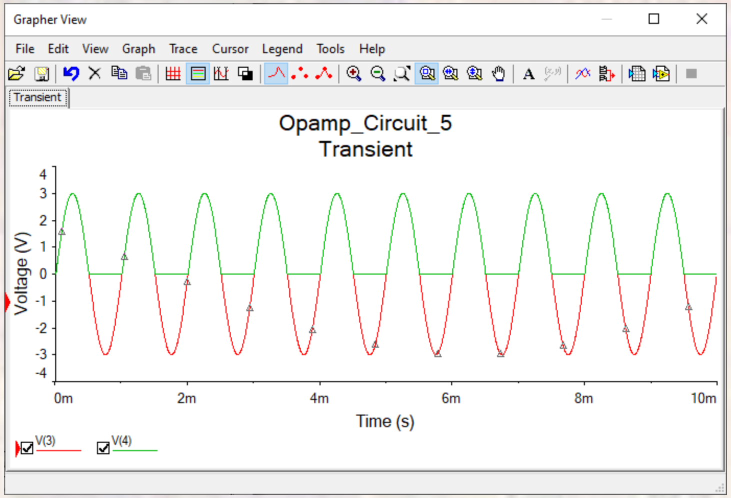




OpAmp Circuits II

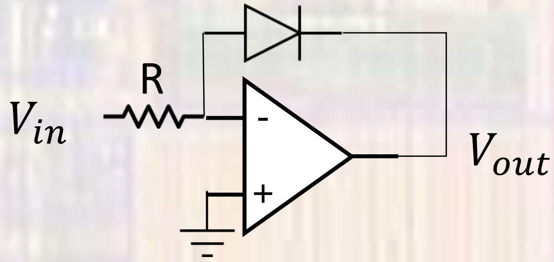
- Half-Wave Precision Rectifier
  - Removes the Diode voltage drop from the output





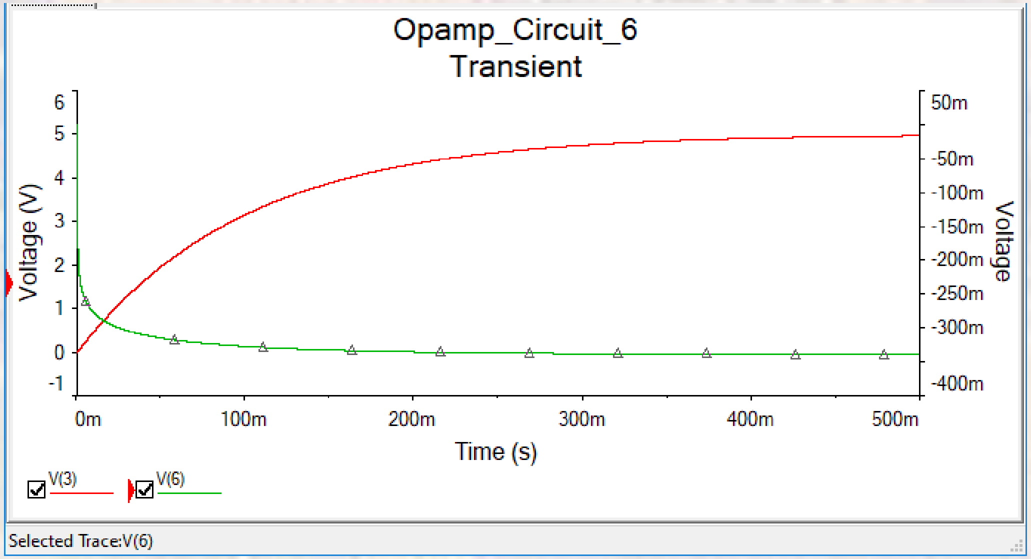
OpAmp Circuits II

- Log Amplifier



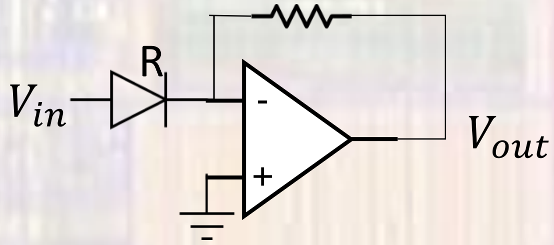
$$V_{in}/R = I_D = I_S e^{\frac{V_D}{nV_T}} = I_S e^{\frac{-V_{out}}{nV_T}}$$

