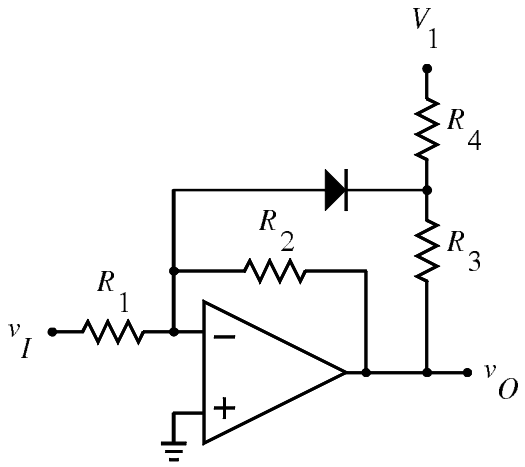
EE 4086 Quiz 2, Summer 1996

SEPTEMER 23, 1996

Professor Leach Name _____

Instructions. Print your name in the space above and on all quiz work sheets. Place a box around all numerical answers. Write the word "over" if you continue your work on another page.

1. Figure P1 shows the circuit diagram of a diode function generator circuit. Both the op-amp and the diode are ideal. The element values are $R_1 = R_2 = 10$ kΩ, $R_3 = 1$ kΩ, $R_4 = 9$ kΩ, and $V_1 = 9$ V. Sketch the graph of v_O versus v_I.



2. The transfer function of a second-order low-pass filter is

$$T(s) = \frac{1}{(s/\omega_o)^2 + (1/Q)(s/\omega_o) + 1}$$

   (a) Form the magnitude-squared transfer function as a function of ω. Write it so that the constant term in the denominator is 1.

   (b) The second-order Chebyshev polynomial is given by

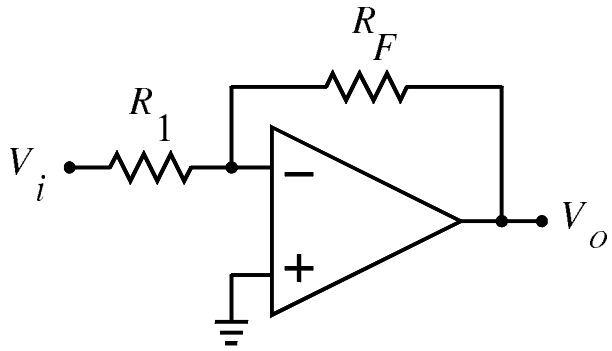
$$f(x) = 2x^2 - 1$$

   Use this polynomial to write the magnitude-squared transfer function as a function of ω for a second-order Chebyshev low-pass filter having a cutoff frequency $\omega_c = 1$ and $\epsilon = 1$. Write it so that the constant term in the denominator is 1 and the gain at $\omega = 0$ is unity.

   (c) Equate the functions found in the two preceding problems and solve for ω_o and Q.

3. An inverting amplifier is shown in Figure P3. The op-amp has the open-loop voltage-gain transfer function

$$V_o = \frac{A_o}{1 + s/\omega_o}(V_+ - V_-)$$



(a) Write the equations for the circuit and solve for V_o/V_i. Put it into the form

$$\frac{V_o}{V_i} = \frac{A_{of}}{1 + s/\omega_{of}}$$

where you must specify A_{of} and ω_{of}.

(b) Show that the gain times the bandwidth is given by $A_o\omega_o R_F/(R_1 + R_F)$.

4. The normalized low-pass transfer function of a particular third-order low-pass Chebyshev filter is given by

$$T(p) = \frac{1}{(1 + 1.60p)(0.875p^2 + 0.548p + 1)}$$

(a) What is the equivalent high-pass transfer function? Write the function so that the constant terms in the denominator are 1.

(b) It is desired to design the high-pass filter for a cutoff frequency of 1 kHz. Specify the pole frequency (in rad/s and in Hz) for the first-order section.

(c) Specify the resonant frequency (in rad/s and in Hz) and the quality factor for the second-order section.