PHYS 235 — Exam #2
Thursday, March 7, 2019

Name:____________________________________

1. (20 pts) Consider the illustrated voltage source and amplifier. The source is set to give an output of 40 mV when it has no load, and it has an output impedance of 100 Ω. The amplifier voltage gain is set to 20, and the amplifier has an input impedance of 500 Ω and an output impedance of 10 Ω.

   (a) Calculate the voltage at the input to the amplifier.

   (b) Calculate v_{out} when there is no load attached to the output of the amplifier.

   (c) Calculate v_{out} when a 100 Ω load resistor is attached across the output terminals of the amplifier.

Voltage Source

$v_{\mathrm{source}} = 40\,\mathrm{mV}$

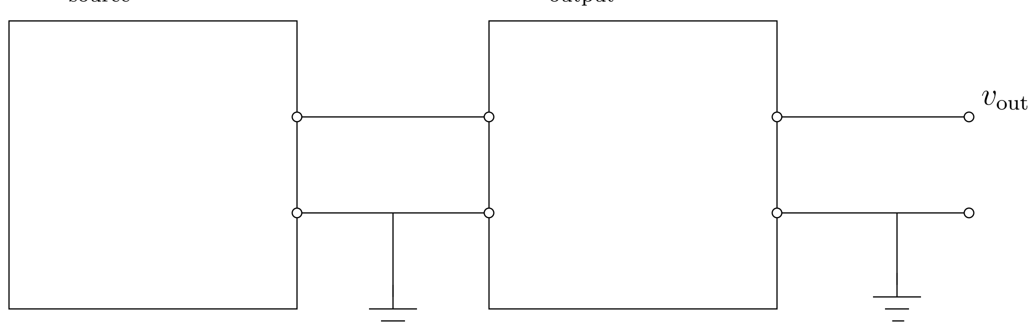
$R_{\mathrm{source}} = 100\,\Omega$

Amplifier

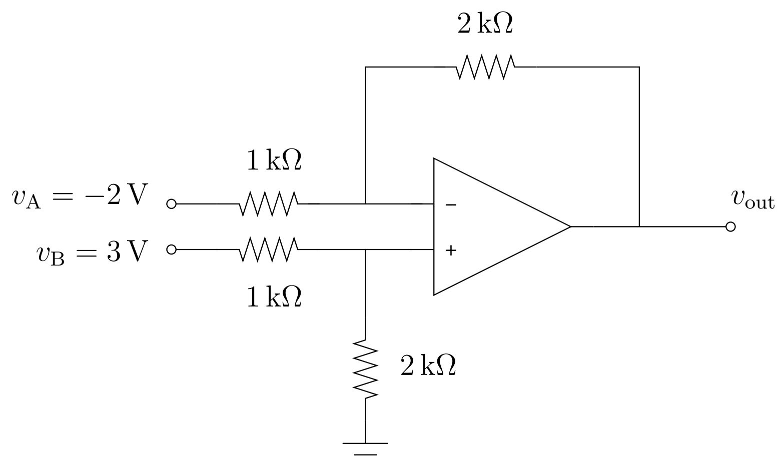
Gain = 20

$R_{\mathrm{input}} = 500\,\Omega$

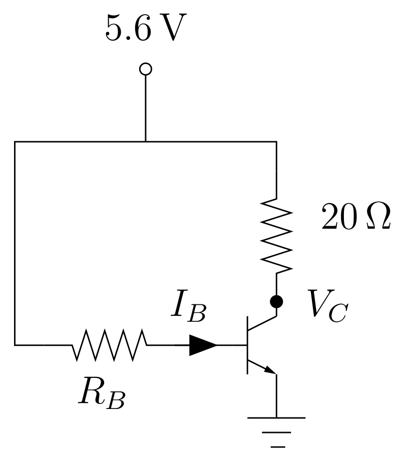
$R_{\mathrm{output}} = 10\,\Omega$



2. (20 pts) Consider the illustrated circuit containing an ideal op-amp and resistors, with the indicated voltages $v_A = -2\,\mathrm{V}$ and $v_B = 3\,\mathrm{V}$ serving as inputs to the circuit. Calculate the value of v_{out}.



