Analog Electronics **Hwk 4**a

***2.44** Figure P2.44 shows a circuit for a digital-to-analog converter (DAC). The circuit accepts a 4-bit input binary word $a_3a_2a_1a_0$, where a_0, a_1, a_2, and a_3 take the values of 0 or 1, and it provides an analog output voltage v_O proportional to the value of the digital input. Each of the bits of the input word controls the correspondingly numbered switch. For instance, if a_2 is 0 then switch S_2 connects the 20-kΩ resistor to ground, while if a_2 is 1 then S_2 connects the 20-kΩ resistor to the +5-V power supply. Show that v_O is given by

$$v_O = -\frac{R_f}{16}[2^0a_0 + 2^1a_1 + 2^2a_2 + 2^3a_3]$$

where R_f is in kilohms. Find the value of R_f so that v_O ranges from 0 to −5 volts.

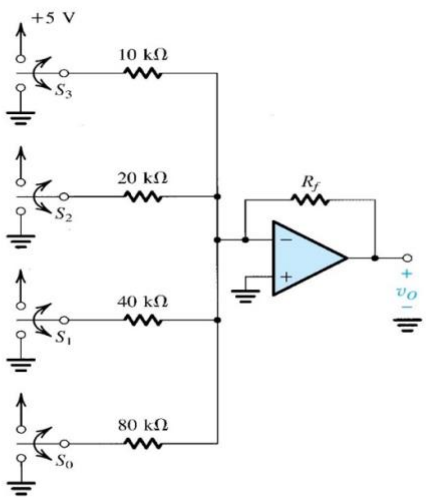
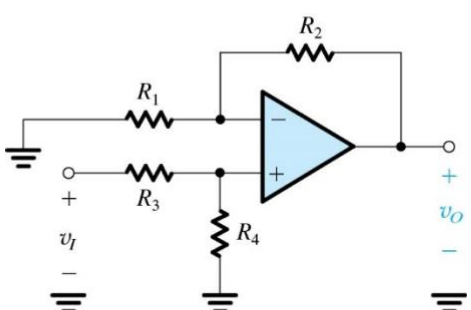


Figure P 2.44

P 2.50. Derive an expression for the voltage gain v_O/v_I for the circuit below.



P 2.51. For the circuit below, use superposition to find v_0 in terms of the input voltages v_1 *and* v_2

$$v_1 = 10\sin(2\pi \times 60t) - 0.1\sin(2\pi \times 5000t), \quad volts$$
$$v_2 = 10\sin(2\pi \times 60t) + 0.1\sin(2\pi \times 5000t), \quad volts$$