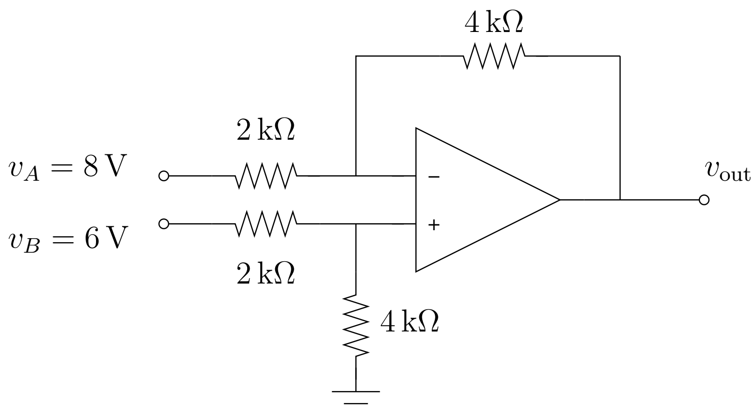
PHYS 235 — Exam #2
Thursday, March 5, 2009

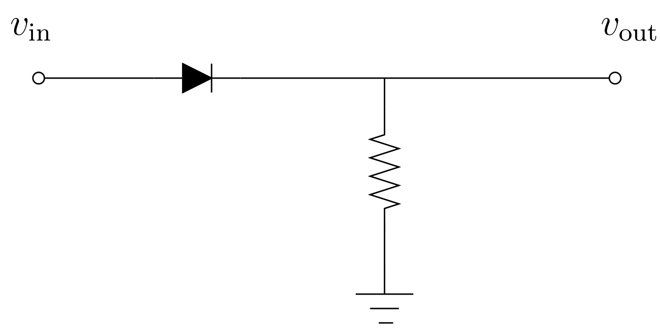
Name:__________________________________

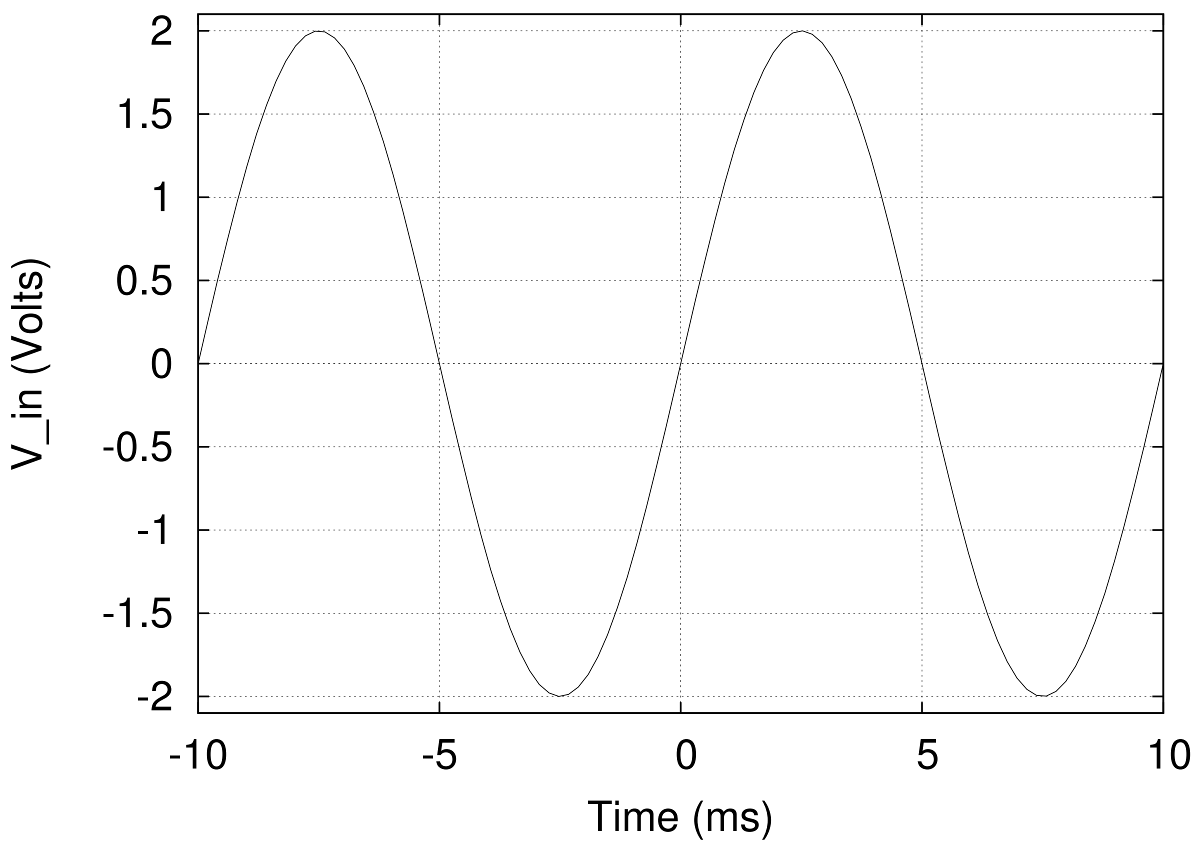
1. (18 pts) Consider the illustrated circuit containing an ideal op-amp (powered from $\pm 15\,\mathrm{V}$ supplies) and resistors. Determine the numerical value of output voltage v_{out}. Be sure to include all reasoning and/or derivations.



