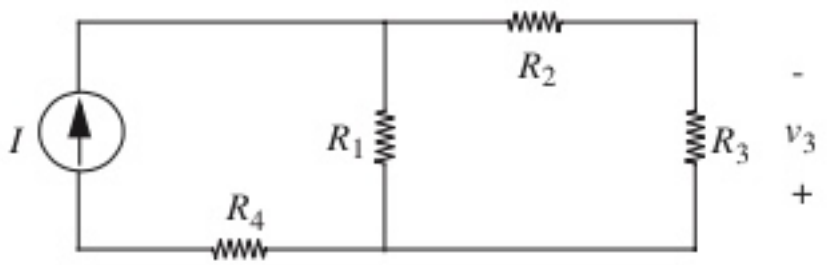
PHYS120 SPRING 2015 FINAL EXAM

Please read all directions carefully and be sure to solve for only what is asked.
Professor David Kleinfeld

Problem 1

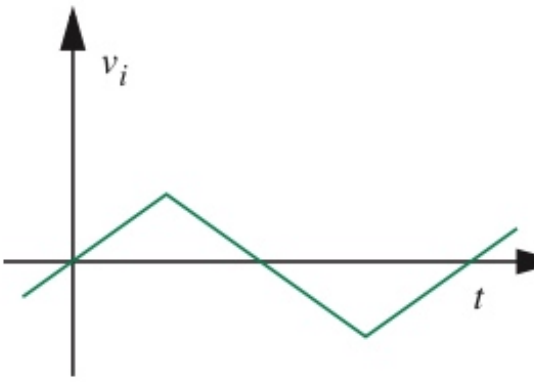
Determine explicitly the voltage v_3 in the following circuit:



Problem 2

a) Assuming the diode can be modeled as an ideal diode, and $R_1 = R_2$, plot the waveform $v_o(t)$ for the circuit in Figure 4.57, assuming a triangle wave input. Write an expression for $v_o(t)$ in terms of v_i, R_1, and R_2.

b) If the triangle wave has a peak amplitude of only 5 volts, and $R_1 = R_2$, a more accurate diode model must be used. Plot and write an expression for v_o assuming that the diode is modeled using an ideal diode in series with a 0.6-volt source. Draw the transfer curve v_o versus v_i.



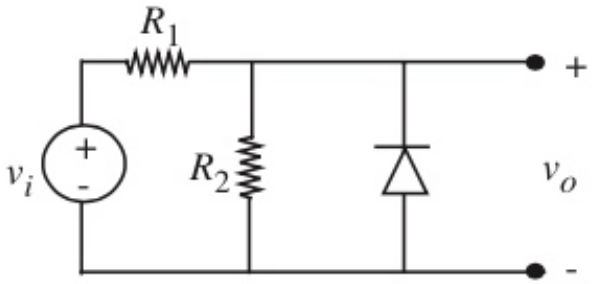
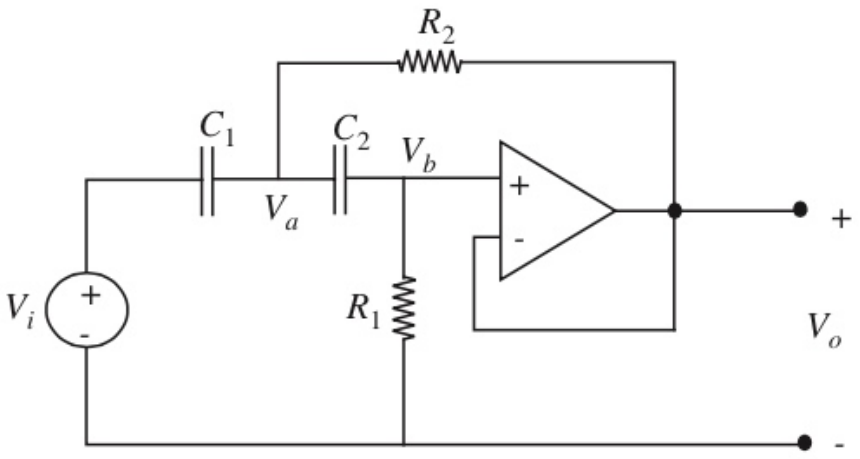


