ELEN30013 Electronic System Implementation

Week 6/1: Review + Driving Actuator + Introduce to Signal Conditioning

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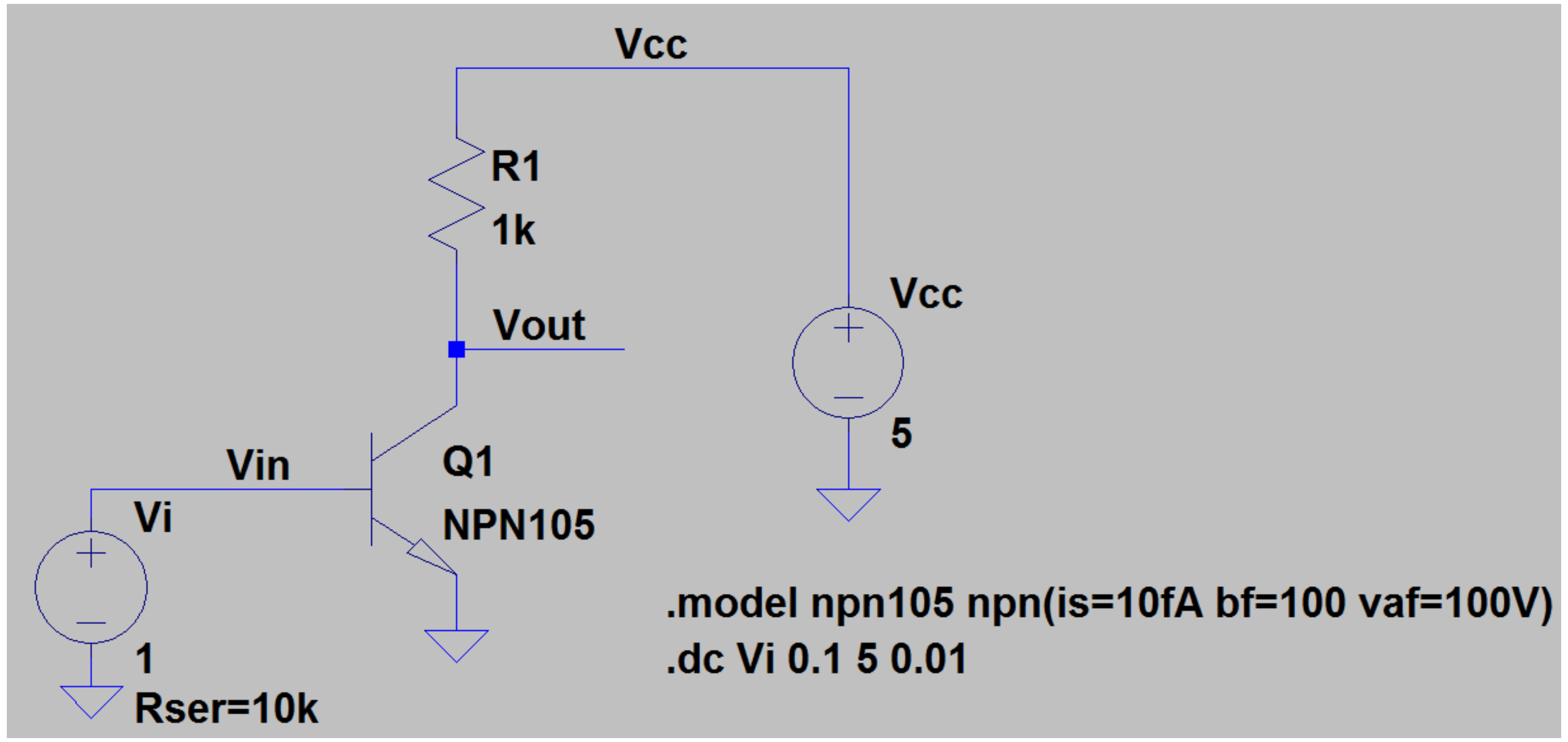
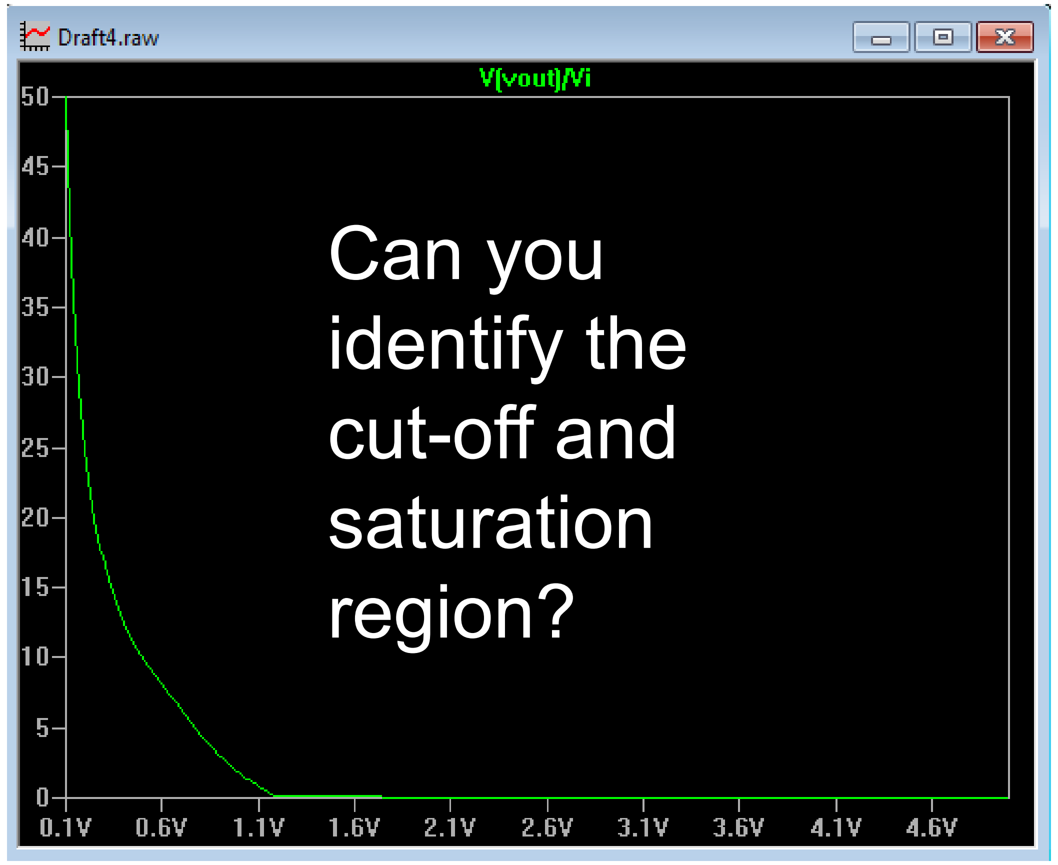
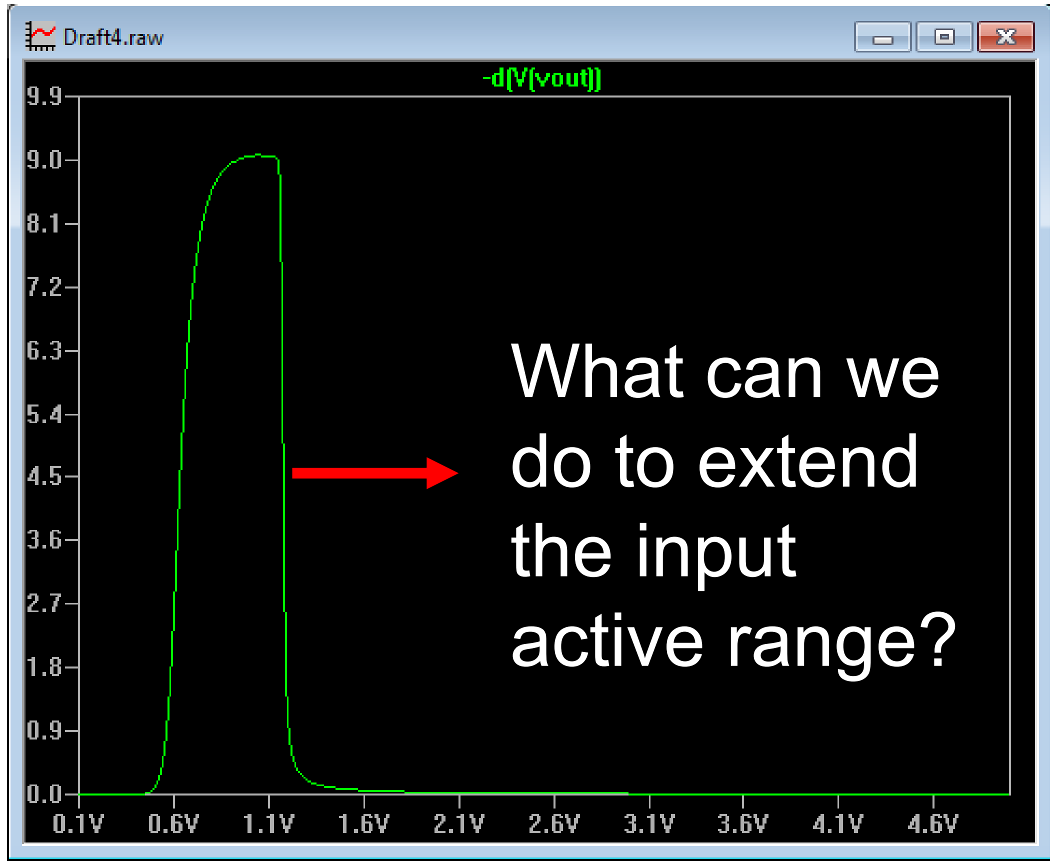
THE UNIVERSITY OF MELBOURNE