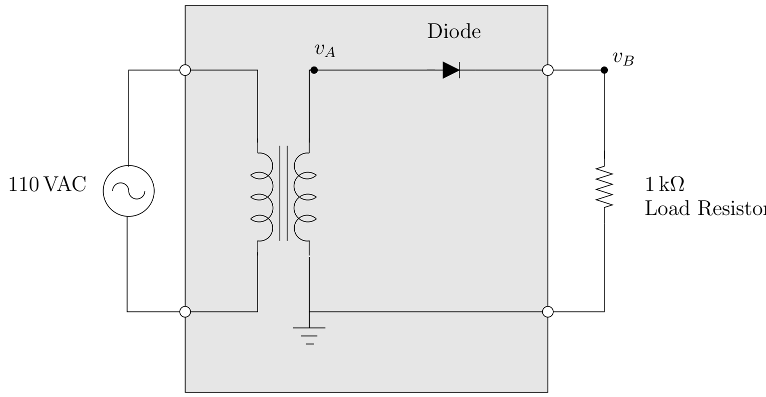
3. (20 pts) Use the "simple" model of transistor behavior to answer the following questions. (Remember that in the "simple" mode, the indicated base current I_B is *not* zero.)

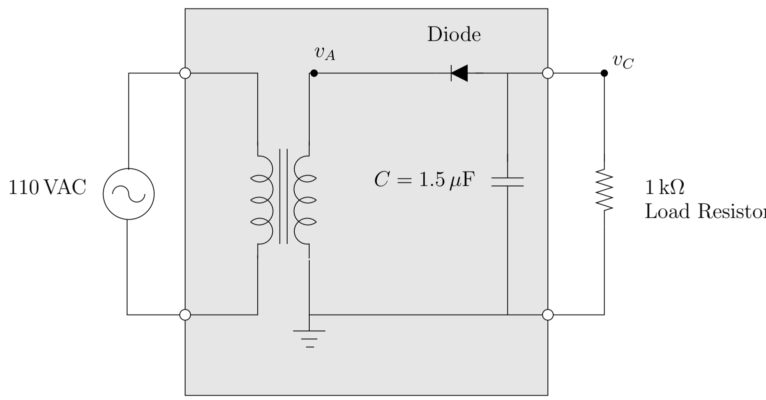


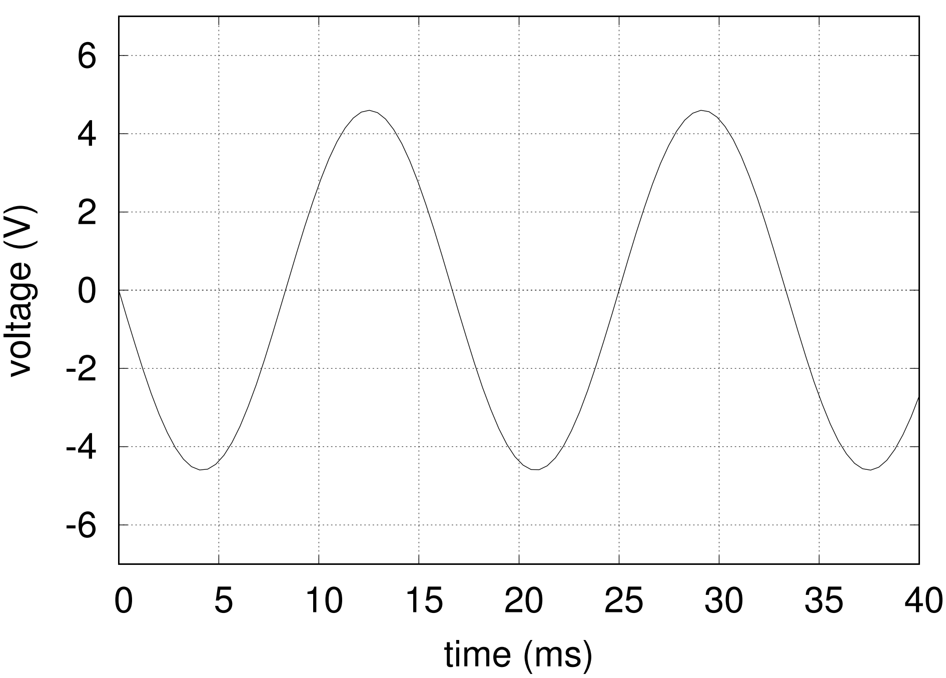
(a) Find V_C when $R_B = 10\,\mathrm{k}\Omega$

(b) Find V_C when $R_B = 1\,\mathrm{k}\Omega$

4. (20 pts) Consider the two illustrated circuits, with an AC voltage source, a transformer, a silicon diode, a resistor, and — in the lower circuit — a capacitor. The graph shows the voltage v_A. On this graph sketch and label the two voltages v_B and v_C.