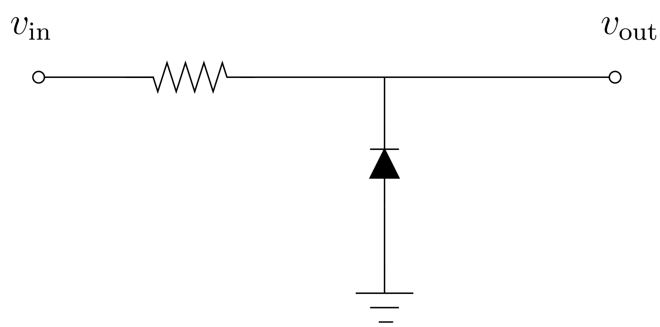
2. (18 pts)

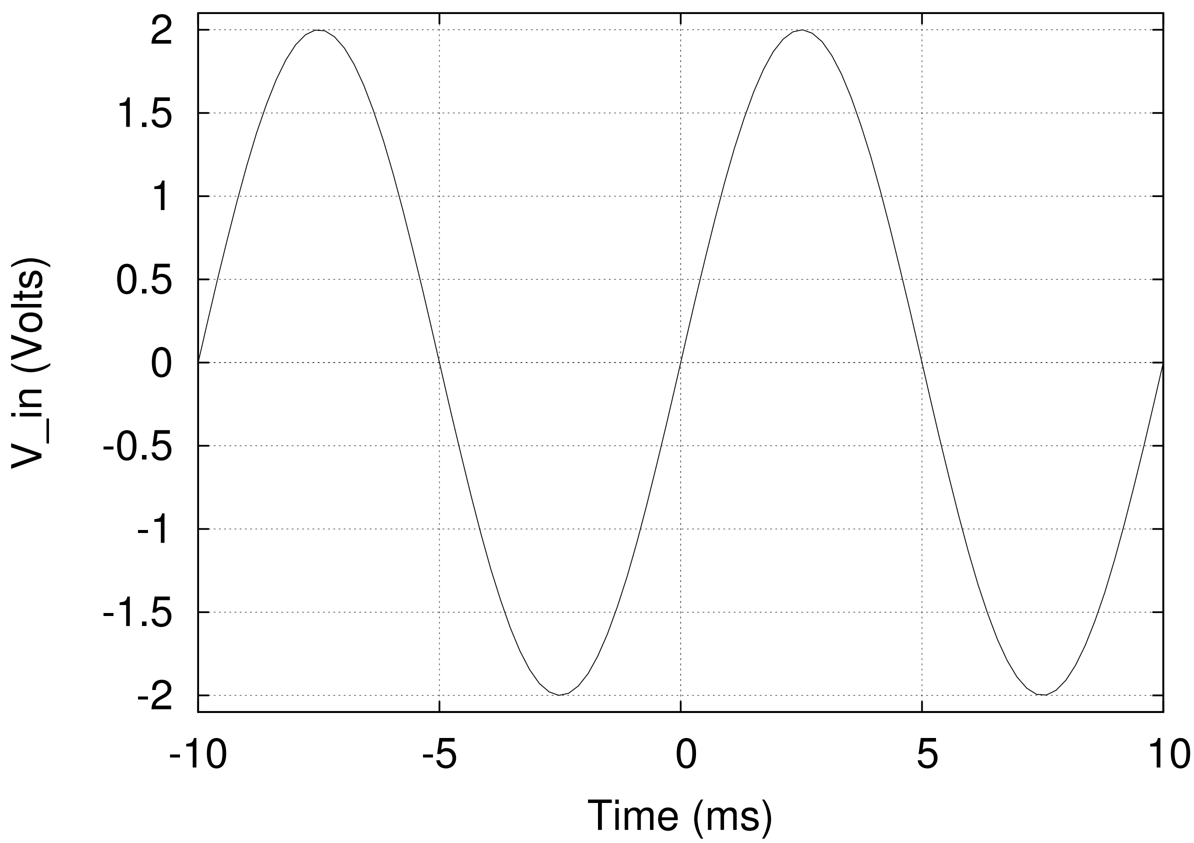
(a) Consider the illustrated circuit with an ideal silicon diode and a resistor, and the illustrated input signal v_{in}. Sketch the output signal you would observe on an oscilloscope. (Draw your sketch on the same set of axes as the input.)