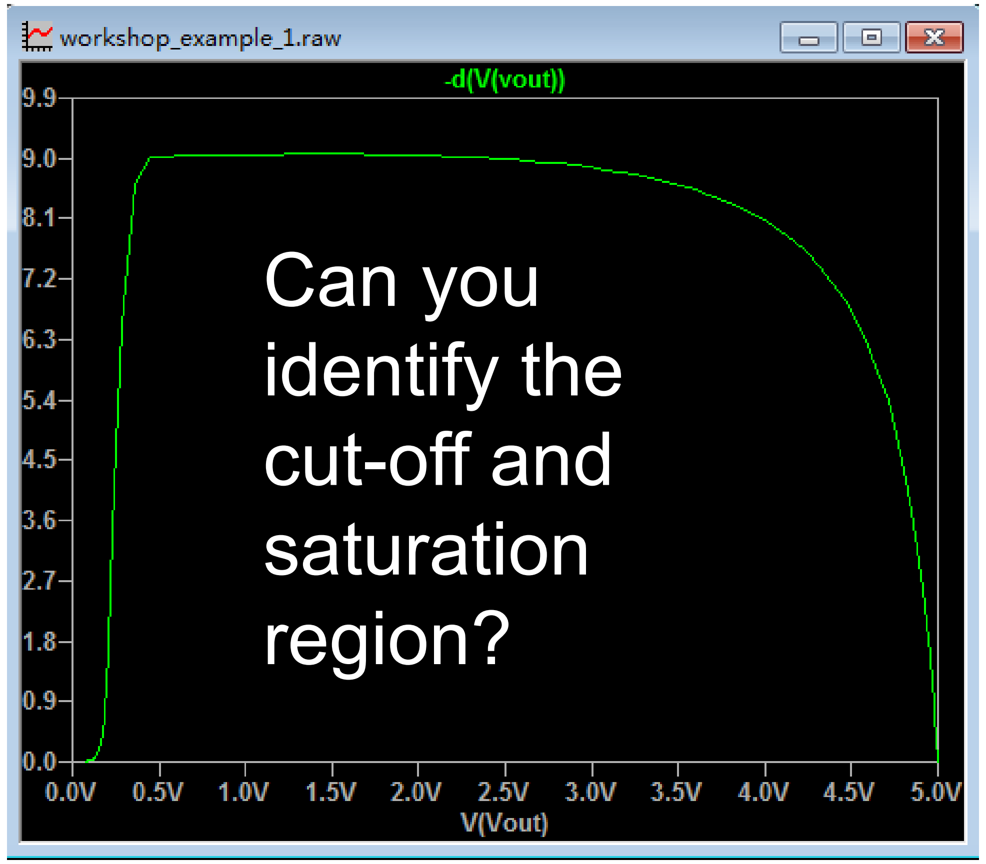
Week 3 Workshop Review: LTspice Simulation

- DC Analysis
  - Identify the operation conditions for different mode
    ➔ Design circuit to meet design requirement



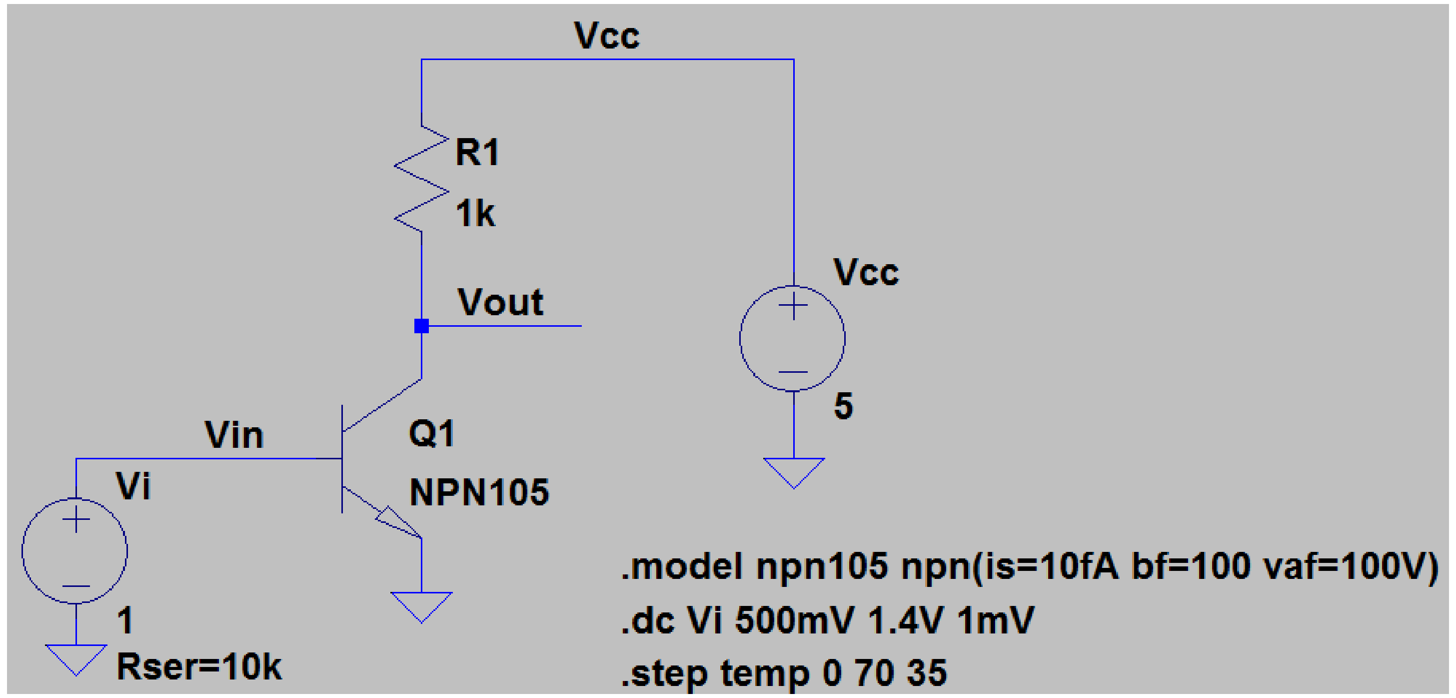


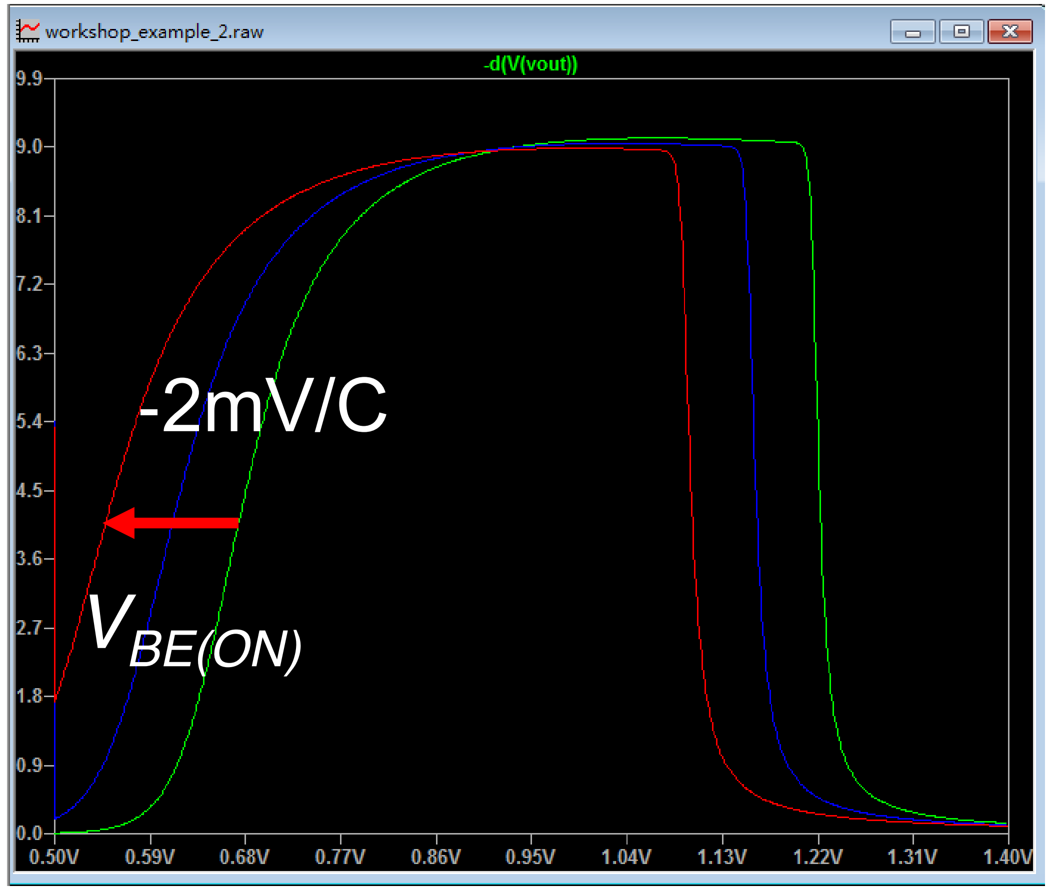


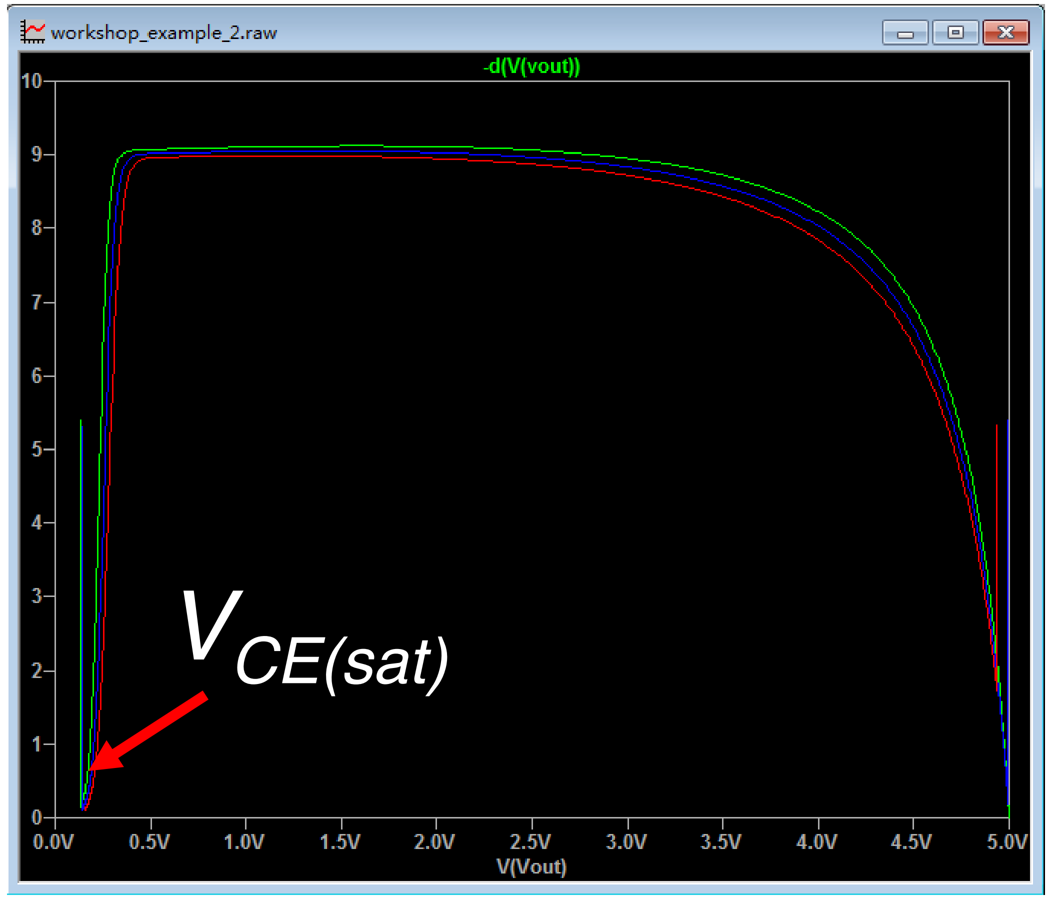


Week 3 Workshop Review: LTspice Simulation

- Temperature variation impact
  - Notice the variation and taken it into your design calibration

