# ECE 321 - Homework #2

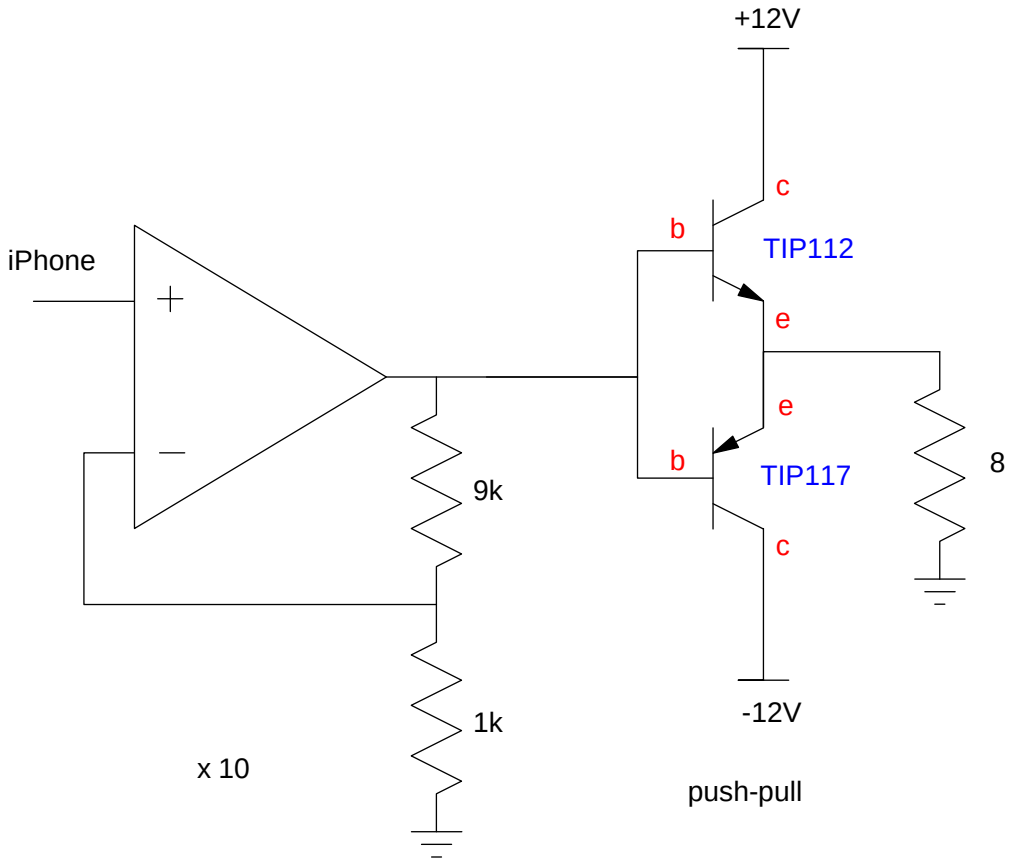
Push-Pull Amplifiers - Phasors - Due Monday, April 13th

1) Design a circuit with a push-pull amplifier to amplify the output of an iPhone

- Input: 1Vpp sine wave, < 10mA
- Output: 8 Ohm 20W speaker
- Relationship: Vo = 10*Vin, ?1V

There are several solutions. The following lets you build it in sections:

