its value for $V_B = 0$ V? For what value of V_B is the transistor just at the edge of conduction? ($v_{BE} = 0.5$ V) What values of V_E and V_C correspond? For what value of V_B does the transistor reach the edge of saturation? What values of V_C and V_E correspond? Find the value of V_B for which the transistor operates in saturation with a forced β of 2.

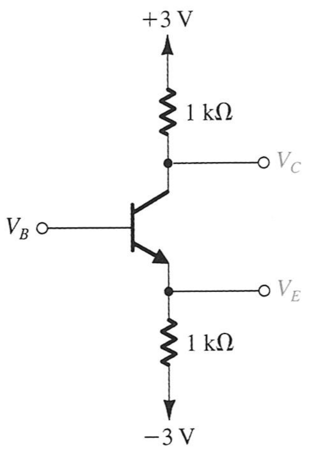

Figure P6.53

6.54 For the transistor shown in Fig. P6.54, assume $\alpha \simeq 1$ and $v_{BE} = 0.5$ V at the edge of conduction. What are the values of V_E and V_C for $V_B = 0$ V? For what value of V_B does the transistor cut off? Saturate? In each case, what values of V_E and V_C result?

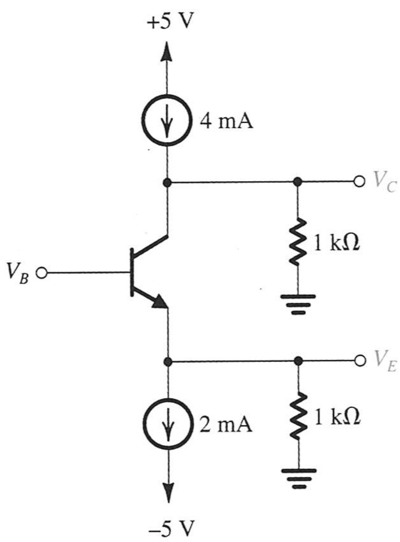

Figure P6.54

D 6.55 Consider the circuit in Fig. P6.51 with the base voltage V_B obtained using a voltage divider across the 3-V supply. Assuming the transistor β to be very large (i.e., ignoring the base current), design the voltage divider to obtain $V_B = 1.2$ V. Design for a 0.1-mA current in the voltage divider. Now, if the BJT $\beta = 100$, analyze the circuit to determine the collector current and the collector voltage.

6.56 A single measurement indicates the emitter voltage of the transistor in the circuit of Fig. P5.56 to be 1.0 V. Under the assumption that $|V_{BE}| = 0.7$ V, what are V_B, I_B, I_E, I_C, V_C, β, and α ? (*Note:* Isn't it surprising what a little measurement can lead to?)

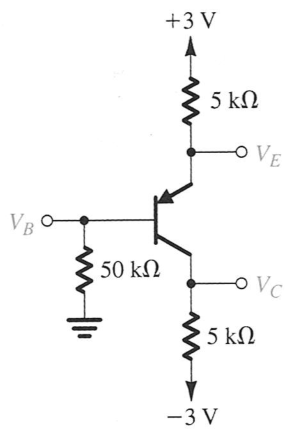

Figure P6.56

D 6.57 Design a circuit using a *pnp* transistor for which $\alpha \simeq 1$ using two resistors connected appropriately to ± 3 V so that $I_E = 0.5$ mA and $V_{BC} = 1$ V. What exact values of R_E and R_C would be needed? Now, consult a table of standard 5% resistor values (e.g., that provided in Appendix J) to select suitable practical values. What values of resistors have you chosen? What are the values of I_E and V_{BC} that result?

6.58 In the circuit shown in Fig. P6.58, the transistor has $\beta = 40$. Find the values of V_B, V_E, and V_C. If R_B is raised to 100 kΩ, what voltages result? With $R_B = 100$ kΩ, what value of β would return the voltages to the values first calculated?

SIM = Multisim/PSpice; * = difficult problem; ** = more difficult; *** = very challenging; D = design problem

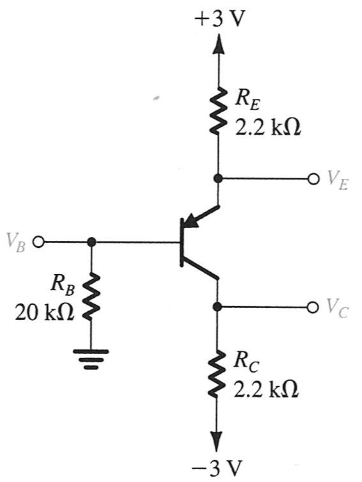

Figure P6.58

6.59 In the circuit shown in Fig. P6.58, the transistor has $\beta = 50$. Find the values of V_B, V_E, and V_C, and verify that the transistor is operating in the active mode. What is the largest value that R_C can have while the transistor remains in the active mode?