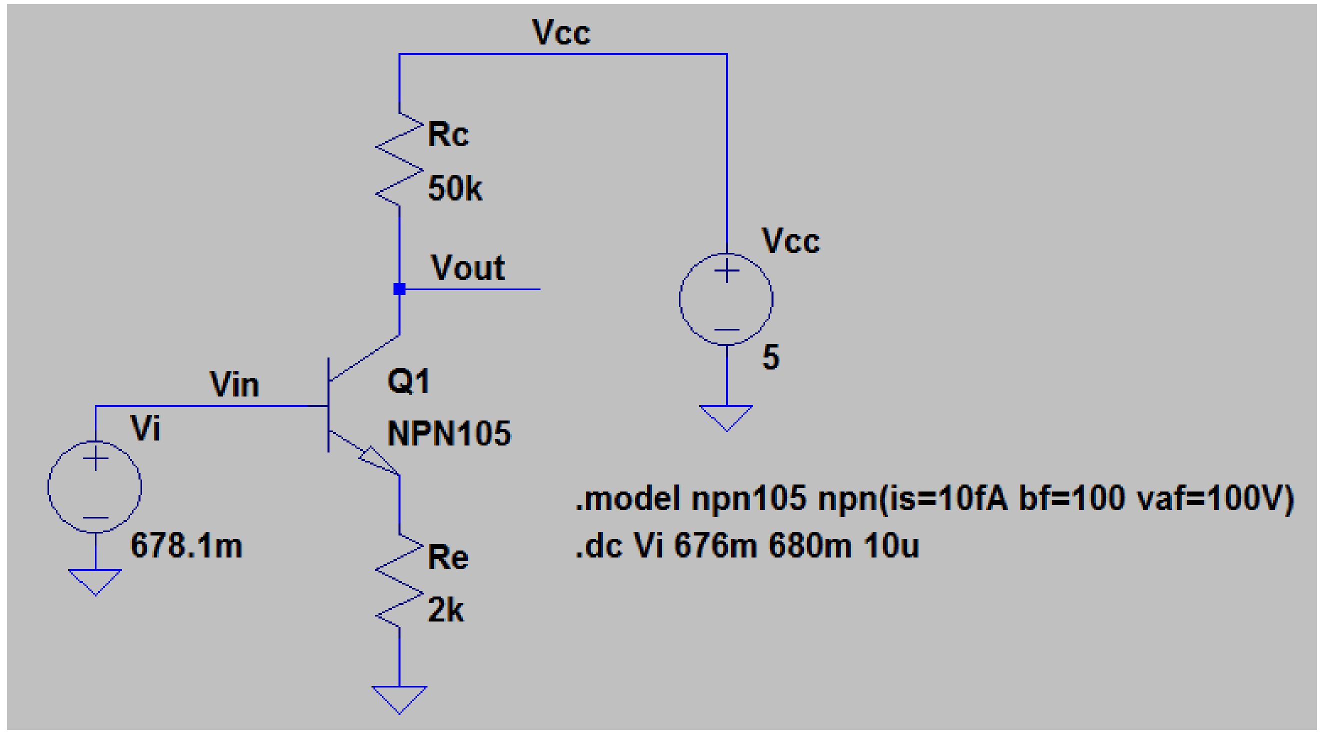






Week 3 Workshop Review: LTspice Simulation

- Why Emitter Degeneration?
  - Gain is a strong function of both temperature and bias current
    ➔ gain becomes unpredictable and unstable
  - Low input dynamic range limits small-signal gain
    ➔ Voltage gain Av ≈ - Rc/Re rather than BJT's intrinsic characteristics

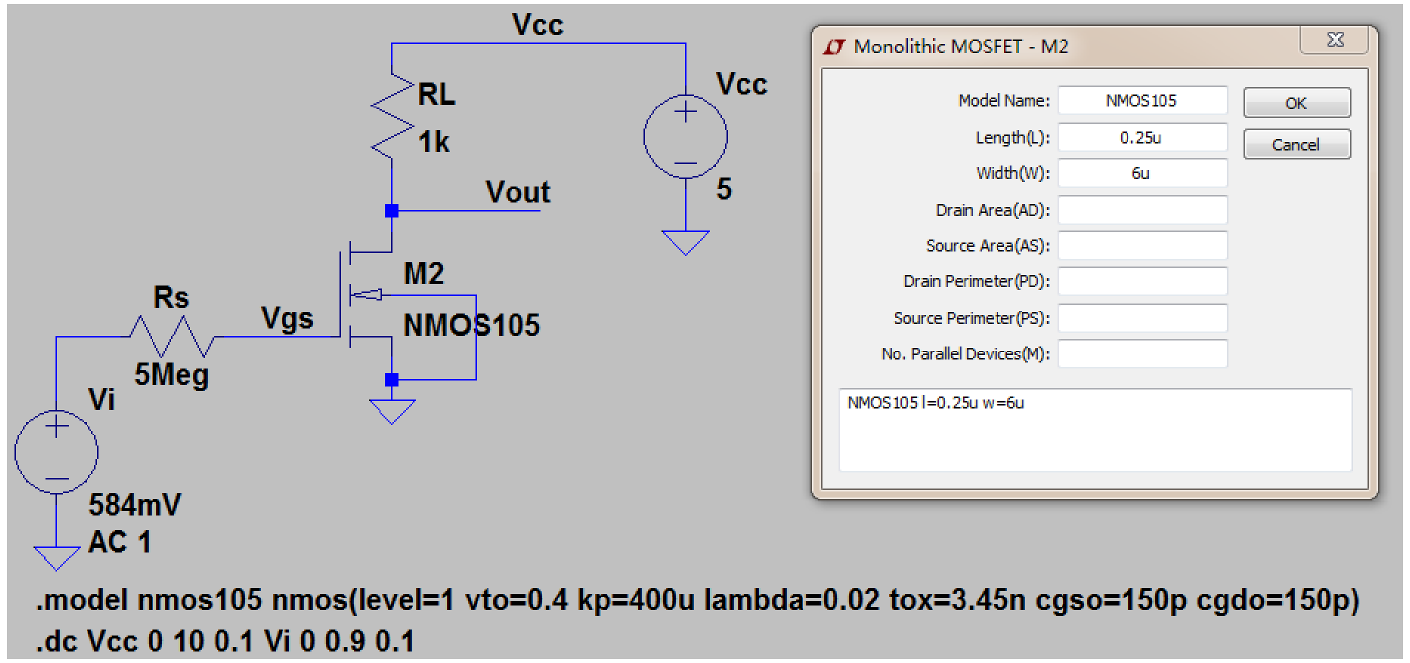


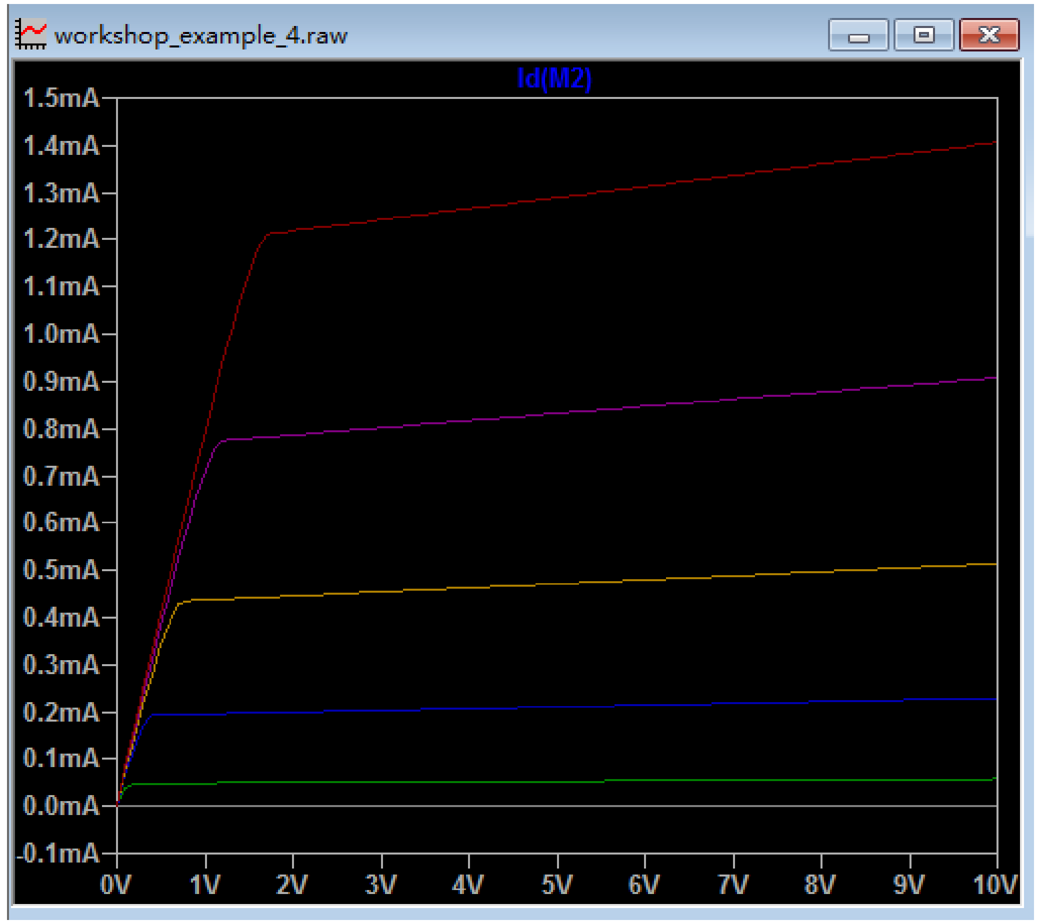
- Transfer Function Analysis
  - Identify Operation Conditions
  - Input / Output Impedance
  - Voltage Gain

