

## PROBLEMS

- 3-1. What type of feedback is applied to an op amp when an external component is connected between the output terminal and the inverting input?
- 3-2. If the open-loop gain is very large, does the closed-loop gain depend on the external components or the op amp?
- 3-3. What two assumptions have been used to analyze the circuits of this chapter?
- 3-4. Identify the circuit in Fig. P3-4.

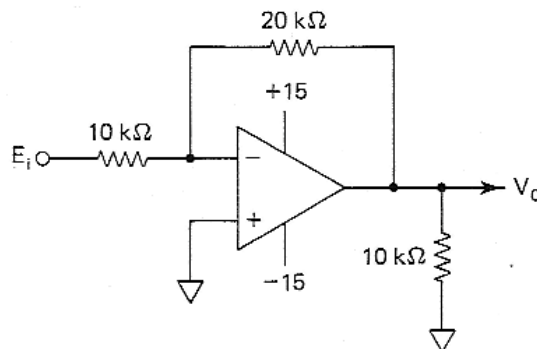


Figure P3-4

- 3-5. Calculate  $V_o$  and the op amp's output current in Fig. P3-4 if  $E_i$  equals (a) +5 V; (b) -2 V. For each situation, state if the op amp sources or sinks current.
- 3-6. Calculate  $E_i$  in Fig. P3-4 if  $V_o$  equals (a) +5 V; (b) -2 V.
- 3-7. Let  $E_i$  be a triangle wave with a frequency of 100 Hz and a peak value of 5 V in Fig. P3-4. (a) Plot  $E_i$  and  $V_o$  vs. time; (b)  $V_o$  vs.  $E_i$ .
- 3-8. Repeat problem 3-7 but let  $E_i$  be increased in amplitude to 8 V. (Assume that  $\pm V_{sat} = \pm 15$  V for ease of plotting.)
- 3-9. Identify the circuit in Fig. P3-9 and calculate  $V_o$  if  $E_i$  equals (a) +5 V; (b) -2 V. Compare your results with Problem 3-5.

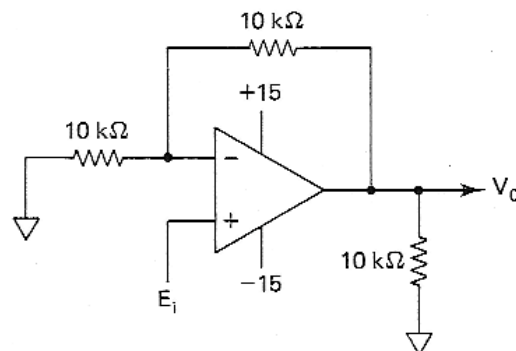


Figure P3-9

- 3-10. Repeat Problem 3-7 except apply it to Fig. P3-9. Compare solutions of both problems to distinguish between inverting and noninverting operation.
- 3-11. Design an inverting amplifier with a gain of -5 and an input resistance of 10 kΩ.

**3-12.** Design a noninverting amplifier with a gain of 5.

**3-13.** Input-output characteristics are shown for three different circuits in Fig. P3-13. Design circuits to recreate plots A, B, and C.

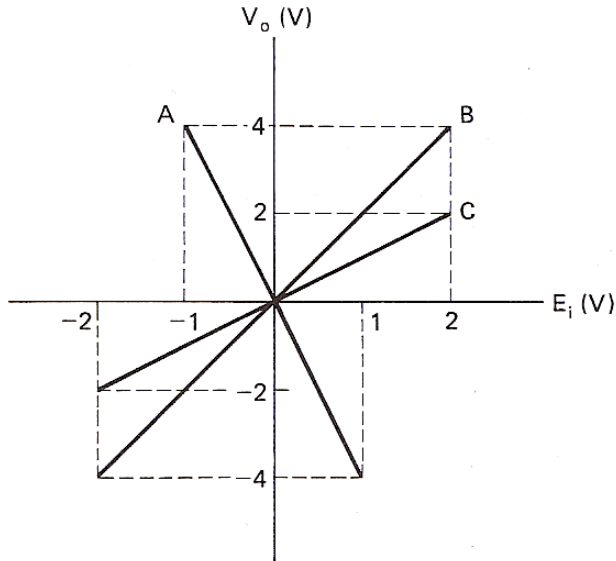


Figure P3-13

**3-14.** The circuit of Fig. P3-14 is called a “subtractor.” Is  $E_1$  subtracted from  $E_2$  or vice versa?

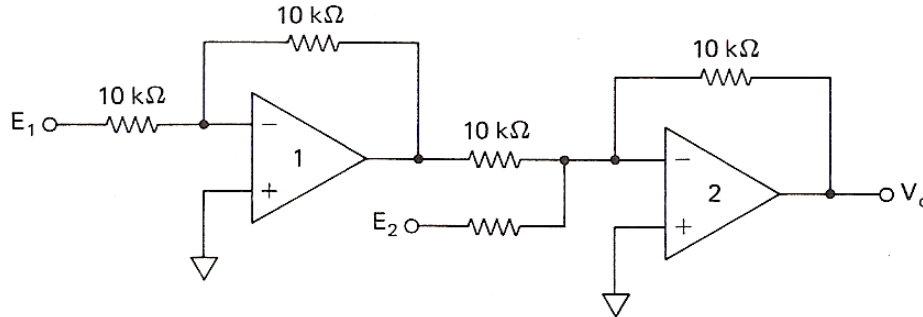


Figure P3-14

**3-15.** A 5-V peak-to-peak sine wave,  $E_i$ , is applied to  $(-)$ In of Fig. P3-15. Plot  $V_o$  vs.  $E_i$  if voltage at  $(+)$ In is (a) +5 V; (b) -5 V.

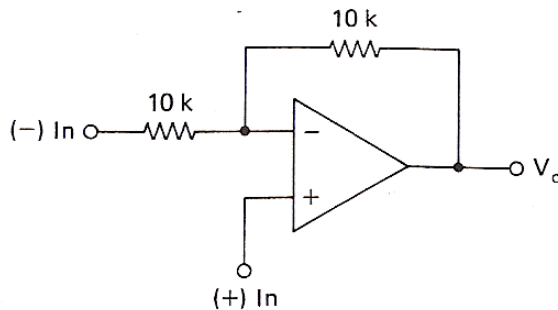


Figure P3-15

- 3-16. A 5-V peak-to-peak sine wave,  $E_i$ , is applied to (+)In of Fig. P3-15. Plot  $V_o$  vs.  $E_i$  if the voltage of (-)In is (a) +5 V; (b) -5 V. (Assume that  $\pm V_{sat} = \pm 15$  V.)
- 3-17. Design a three-channel inverting amplifier. Gains are to be -1 for channel 1, -3 for channel 2, and -5 for channel 3 (refer to Section 3-3.2).