(b) Consider the illustrated circuit with an ideal silicon diode and a resistor, and the illustrated input signal v_{in}. Sketch the output signal you would observe on an oscilloscope. (Draw your sketch on the same set of axes as the input.)



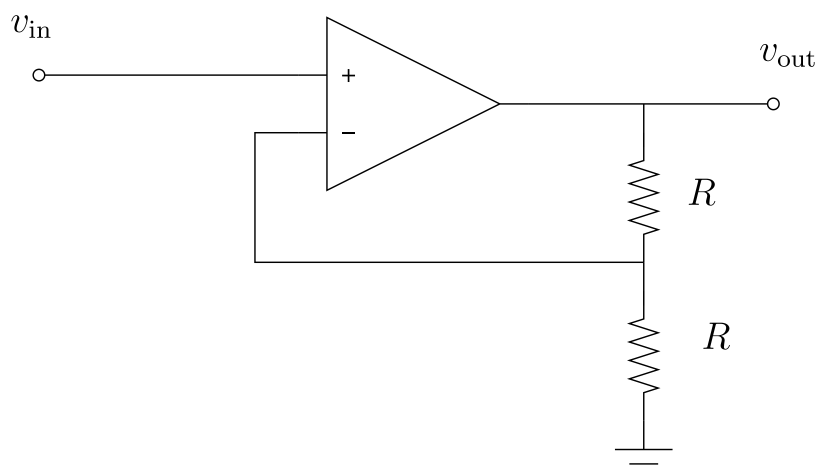


3. (10 pts) Why is an amplifier with a voltage gain of 1, i.e., with $v_{\text{out}} = v_{\text{in}}$, of any use to anyone? (Specific examples may help your explanation.)

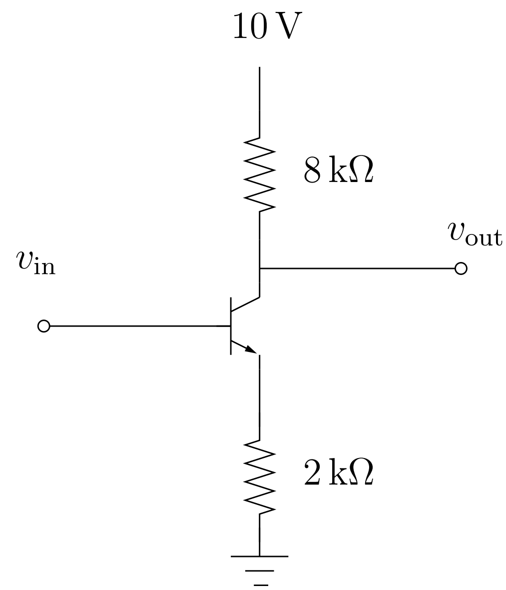
4. (18 pts)

(a) Assume that the op-amp is ideal and determine an expression for the gain of the illustrated circuit.

(b) Assume the that illustrated op-amp is **not** ideal in one respect: the open-loop gain A_0 is **not** infinite. Determine an expression for the gain of the circuit. (This result should reduce to your previous result in the limit $A_0 \to \infty$.)



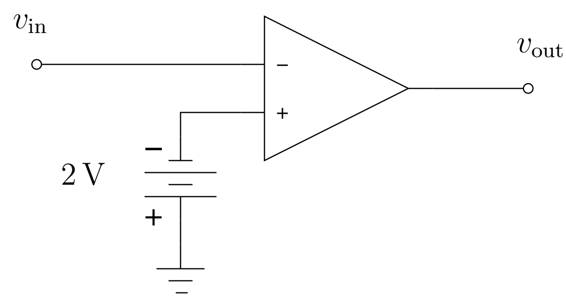
5. (18 pts) Consider the illustrated circuit with a transistor and two resistors. You may use the "simplest" model of transistor behavior in this problem, i.e., $I_B \simeq 0$.