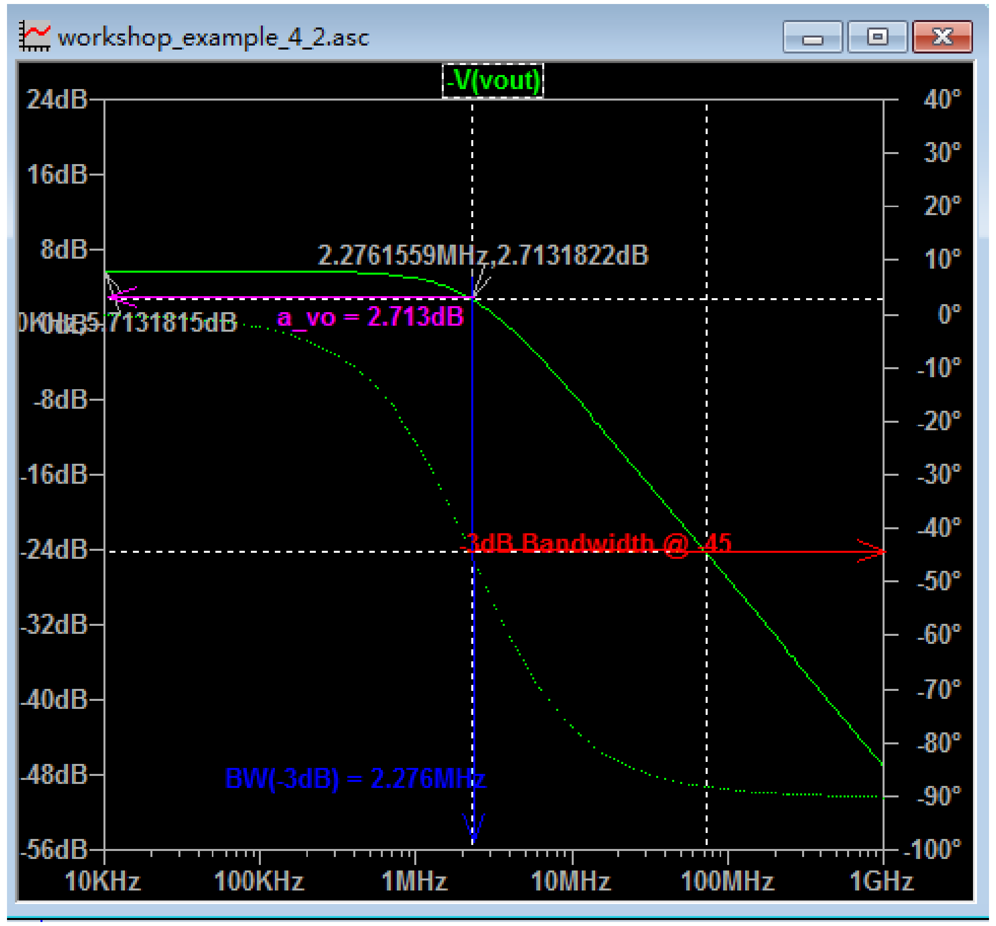
	Definition	Expression with emitter degeneration	Exp. w/o emitter deg. (Re=0)
Current Gain	$A_i=i_{out}/i_{in}$	β	β
Voltage Gain	$A_v=v_{out}/v_{in}$	$-\dfrac{\beta R_C}{r_\pi + (\beta+1)R_E}$	$\approx -g_m R_C$
Input Impedance	$r_{in}=v_{in}/i_{in}$	$r_\pi + (\beta+1)R_E$	r_π
Output Impedance	$r_{out}=v_{out}/i_{out}$	R_C	R_C

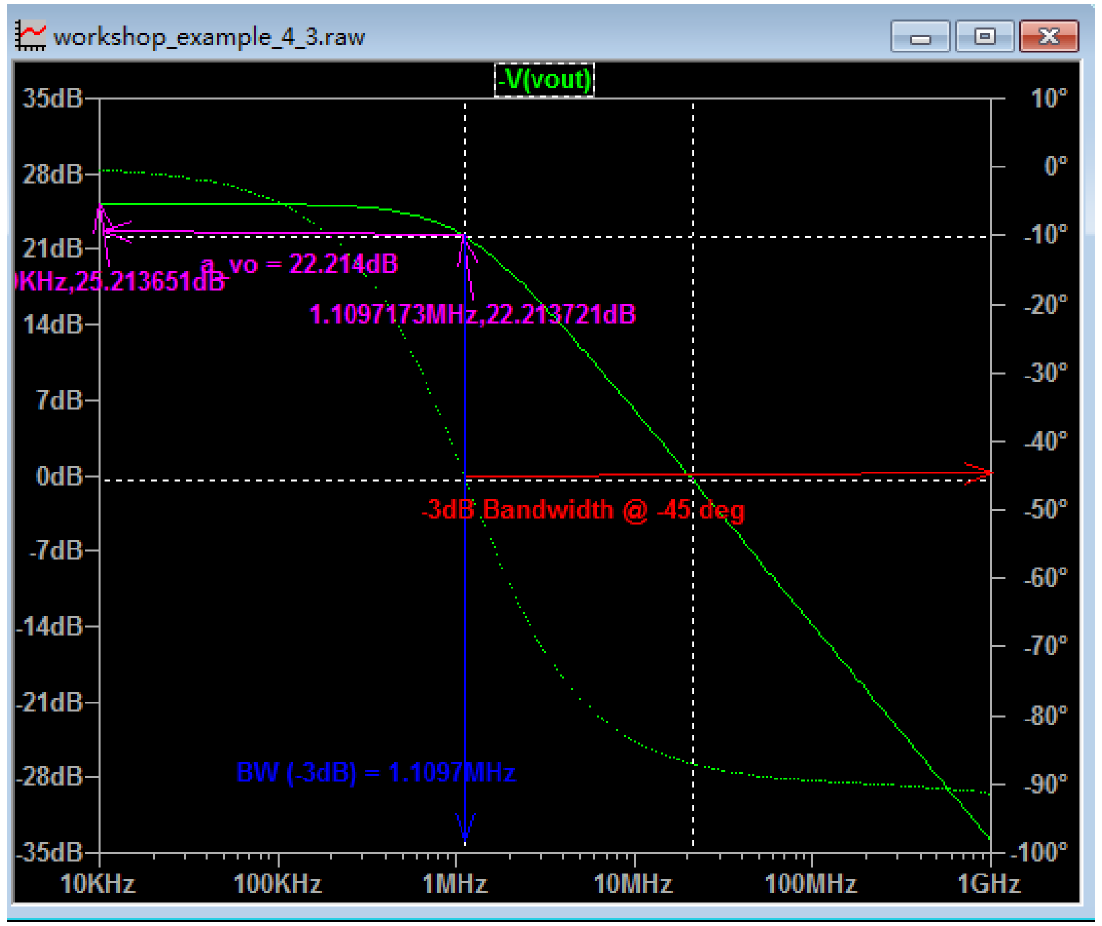
Week 3 Workshop Review: LTspice Simulation

- AC Analysis
  - Identify the operation conditions (voltage controlled device - Difference compare to BJT?)
  - Gain/Phase vs. frequency