$$V_{out} = -nV_T ln\left(\frac{V_{in}}{I_S R}\right)$$



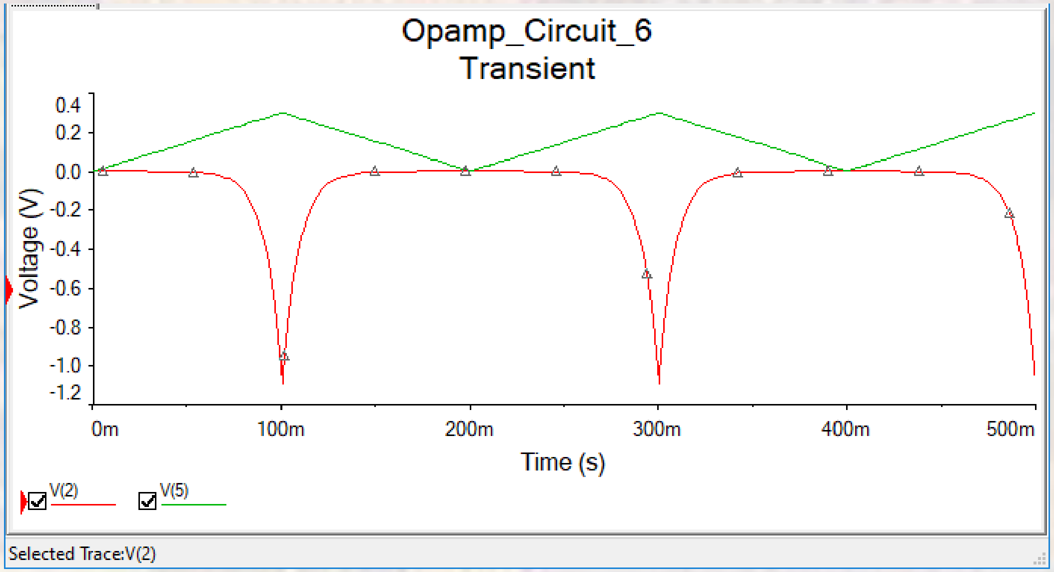
OpAmp Circuits II

- Exponential Amplifier



$$V_{out}/R = I_D = I_S e^{\frac{V_D}{nV_T}} = I_S e^{\frac{V_{in}}{nV_T}}$$

$$V_{out} = -RI_S e^{\frac{V_{in}}{nV_T}}$$

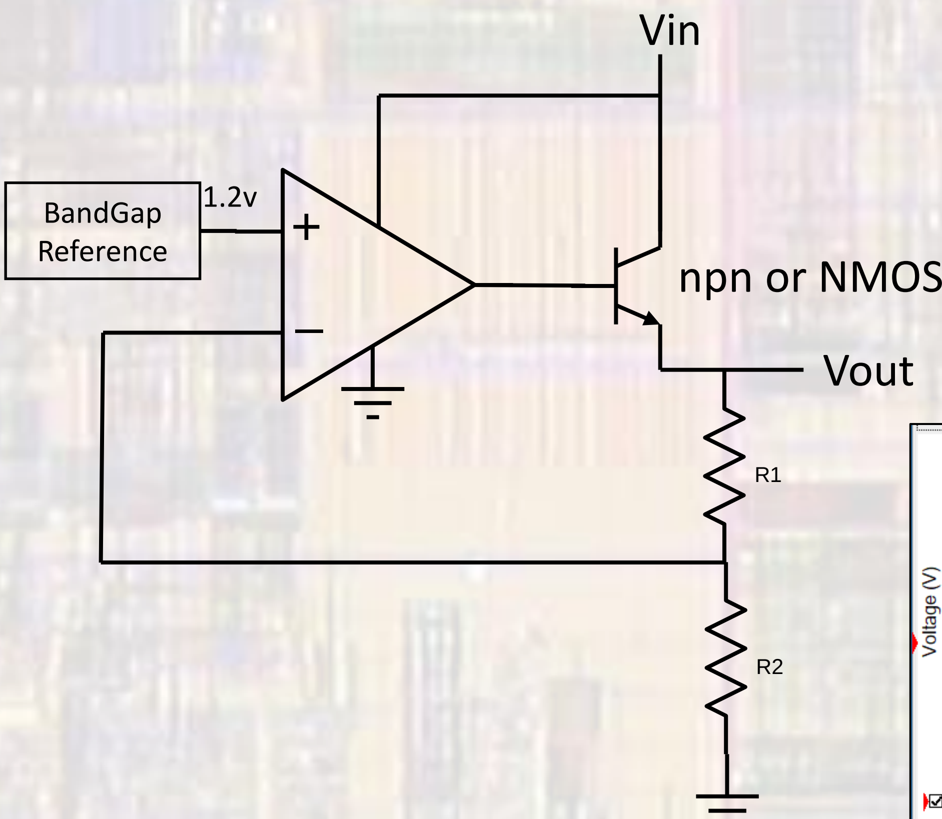


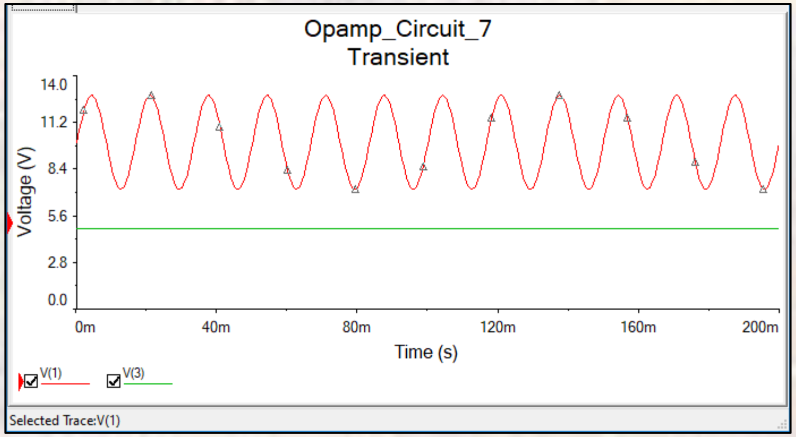
