Problems

SEC. 20-1 INVERTING-AMPLIFIER CIRCUITS

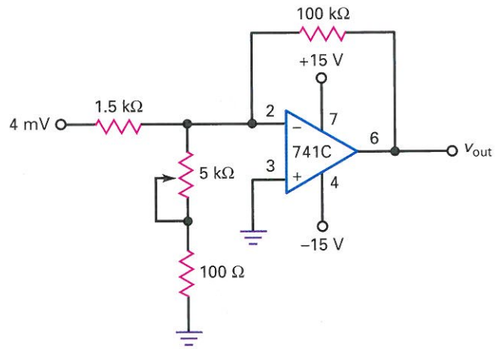
20-1 In the probe of Fig. 20-1, $R_1 = 10\ \text{M}\Omega$, $R_2 = 20\ \text{M}\Omega$, $R_3 = 15\ \text{k}\Omega$, $R_4 = 15\ \text{k}\Omega$, and $R_5 = 75\ \text{k}\Omega$. What is the attenuation of the probe in each switch position?

20-2 In the ac-coupled inverting amplifier of Fig. 20-2, $R_1 = 1.5\ \text{k}\Omega$, $R_f = 75\ \text{k}\Omega$, $R_L = 15\ \text{k}\Omega$, $C_1 = 1\ \mu\text{F}$, $C_2 = 4.7\ \mu\text{F}$, and $f_{\text{unity}} = 1\ \text{MHz}$. What is the voltage gain in the midband of the amplifier? What are the upper and lower cutoff frequencies?

20-3 In the adjustable-bandwidth circuit of Fig. 20-3, $R_1 = 10\ \text{k}\Omega$ and $R_f = 180\ \text{k}\Omega$. If the 100-$\Omega$ resistor is changed to 130 Ω and the variable resistor to 25 kΩ, what is the voltage gain? What are the minimum and maximum bandwidth if $f_{\text{unity}} = 1\ \text{MHz}$?

20-4 What is the output voltage in Fig. 20-37? What are the minimum and maximum bandwidth? (Use $f_{\text{unity}} = 1\ \text{MHz}$.)

Figure 20-37



SEC. 20-2 NONINVERTING-AMPLIFIER CIRCUITS

20-5 In Fig. 20-4, $R_1 = 2\ \text{k}\Omega$, $R_f = 82\ \text{k}\Omega$, $R_L = 25\ \text{k}\Omega$, $C_1 = 2.2\ \mu\text{F}$, $C_2 = 4.7\ \mu\text{F}$, and $f_{\text{unity}} = 3\ \text{MHz}$. What is the voltage gain in the midband of the amplifier? What are the upper and lower cutoff frequencies?

20-6 What is the voltage gain in the midband of Fig. 20-38? What are the upper and lower cutoff frequencies?

20-7 MultiSim In the distribution amplifier of Fig. 20-5, $R_1 = 2\ \text{k}\Omega$, $R_f = 100\ \text{k}\Omega$, and $v_{\text{in}} = 10\ \text{mV}$. What is the output voltage for *A*, *B*, and *C*?

20-8 The JFET-switched amplifier of Fig. 20-6 has these values: $R_1 = 91\ \text{k}\Omega$, $R_f = 12\ \text{k}\Omega$, and $R_2 = 1\ \text{k}\Omega$. If $v_{\text{in}} = 2\ \text{mV}$, what is the output voltage when the gate is low? When it is high?

20-9 If $V_{GS(\text{off})} = -5\ \text{V}$, what are the minimum and maximum output voltage in Fig. 20-39?

20-10 The voltage reference of Fig. 20-7 is modified to get $R_1 = 10\ \text{k}\Omega$ and $R_f = 10\ \text{k}\Omega$. What is the new output reference voltage?

SEC. 20-3 INVERTER/NONINVERTER CIRCUITS

20-11 In the adjustable inverter of Fig. 20-10, $R_1 = 1\ \text{k}\Omega$ and $R_2 = 10\ \text{k}\Omega$. What is the maximum positive gain? The maximum negative gain?

20-12 What is the voltage gain in Fig. 20-11 when the wiper is at the ground end? When it is 10 percent away from ground?

20-13 Precision resistors are used in Fig. 20-12. If $R = 5\ \text{k}\Omega$, $nR = 75\ \text{k}\Omega$, and $nR/(n-1)R = 5.36\ \text{k}\Omega$, what are the maximum positive and negative gains?

20-14 In the phase shifter of Fig. 20-13, $R' = 10\ \text{k}\Omega$, $R = 22\ \text{k}\Omega$, and $C = 0.02\ \mu\text{F}$. What is the phase shift when the input frequency is 100 Hz? 1 kHz? 10 kHz?