SIM **6.60** For the circuit in Fig. P6.60, find V_B, V_E, and V_C for $R_B = 100$ kΩ, 10 kΩ, and 1 kΩ. Let $\beta = 100$.

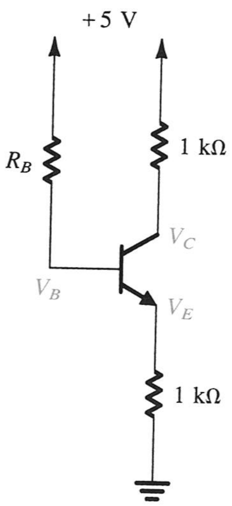

Figure P6.60

6.61 For the circuits in Fig. P6.61, find values for the labeled node voltages and branch currents. Assume β to be very high.

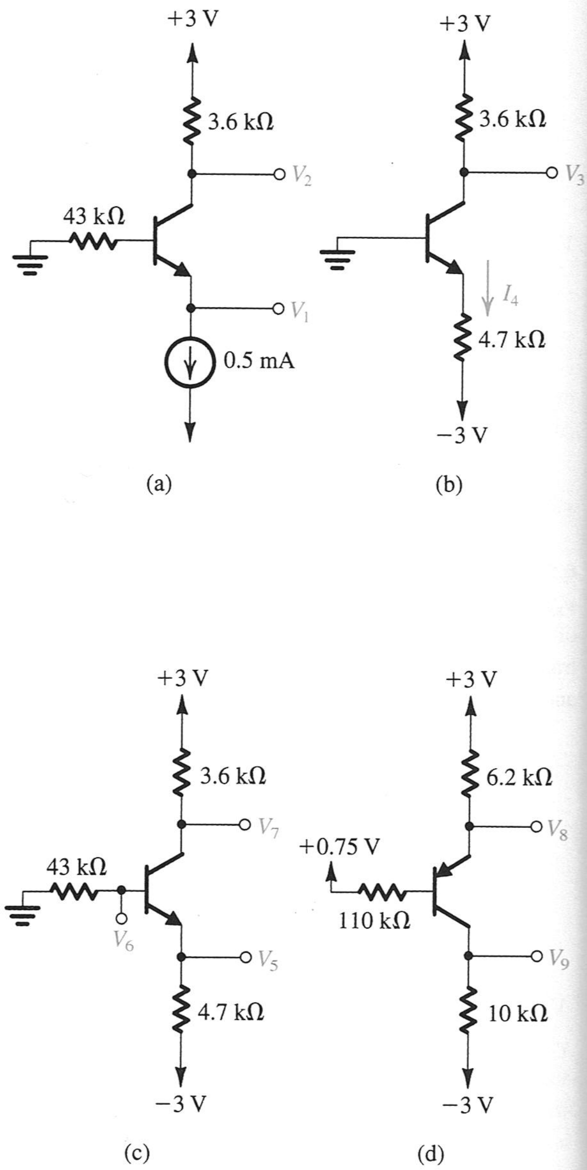

Figure P6.61

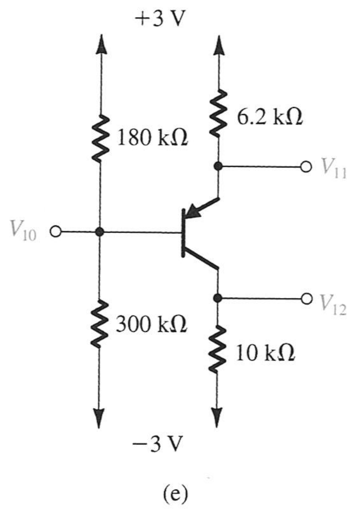

Figure P6.61 *continued*

*6.62 Repeat the analysis of the circuits in Problem 6.61 using $\beta = 100$. Find all the labeled node voltages and branch currents.