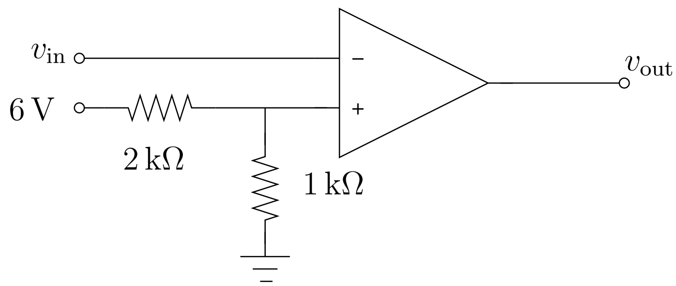


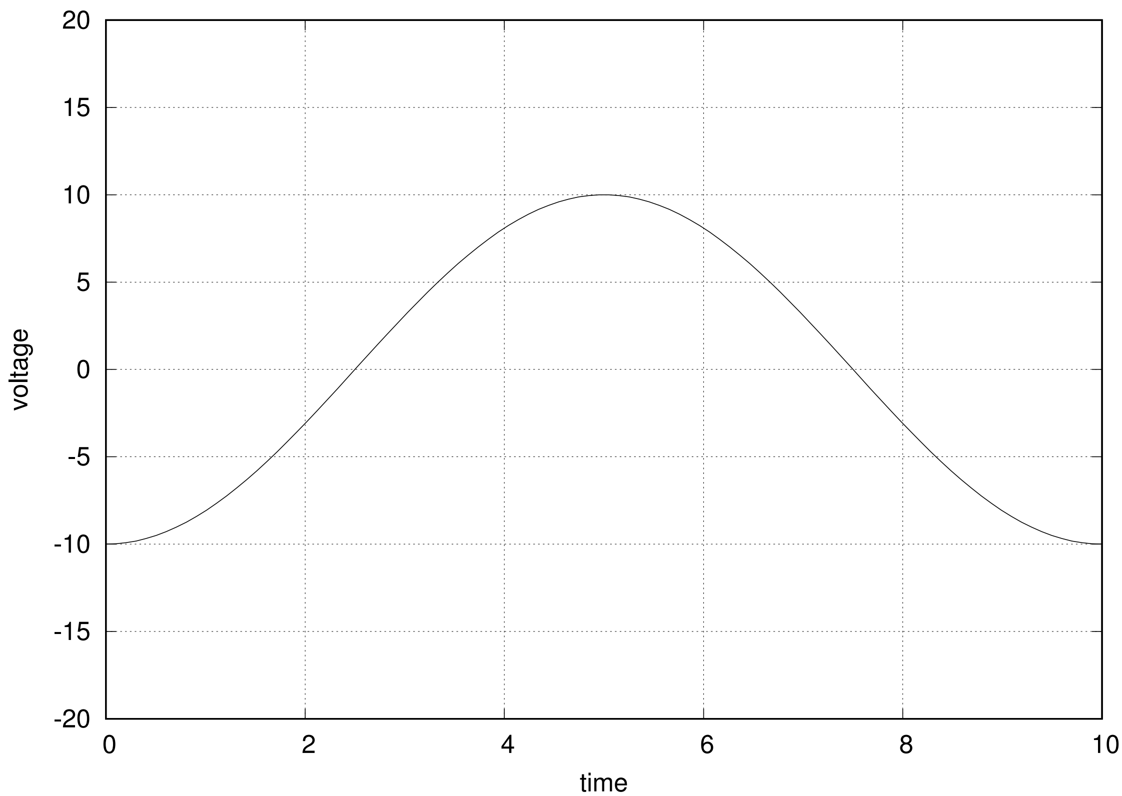




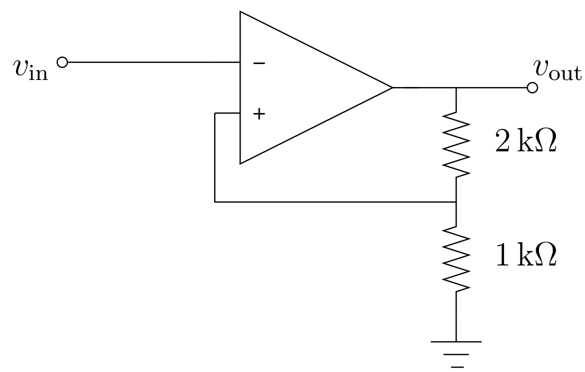
5. (20 pts)