Figure 20-38

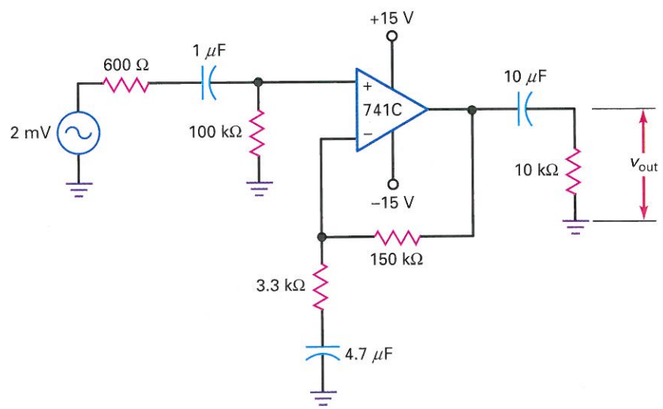
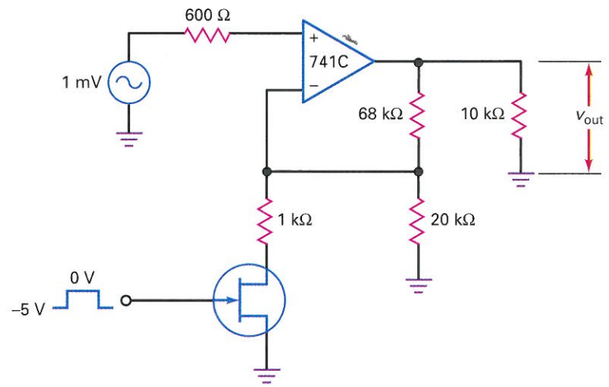


Figure 20-39



SEC. 20-4 DIFFERENTIAL AMPLIFIERS

20-15 The differential amplifier of Fig. 20-14 has $R_1 = 1.5\ \text{k}\Omega$ and $R_2 = 30\ \text{k}\Omega$. What is the differential voltage gain? The common-mode gain? (Resistor tolerance = ± 0.1 percent.)

20-16 In Fig. 20-15, $R_1 = 1\ \text{k}\Omega$ and $R_2 = 20\ \text{k}\Omega$. What is the differential voltage gain? The common-mode gain? (Resistor tolerance = ± 1 percent.)

20-17 In the Wheatstone bridge of Fig. 20-16, $R_1 = 10\ \text{k}\Omega$, $R_2 = 20\ \text{k}\Omega$, $R_3 = 20\ \text{k}\Omega$, and $R_4 = 10\ \text{k}\Omega$. Is the bridge balanced?

20-18 In the typical application of Fig. 20-17, transducer resistance changes to 985 Ω. What is the final output voltage?

SEC. 20-5 INSTRUMENTATION AMPLIFIERS

20-19 In the instrumentation amplifier of Fig. 20-18, $R_1 = 1\ \text{k}\Omega$ and $R_2 = 99\ \text{k}\Omega$. What is the output voltage if $v_{\text{in}} = 2\ \text{mV}$? If three OP-07A op amps are used and $R = 10\ \text{k}\Omega \pm 0.5$ percent, what is the CMRR of the instrumentation amplifier?

20-20 In Fig. 20-19, $v_{\text{in(CM)}} = 5\ \text{V}$. If $R_3 = 10\ \text{k}\Omega$, what does the guard voltage equal?

20-21 The value of R_G is changed to 1008 Ω in Fig. 20-20. What is the differential output voltage if the differential input voltage is 20 mV?

SEC. 20-6 SUMMING AMPLIFIER CIRCUITS

20-22 What does the output voltage equal in Fig. 20-21 if $R = 10\ \text{k}\Omega$, $v_1 = -50\ \text{mV}$ and $v_2 = -30\ \text{mV}$?

20-23 MultiSim In the summing circuit of Fig. 20-22, $R_1 = 10\ \text{k}\Omega$, $R_2 = 20\ \text{k}\Omega$, $R_3 = 15\ \text{k}\Omega$, $R_4 = 15\ \text{k}\Omega$, $R_5 = 30\ \text{k}\Omega$, and $R_f = 75\ \text{k}\Omega$. What is the output voltage if $v_0 = 1\ \text{mV}$, $v_1 = 2\ \text{mV}$, $v_2 = 3\ \text{mV}$, and $v_3 = 4\ \text{mV}$?

20-24 The averaging circuit of Fig. 20-23 has $R = 10\ \text{k}\Omega$. What is the output if $v_1 = 1.5\ \text{V}$, $v_2 = 2.5\ \text{V}$, and $v_3 = 4.0\ \text{V}$?

20-25 The D/A converter of Fig. 20-24 has an input of $v_0 = 5\ \text{V}$, $v_1 = 0$, $v_2 = 5\ \text{V}$, and $v_3 = 0$. What is the output voltage?

20-26 In Fig. 20-25, if the number of binary inputs is expanded to eight and D_7 to D_0 equals 10100101, determine the decimal equivalent input value, BIN.

20-27 In Fig. 20-25, if the binary inputs were expanded so D_7 to D_0 equaled 01100110, what would be the output voltage?

20-28 In Fig. 20-25, using an input reference voltage of 2.5 V, determine the smallest incremental output voltage step.

SEC. 20-7 CURRENT BOOSTERS

20-29 The noninverting amplifier of Fig. 20-40 has a current-boosted output. What is the voltage gain of the circuit? If the transistor has a current gain of 100, what is the short-circuit output current?

20-30 What is the voltage gain in Fig. 20-41? If the transistors have a current gain of 125, what is the short-circuit output current?

Figure 20-40