OpAmp Circuits II

- Regulated Supply
  - Super Simple Regulator

$$\frac{R2}{R1 + R2} Vout = Vbg$$

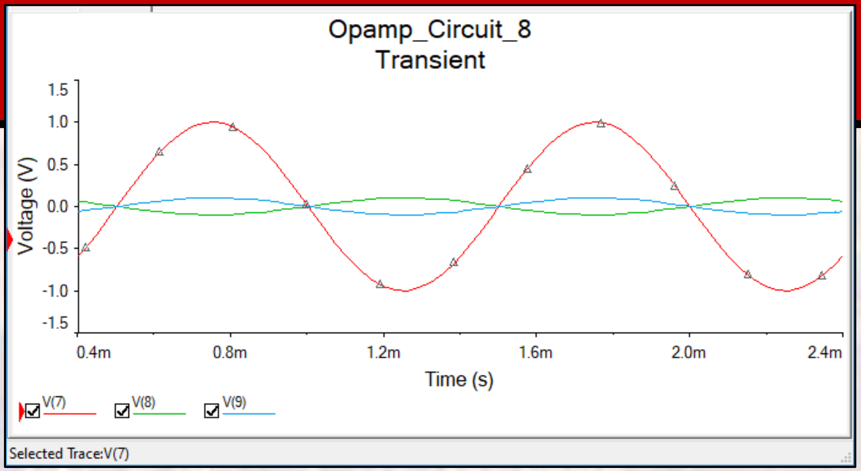
$$Vout = Vbg \frac{R1 + R2}{R2}$$

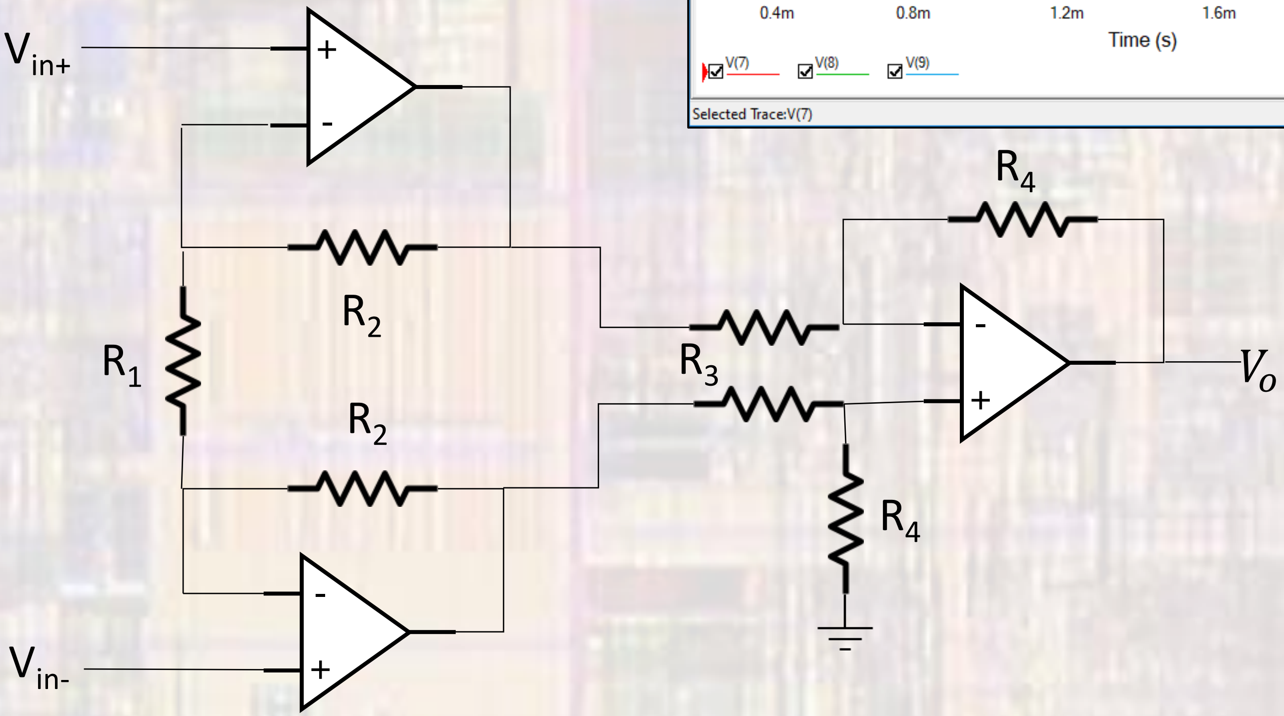




OpAmp Circuits II

- Instrumentation Amplifier





$$V_o = \frac{R_4}{R_3}\left(1 + \frac{2R_2}{R_1}\right)(V_{in+} - V_{in-})$$