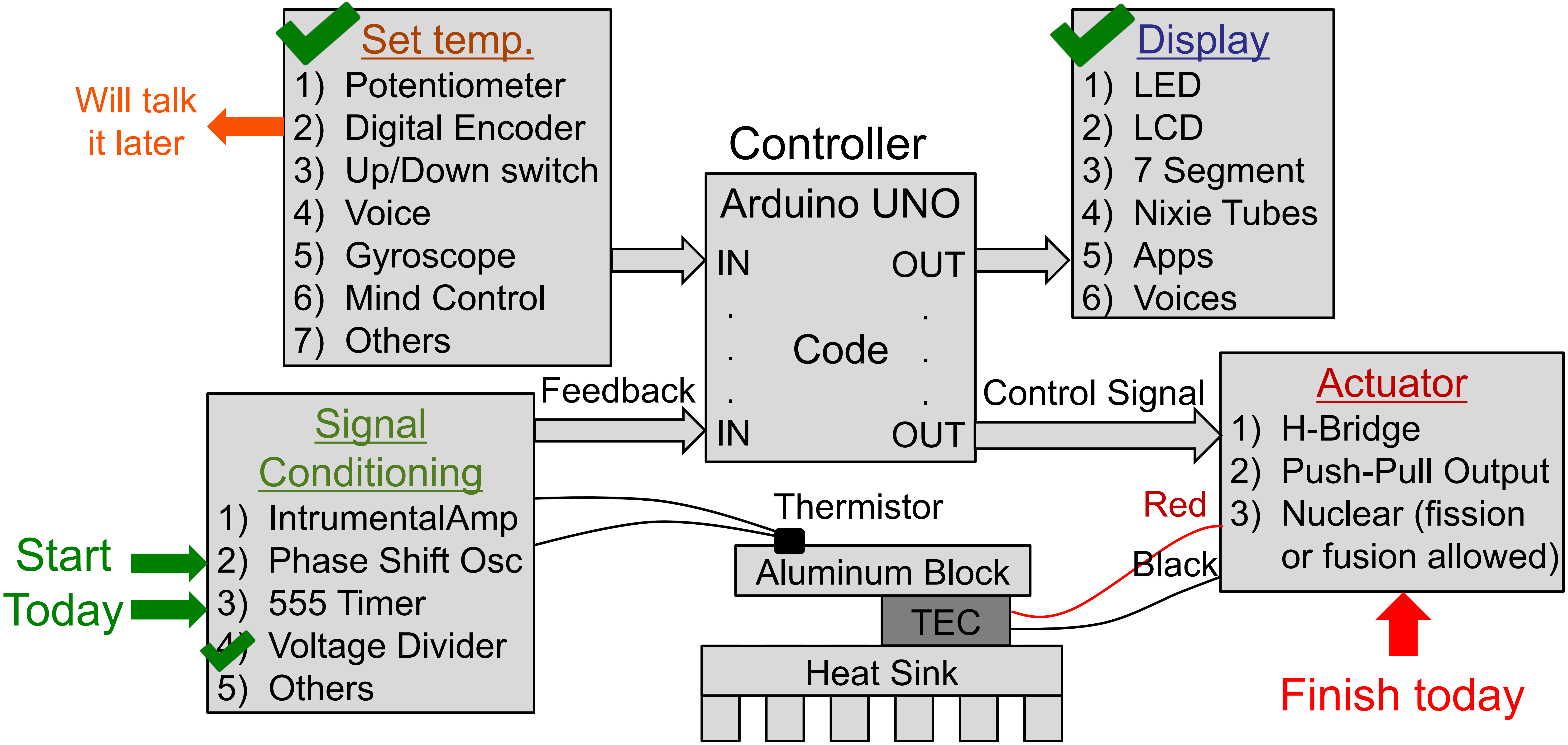








Project Overview

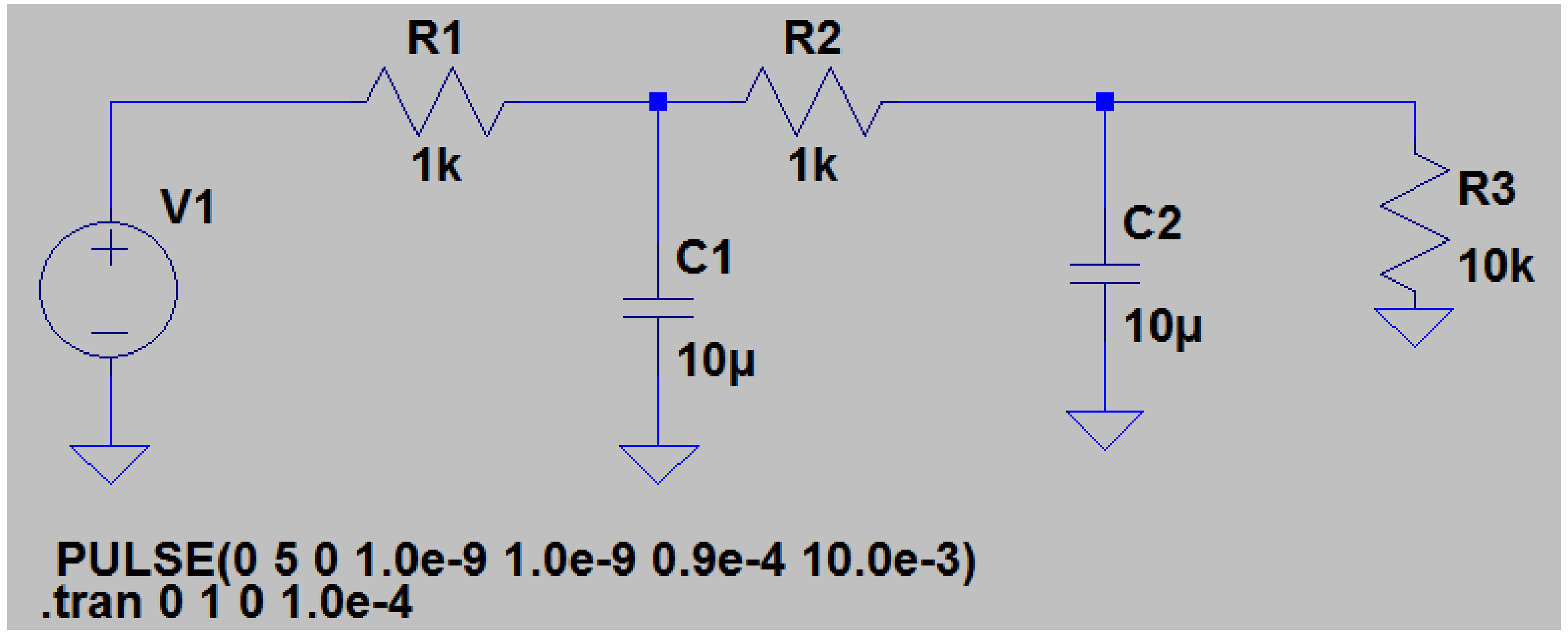


Drive the Actuator

High frequency/ current?

- H-bridge
  - PWM – Run simulation first!
  - Important: which transistor to pick (BC337!?)
- Push-Pull
  - PWM + LPF(what value to pick?)

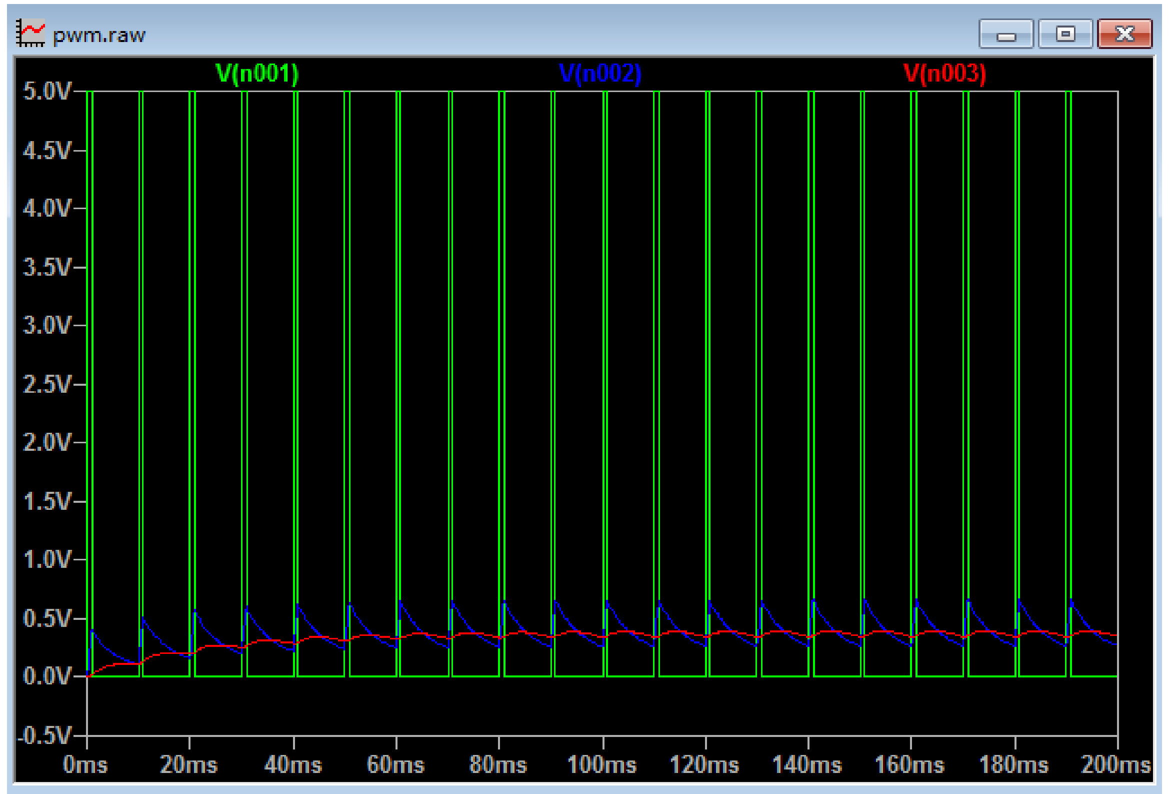
bc337: max input current?

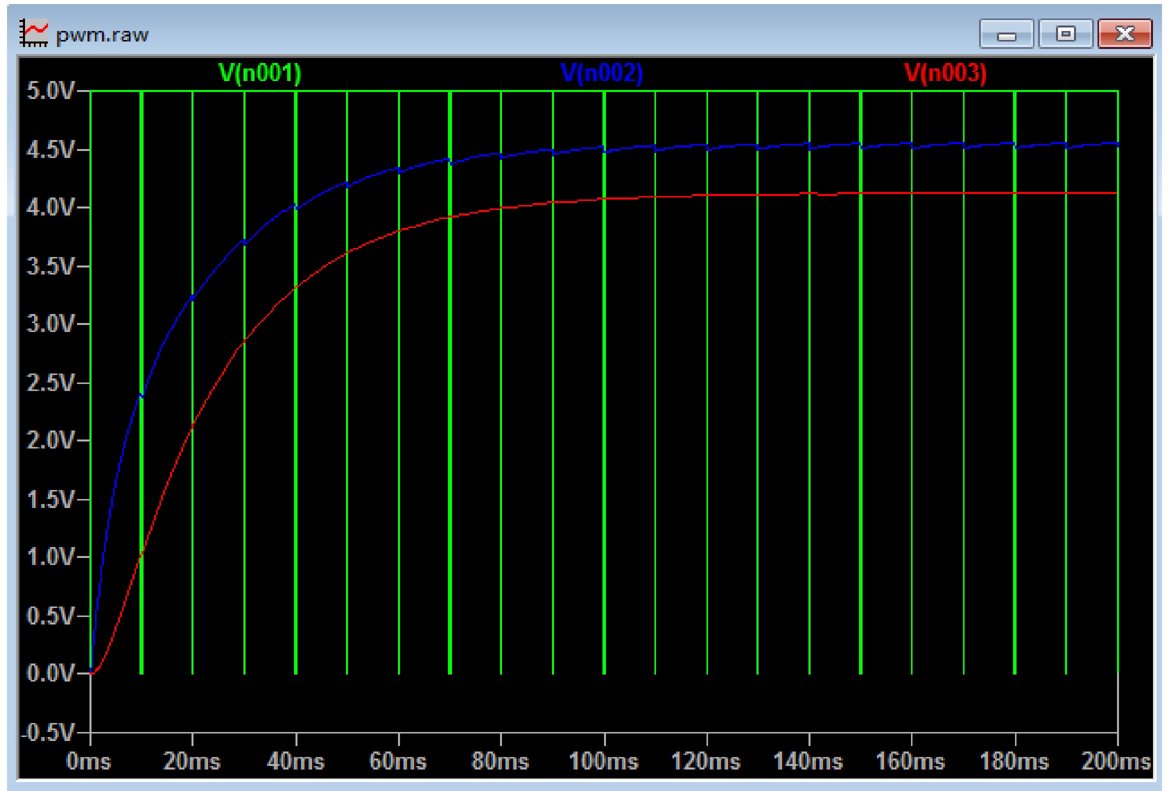


Push Pull; pnp&npn
H-bridge:?

- Which solution to pick
  - component counts, power consumption, accuracy, etc.