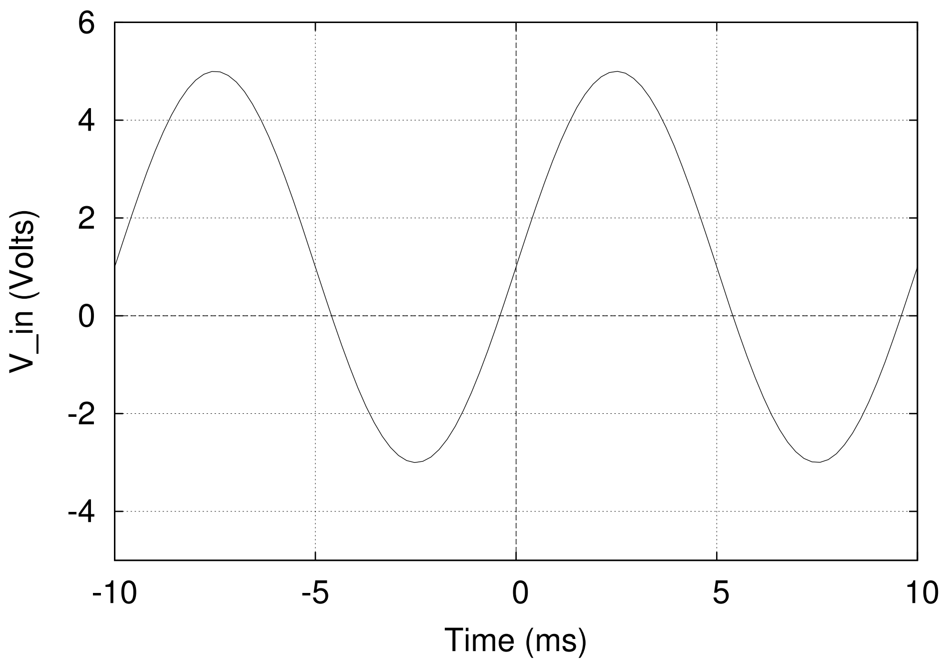


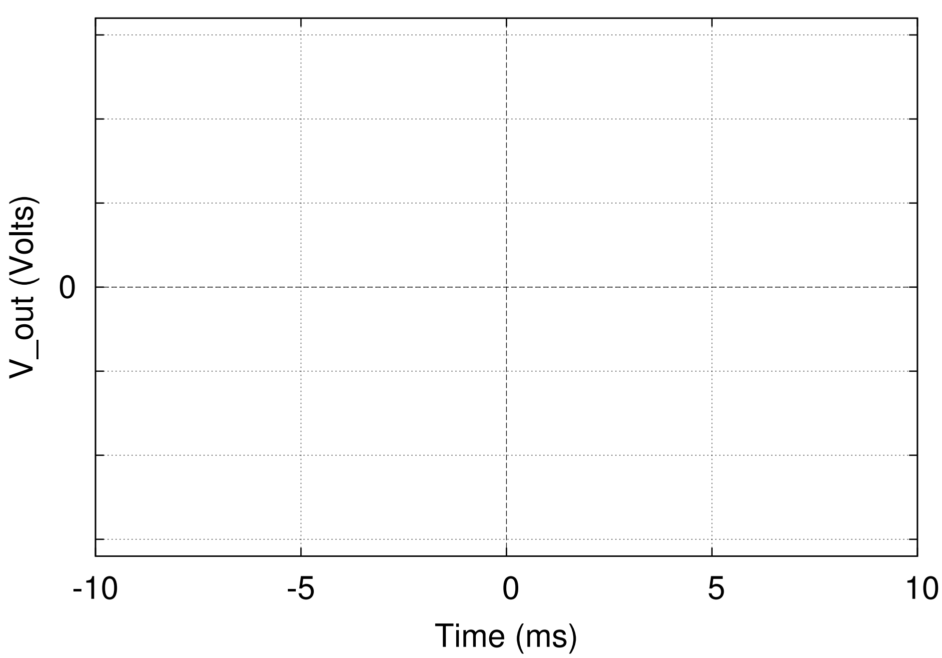
(a) Determine the output when $v_{\text{in}} = 2\,\text{V}$.

(b) Determine the output when $v_{\text{in}} = 4\,\text{V}$.

6. (18 pts) Sketch the output of the illustrated circuit for the given input.







Equations

$$v_{\text{out}} = A_0(v_2 - v_1)$$

$$I_C = \beta I_B$$

$$I_E = I_B + I_C$$

$$\Delta V_R = IR \longleftrightarrow \Delta v = iZ$$

$$Z_R = R$$

$$Z_C = \frac{1}{j\omega C} = -\frac{j}{\omega C}$$

$$Z_L = j\omega L$$

$$Z_{\text{series}} = Z_1 + Z_2$$

$$\frac{1}{Z_{\text{parallel}}} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

$$Z_{\text{parallel}} = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$C = \frac{q}{V}$$

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

$$I = n_q v A q$$

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

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