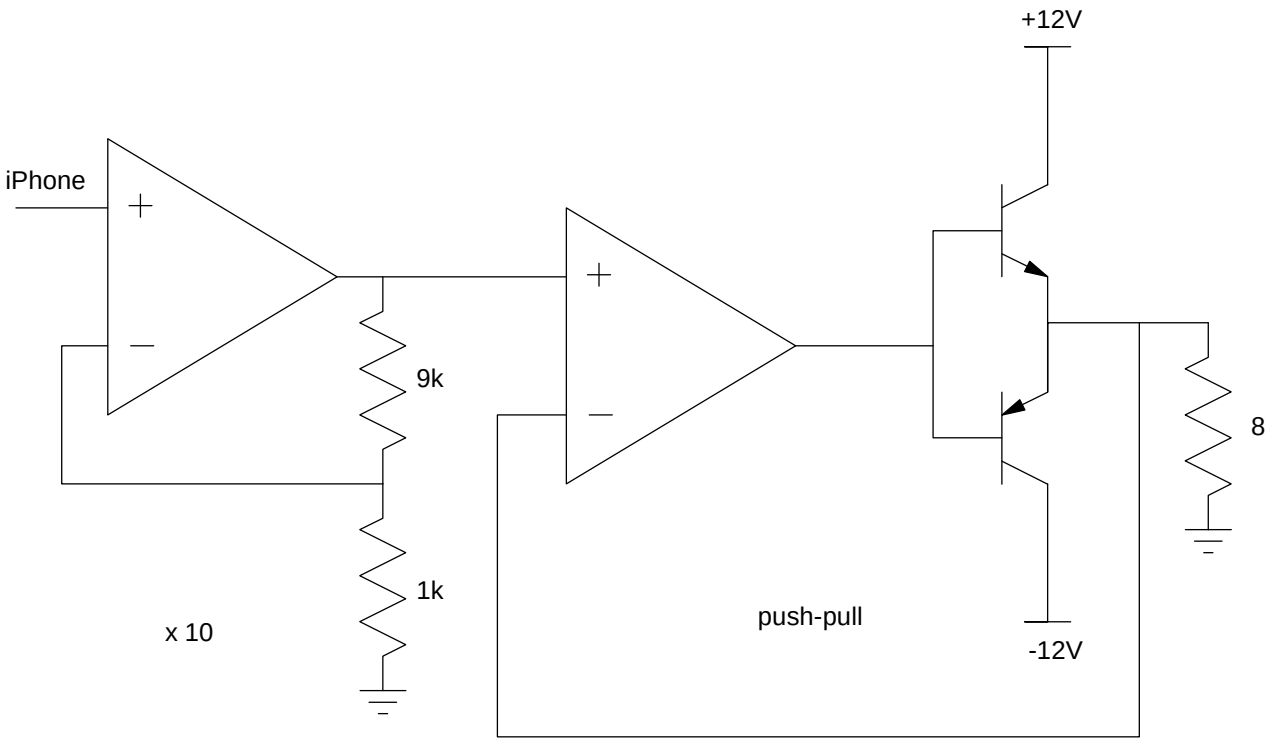
- x10
- push-pull aplifier



2) Design a push-pull amplifier without crossover distortion to amplify the output of an iPhone

- Input: 1Vpp sine wave, < 10mA
- Output: 8 Ohm 20W speaker
- Relationship: Vo = 10*Vin, ?100mV

Same circuit as before, but add an op-amp to force the voltage at the speaker to match the voltage at the output of the first op-amp



3) For the following filter:

$$Y = \left(\frac{20}{s^2+5s+20}\right)X$$

3a) What is the differential equation relating X and Y?

Cross multiply

$$(s^2 + 5s + 20)Y = 20X$$

'sY' means "the derivative of Y"

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 20y = 20x$$

3b) Find y(t) if x(t) = 2 + 3 sin(4t)

Use superposition:

x(t) = 2

s = 0

$$\left(\frac{20}{s^2+5s+20}\right)_{s=0} = 1$$

y(t) = (1) * 2 = 2

x(t) = 3 sin(4t)

s = j4

$$\left(\frac{20}{s^2+5s+20}\right)_{s=j4} = 0.9806\angle -76.7^0$$

$$y(t) = (0.9806\angle -76.7^0) \cdot 3\sin(4t)$$

$$y(t) = 2.9417\sin(4t - 76.7^0)$$

x(t) = 2 + 3 sin(4t)

$$y(t) = 2 + 2.9417\sin(4t - 76.7^0)$$

4) For the following filter: $Y = \left(\frac{300}{(s+10)(s+20)}\right) X$

4a) What is the differential equation relating X and Y?

Cross multiply

$$(s+1)(s+2)Y = 300X$$

$$(s^2+3s+2)Y = 300X$$

'sY' means 'the derivative of Y'

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = 300x$$

4b) Find y(t) if x(t) = 2 + 3 sin(4t)

Use superposition:

x(t) = 2

s = 0

$$\left(\frac{300}{(s+10)(s+20)}\right)_{s=0} = 1.5$$

$$y = (1.5)\cdot 2$$

$$y(t) = 3$$

x(t) = 3 sin(4t)

s = j4

$$\left(\frac{300}{(s+10)(s+20)}\right)_{s=j4} = 1.3657\angle -33.1^0$$

$$y(t) = (1.3657\angle -33.1^0)\cdot 3\sin(4t)$$

$$y(t) = 4.0970\sin(4t - 33.1^0)$$

x(t) = 2 + 3 sin(4t)

$$y(t) = 3 + 4.0970\sin(4t - 33.1^0)$$

Term Project

5) Specify the requirements for your ECE 321 term project in terms of

- Input
- Output
- Relationship.

For ECE 321, the output must be an analog signal (i.e. able to take on any voltage between a rance, such as -10V to +10V).