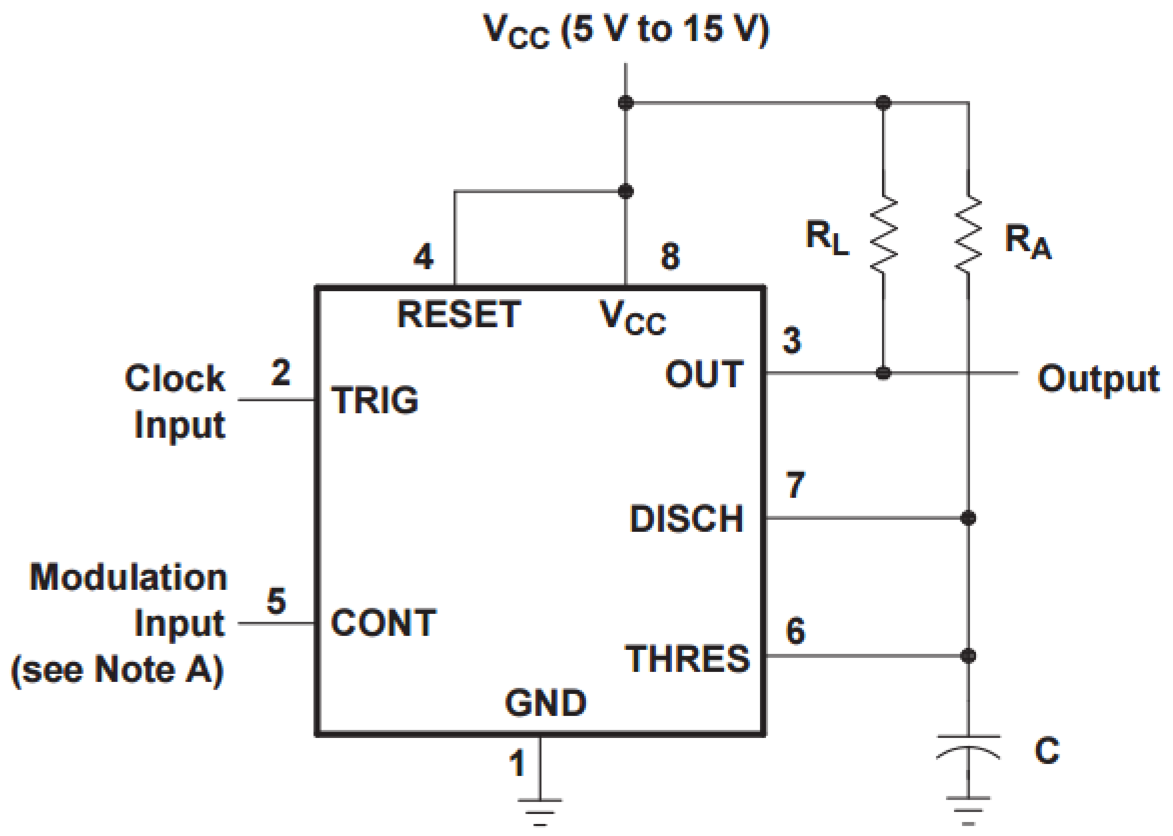
which has less component? speed to change the temp?





Drive the Actuator using 555 Timer

- 555 timer can time from microseconds to hours
- Adjustable duty cycle
  ➔ Modulated output based on input voltage



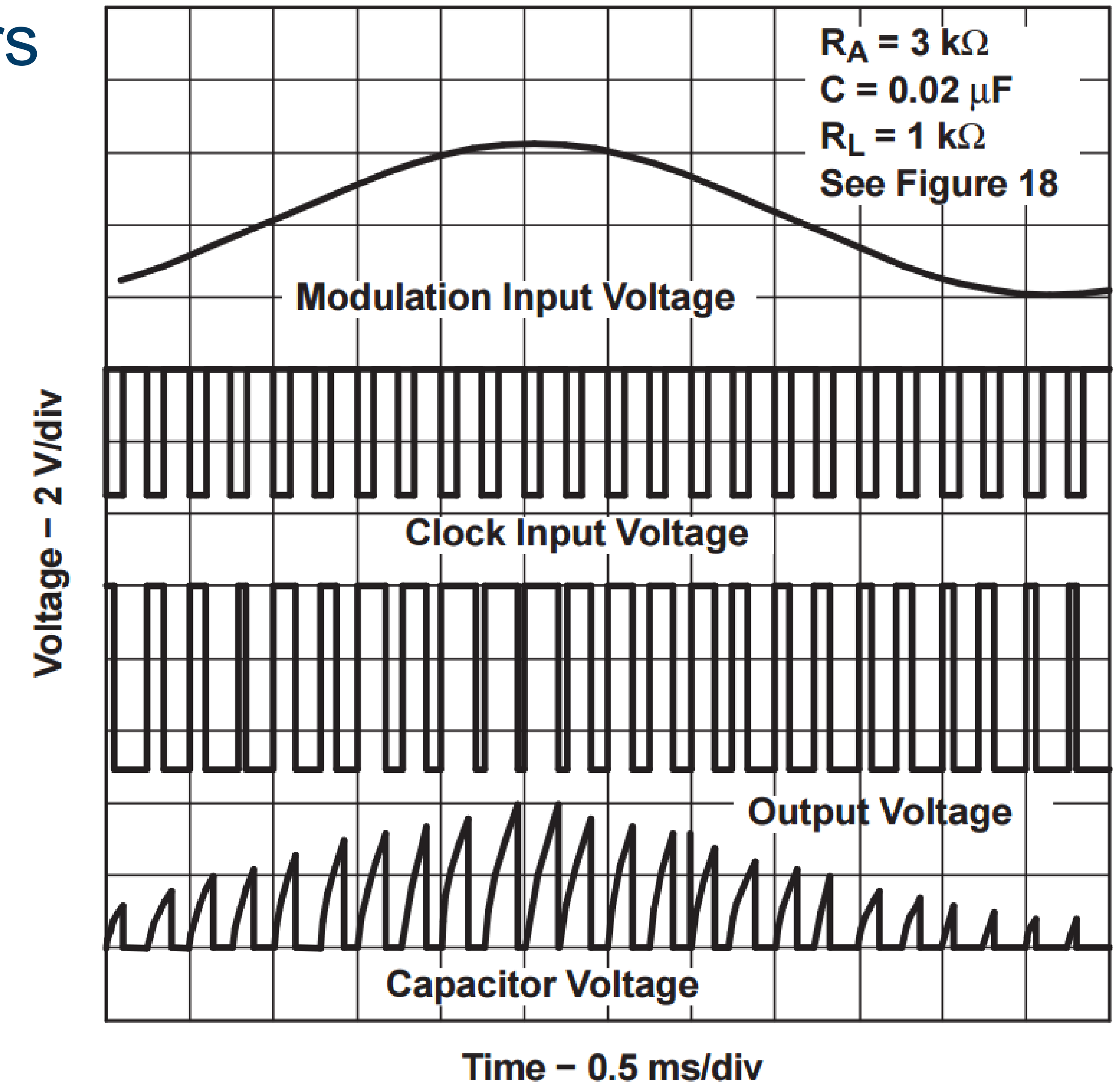
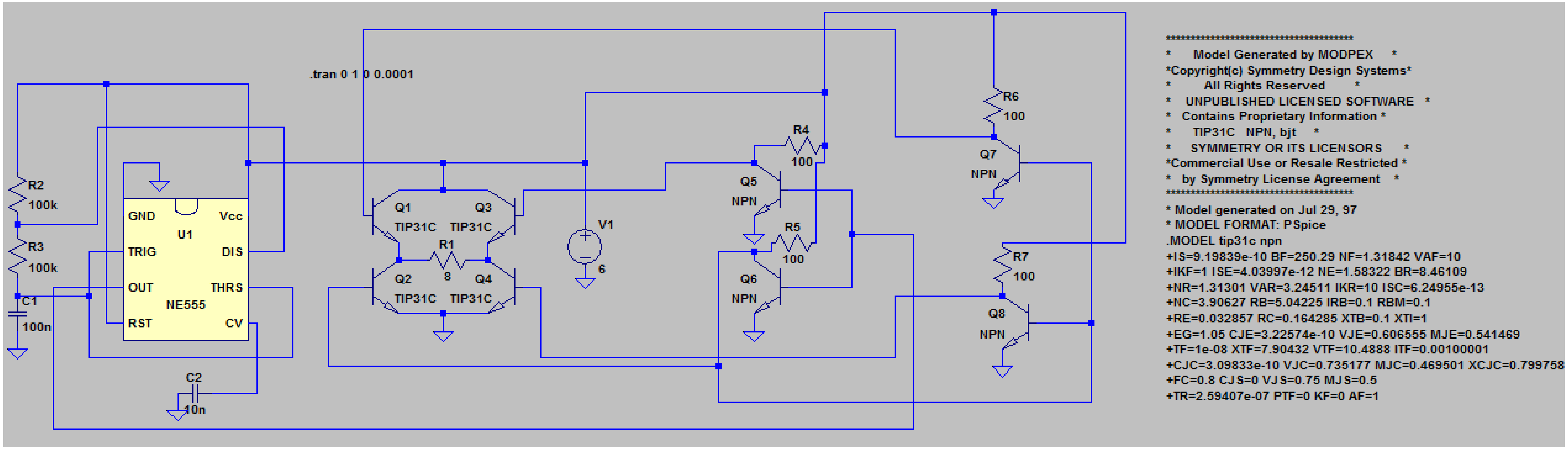


