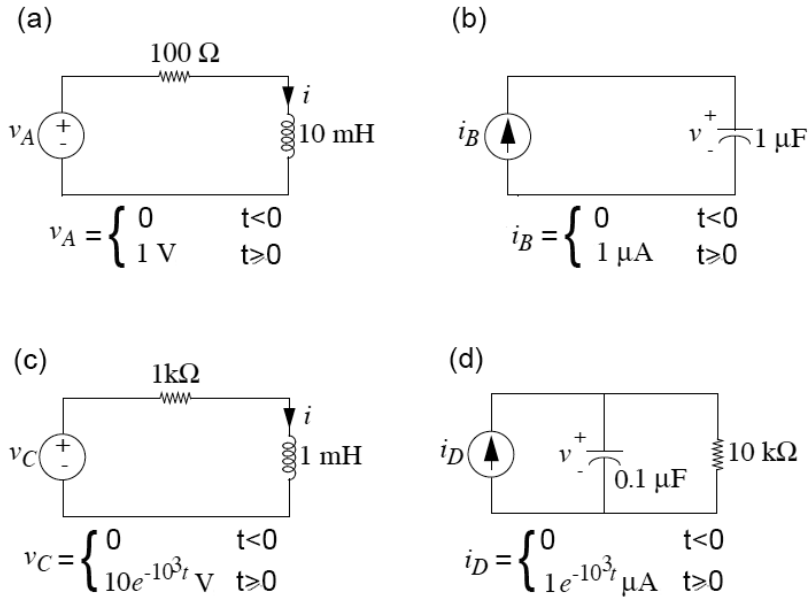
Final Exam for Physics 120A (closed book)
Thursday 12 June 2014; 8:00 - 11:00 AM

Problem 1.

For each of the circuits (a - d) below, find the indicated voltage (v) or current (i) for all t > 0. Time "t" is in seconds.



Problem 2.

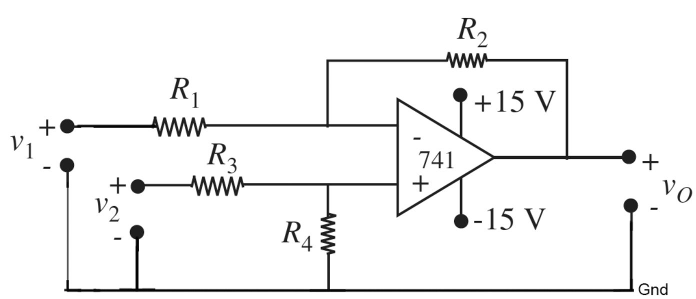
The circuit below is called a differential amplifier.

(a) Using the ideal Op Amp model (infinite open loop gain, infinite input resistance, zero output resistance) derive an expression for the output voltage v_O in terms of the input voltages v_1 and v_2 and the resistances R_1, R_2, R_3, and R_4.

(b) Does connecting a load resistor R_L between the output and ground change the previous expression for v_O? Why?

(c) Let $v_1 = v_2$ and R_1 = 1 kΩ, R_2 = 30 kΩ, and R_3 = 1.5 kΩ. Find R_4 so that $v_O = 0$.

(d) Let $v_2 = 0$ and v_1 = 1 Volt. Using the preceding resistor values, including that computed for $R4$ in part (c), find v_O.



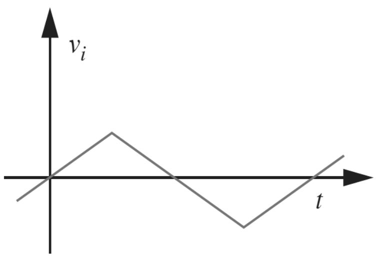
Problem 3.

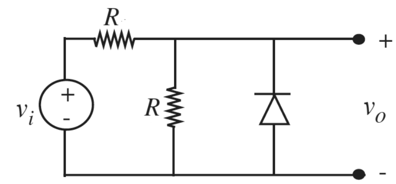
(a) In the circuit below, assume that the diode can be modeled as an ideal diode. Plot the waveform $v_o(t)$ assuming a triangle wave input for $v_i(t)$.

(b) Write an expression for v_o(t) in terms of v_i(t) and R.

(c) If the triangle wave has a peak amplitude of only 2 Volts, a more accurate diode model must be used. Plot the waveform for $v_o(t)$ assuming that the diode is modeled using an ideal diode in series with a 0.6-Volt source.

(d) Write an expression for v_o(t) in terms of v_i(t) and R assuming that the diode is modeled using an ideal diode in series with a 0.6-Volt source.





Problem 4.

Consider the common emitter BJT amplifier shown below. The input voltage comprises the sum of a DC bias voltage, V_I = 0.7 Volts, and a sinusoid of the form $v_i(t)$ = 0.001 sin(ωt) Volts.

In your analysis of the circuit, you may assume that the amplitude of $v_i(t)$ is very small compared to V_I, and that the BJT always operates in its active region. The figure also shows a small-signal model for the BJT in its active region.

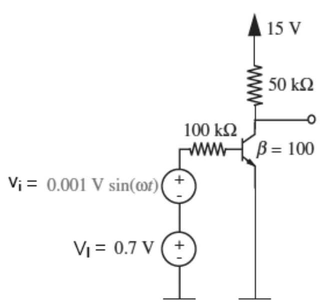
Let the output voltage comprise an operating-point voltage V_O and a small-signal response term v_o(t).

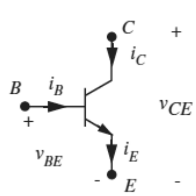
(a) Determine the operating-point voltage V_O for the input bias of V_I = 0.7 Volts.

(b) Draw the small-signal equivalent circuit for the amplifier?

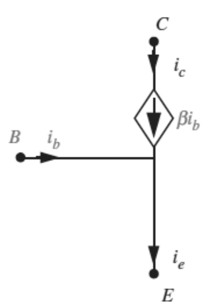
(c) Determine the small-signal gain of the amplifier?

(d) What is the small-signal response v_o(t) given the small signal input $v_i(t)$?





BJT



BJT small-signal model

Fini!