FIGURE 4.57

Problem 3



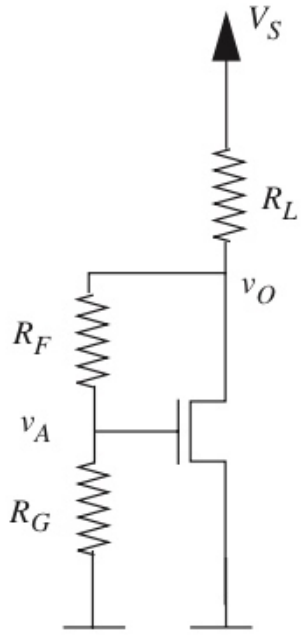
a) Write the sinusoidal steady state node equations for the complex amplitudes of V_a and V_b.

b) Solve for V_O/V_i using the results in (a). Simplify your answer so that the denominator follows the form $As^2 + Bs + C$. This will help you in the next step.

c) Assuming the circuit is under-damped, find the frequency at which the peak occurs, the magnitude of the transfer function at the peak, and the Q of resonance.

*YOU DO NOT NEED TO GRAPH THIS.

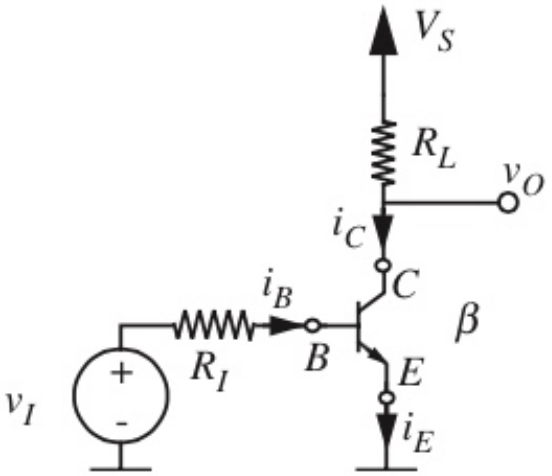
Problem 4



Consider the MOSFET circuit shown to the left. Determine the value of V_O in terms of the other circuit parameters. Assume the MOSFET is in saturation and is characterized by the parameters K and V_T.

HINT: V_A should NOT be in your answer.

Problem 5



Consider the BJT amplifier to the left. Assume that the BJT is characterized by the large signal model and that the BJT operates in its active region. Assume further that V_s = 10 V, R_L = 20 kΩ, R_I = 500 kΩ and β = 100.

a) Write an expression relating V_O to i_C

b) Write an expression relating i_C to V_I

c) Write an expression relating i_E to i_B

d) Write an expression relating V_O to V_I

e) What is the value of V_O for an input voltage V_I = 1? What are the corresponding values of i_B, i_C, and i_E

Problem 6

$$(A + \overline{B})(\overline{A} \cdot \overline{B} + C) + \overline{C \cdot D}$$

$$(A \cdot \overline{C} + \overline{B \cdot D})\overline{(D + \overline{B} + A}$$

$$A + \overline{\overline{B} \cdot D} + A \cdot C \cdot \overline{D}$$

$$\overline{((\overline{A + \overline{C}}) + B + \overline{D}) + A \cdot \overline{C} \cdot D}$$

a) Give an implementation using gates for each of the four logic expressions.

b) Write the truth table for each of the four expressions.

c) Suppose you know that $A = 0$. Simplify the four expressions under this constraint.

d) Simplify the four expressions assuming that A and B are related as $A = \overline{B}$.

THE END

* If you so choose, draw a picture of Dr. Kleinfeld in the space you have remaining in your blue book.
*Best one gets +1 point to their final!