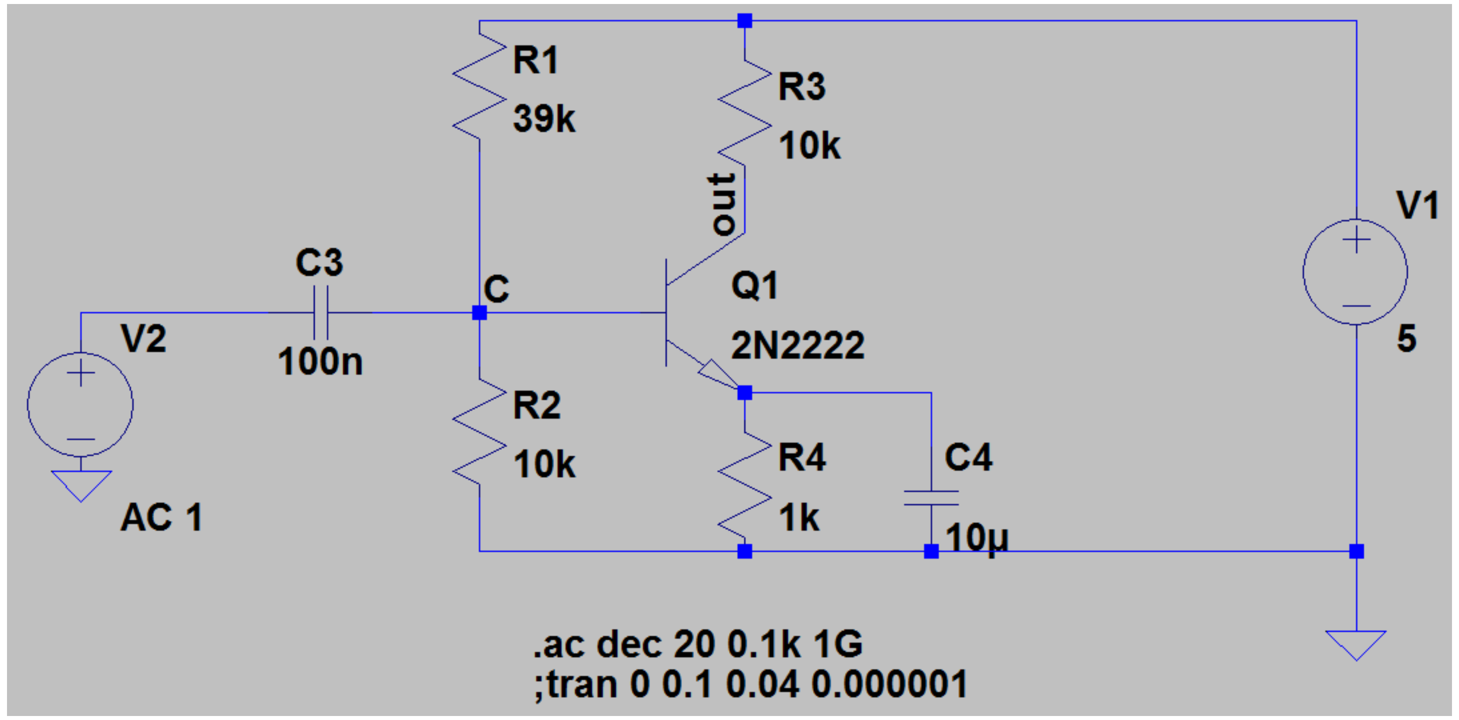
Figure 19. Pulse-Width-Modulation Waveforms

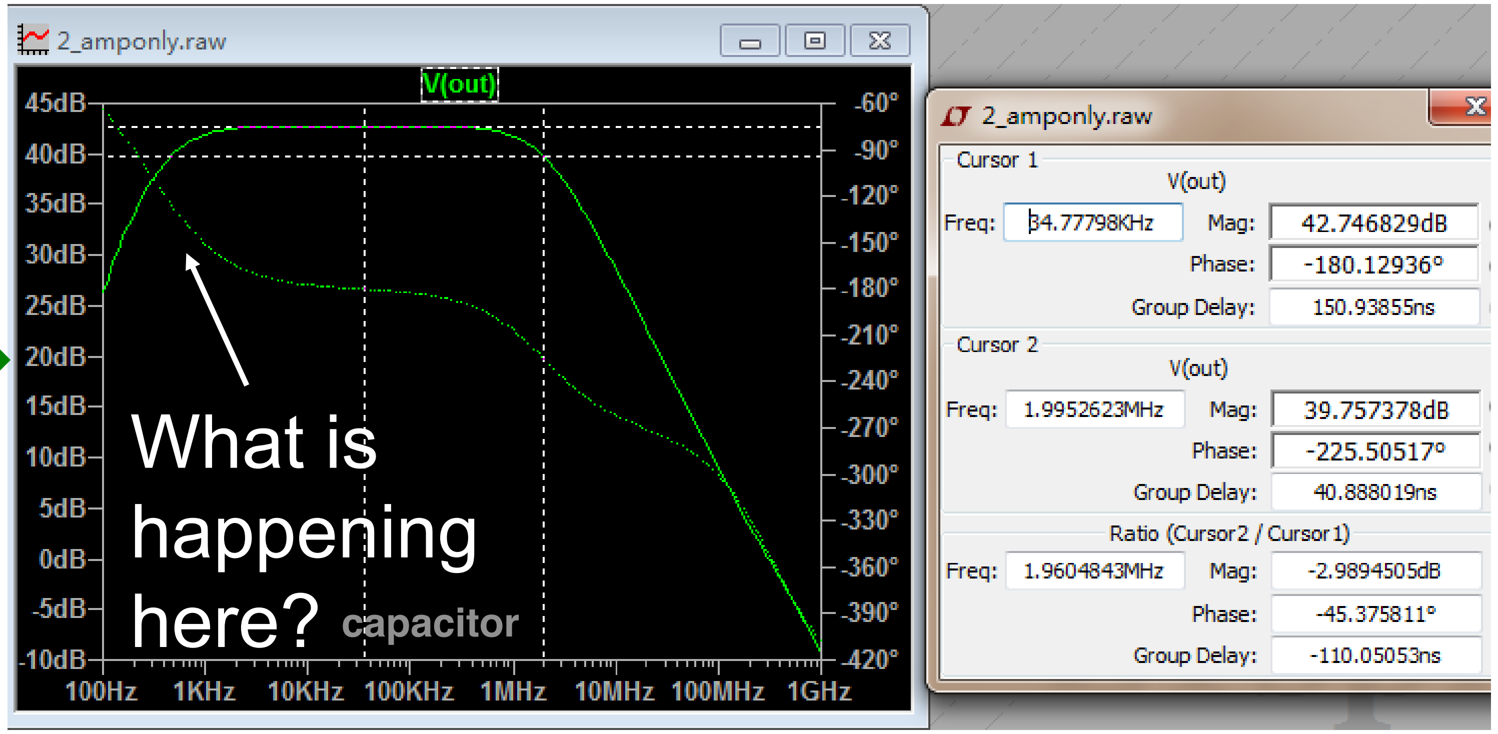
- Can be used for both driving the actuator and signal conditioning



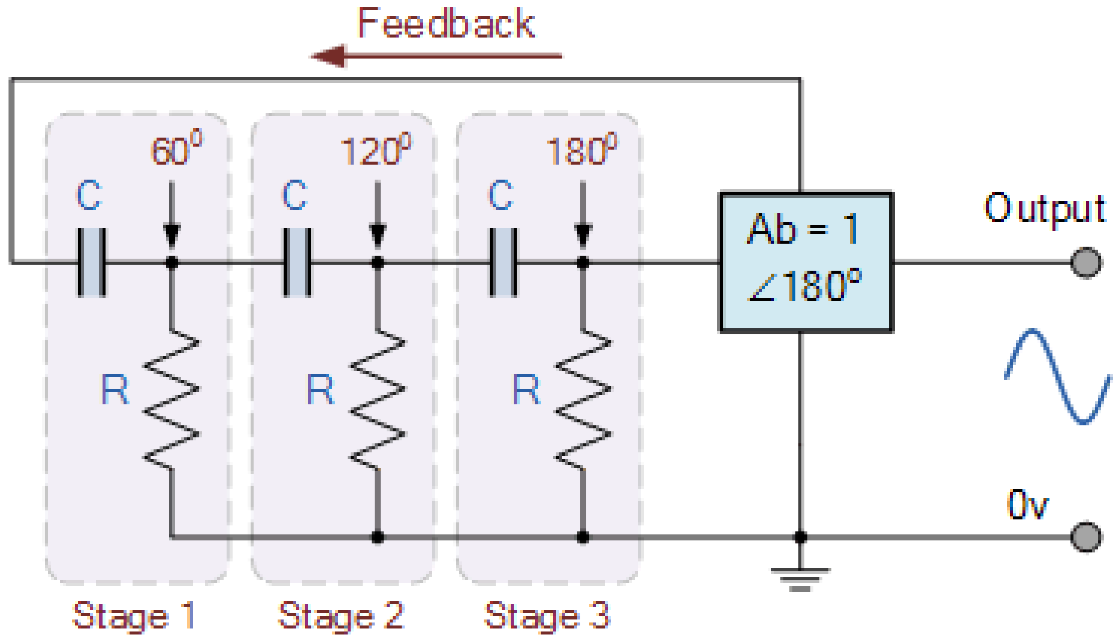
Phase Shift Oscillator

- Single stage CE BJT amplifier (Class A) ➔ 180 phase shift (v_{out} vs v_{in})

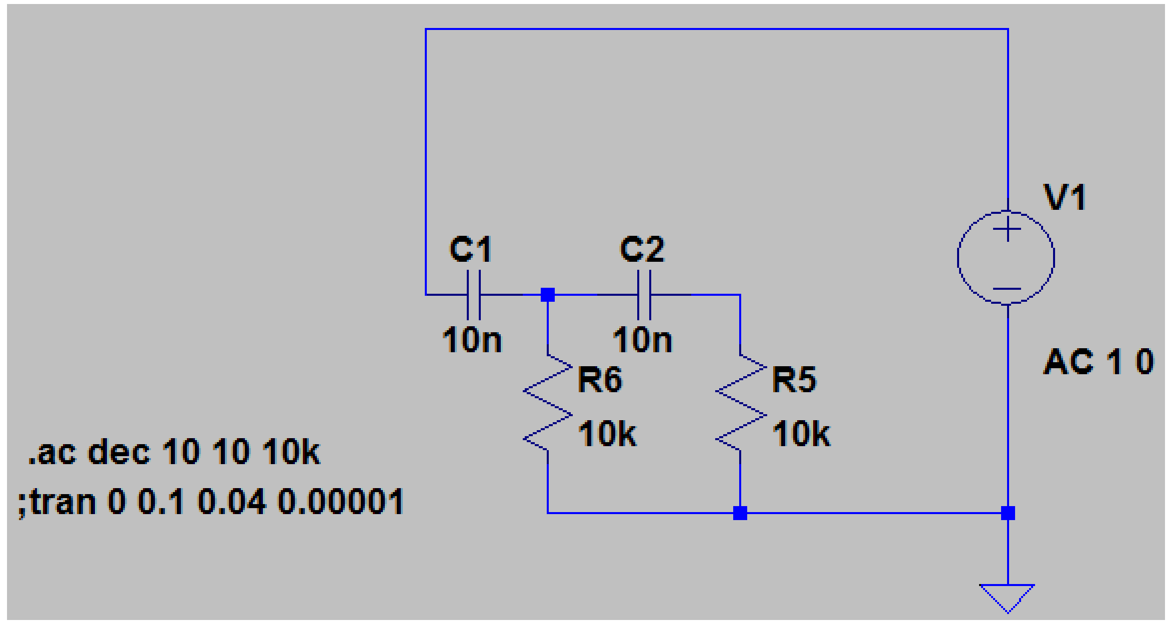




- An oscillator 🡐 sufficient feedback of the correct phase (i.e, “Positive Feedback”)