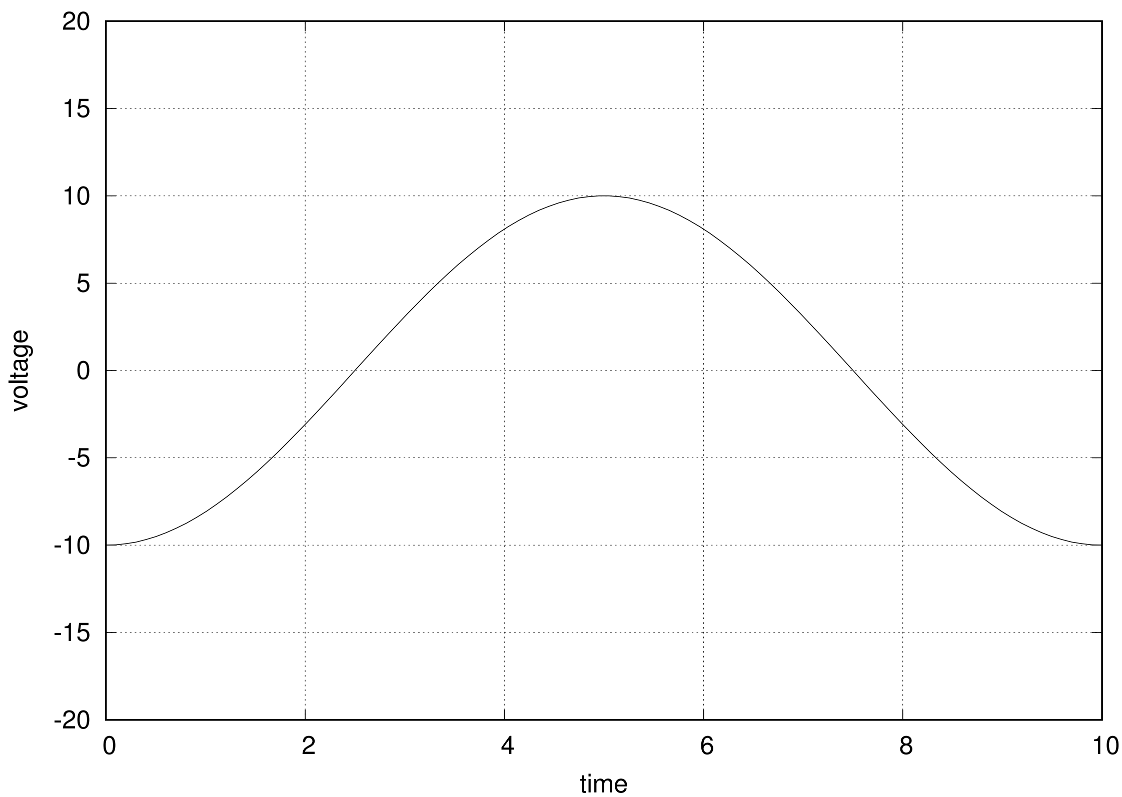
(a) Consider the following circuit with an ideal op-amp powered with $\pm 15\,\text{V}$. On the graph below sketch the output, v_{out}, for the illustrated input.





(b) Consider the following circuit with an ideal op-amp powered with $\pm 15\,\mathrm{V}$. On the graph below sketch the output, v_{out}, for the illustrated input.





Equations

$$I_C = \beta I_B \simeq 100 I_B$$

$$v_{\text{out}} = A_0(v_+ - v_-)$$

where v_+ is the voltage at the non-inverting input, and v_- is the voltage at the inverting input

$$\Delta V_R = IR \longleftrightarrow \Delta\hat{v} = \hat{i}\hat{Z}$$

$$\hat{Z}_R = R$$

$$\hat{Z}_C = \frac{1}{j\omega C} = -\frac{j}{\omega C}$$

$$R_{\text{series}} = R_1 + R_2 \longrightarrow \hat{Z}_{\text{series}} = \hat{Z}_1 + \hat{Z}_2$$

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} \longrightarrow \frac{1}{\hat{Z}_{\text{parallel}}} = \frac{1}{\hat{Z}_1} + \frac{1}{\hat{Z}_2}$$

$$R_{\text{parallel}} = \frac{R_1 R_2}{R_1 + R_2} \longrightarrow \hat{Z}_{\text{parallel}} = \frac{\hat{Z}_1\hat{Z}_2}{\hat{Z}_1 + \hat{Z}_2}$$

$$C = \frac{Q}{\Delta V}$$

$$R = \rho\frac{L}{A} = \frac{1}{\sigma}\frac{L}{A}$$

$$I = n_q v A q$$

$$Q(t) = CV_0(1 - e^{-t/RC})$$

$$Q(t) = Q(0)e^{-t/RC}$$

$$\sum_i \Delta V_i = 0 \longleftrightarrow \sum_i \hat{v}_i = 0$$

$$\sum_i I_i = 0 \longleftrightarrow \sum_k \hat{i}_k = 0$$