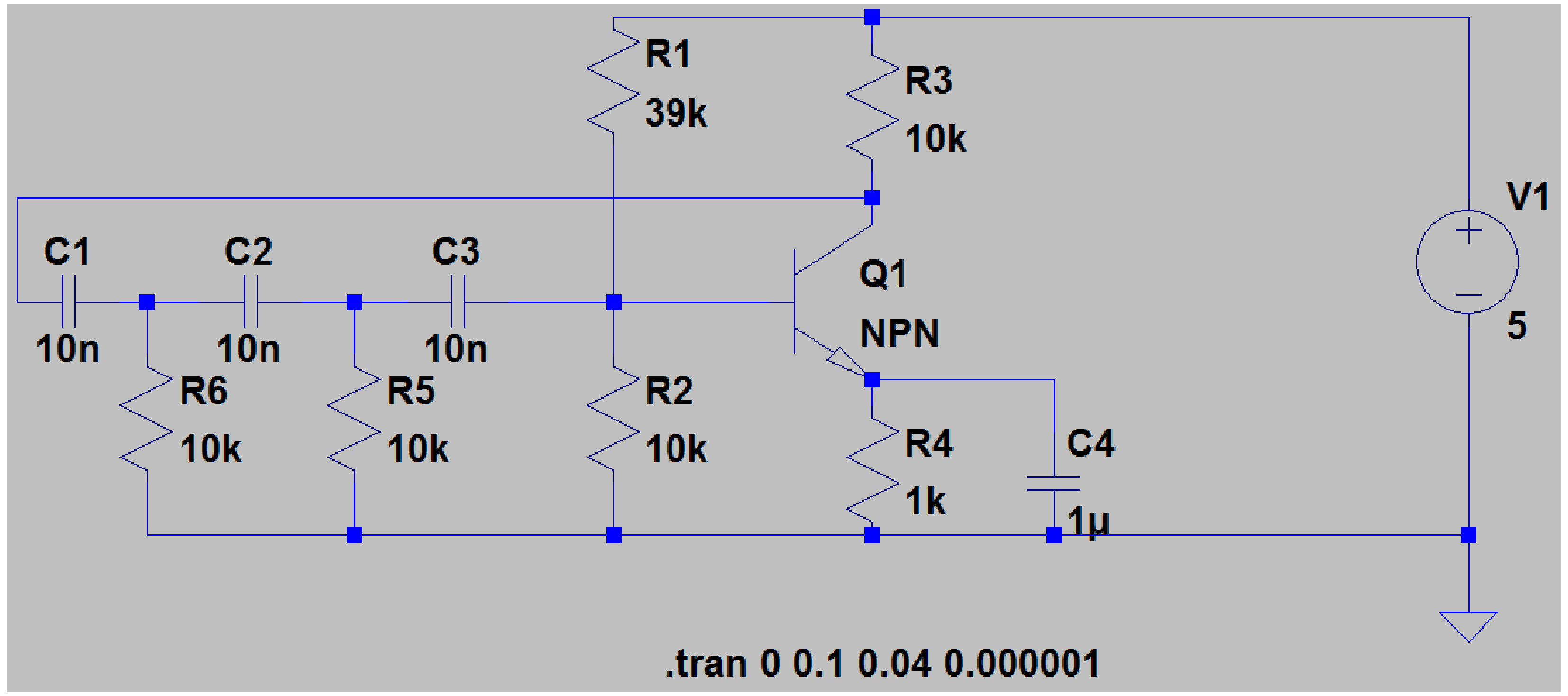
Resistance-Capacitance Oscillator (RC Oscillator)

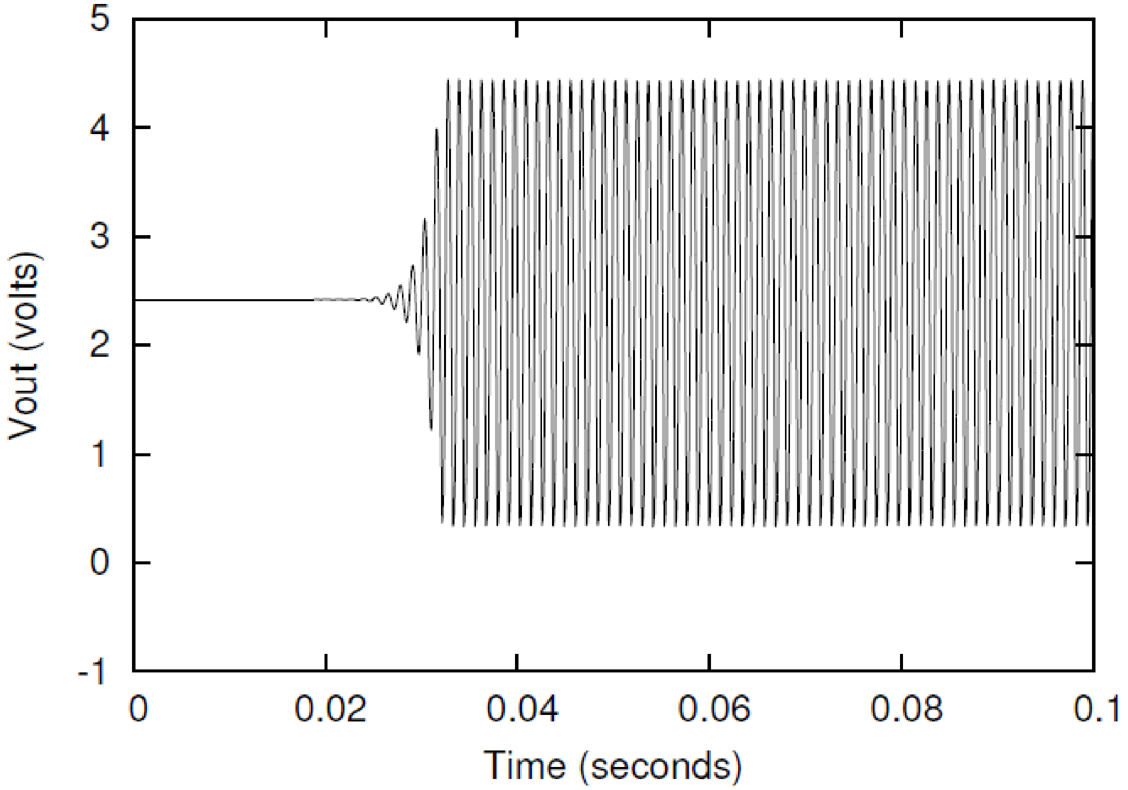


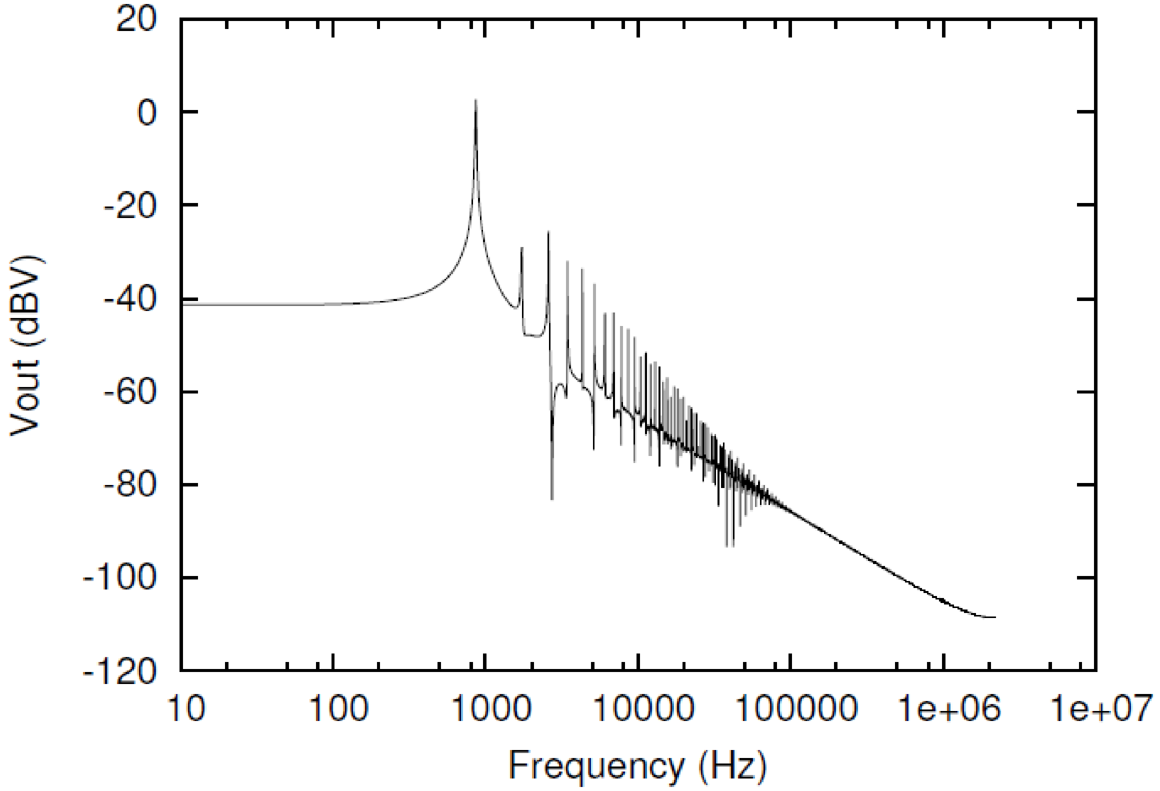
Phase Shift Oscillator

- RC Phase Angle:
  - $X_C = \frac{1}{2\pi f c}, \qquad R=R$

    $\rightarrow Z = \sqrt{R^2 + X_C^2}, \; \emptyset = tan^{-1}\frac{X_C}{R}$
- RC oscillator frequency
  - $f_r = \frac{1}{2\pi RC\sqrt{2N}}$
  - N: number of RC stages (i.e. 3)







Phase Shift Oscillator

- Phase Shift Oscillator as temperature sensor
  - Replace R in filter section with a thermistor
  - Frequency and period become temperature dependent
  - Measure period using time for subsequent transitions to HIGH
  - How can we quantify quality of this measurement technique

$$\frac{R_T}{R_{25}} = \exp\left(A + \frac{B}{T} + \frac{C}{T^2} + \frac{D}{T^3}\right)$$