D **6.63 It is required to design the circuit in Fig. P6.63 so that a current of 1 mA is established in the emitter and a voltage of −1 V appears at the collector. The transistor type used has a nominal β of 100. However, the β value can be as low as 50 and as high as 150. Your design should ensure that the specified emitter current is obtained when $\beta = 100$ and that at the extreme values of β the emitter current does not change by more than 10% of its nominal value. Also, design for as large a value for R_B as possible. Give the values of R_B, R_E, and R_C to the nearest kilohm. What is the expected range of collector current and collector voltage corresponding to the full range of β values?

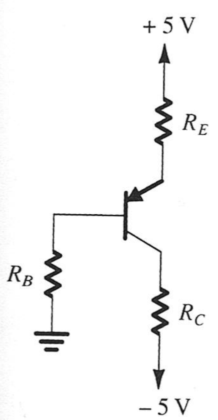

Figure P6.63

D 6.64 The *pnp* transistor in the circuit of Fig. P6.64 has $\beta = 50$. Find the value for R_C to obtain $V_C = +2$ V. What happens if the transistor is replaced with another having $\beta = 100$? Give the value of V_C in the latter case.

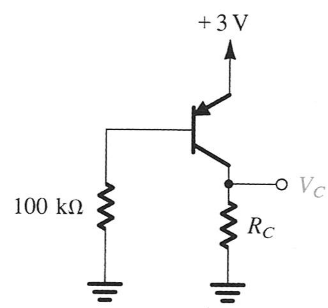

Figure P6.64

***6.65 Consider the circuit shown in Fig. P6.65. It resembles that in Fig. 6.30 but includes other features. First, note diodes D_1 and D_2 are included to make design (and analysis) easier and to provide temperature compensation for the emitter–base voltages of Q_1 and Q_2. Second, note resistor R, whose purpose is to provide negative feedback (more on this later in the book!). Using $|V_{BE}|$ and $V_D = 0.7$ V independent of current, and $\beta = \infty$, find the voltages V_{B1}, V_{E1}, V_{C1}, V_{B2}, V_{E2}, and V_{C2}, initially with R open-circuited and then with R connected. Repeat for $\beta = 100$, with R open-circuited initially, then connected.

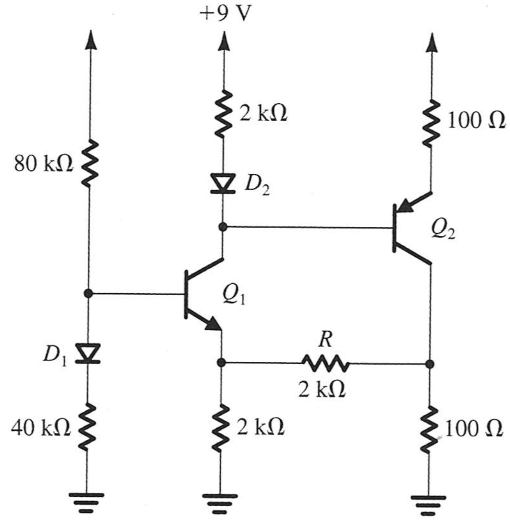

Figure P6.65

*6.66 For the circuit shown in Fig. P6.66, find the labeled node voltages for:

(a) $\beta = \infty$
(b) $\beta = 100$

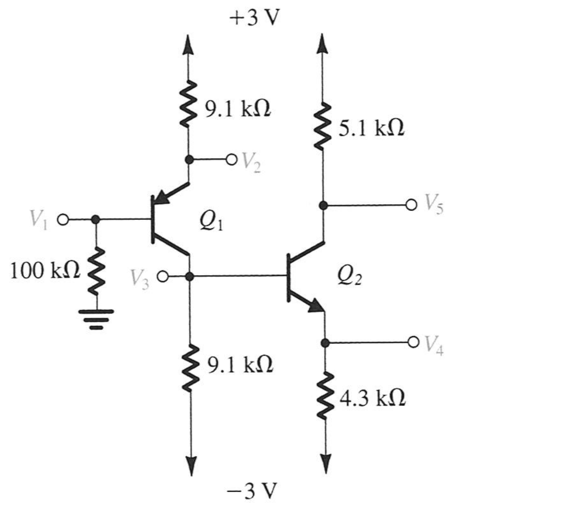

Figure P6.66

D *6.67 Using $\beta = \infty$, design the circuit shown in Fig. P6.67 so that the emitter currents of Q_1, Q_2, and Q_3 are 0.5 mA, 0.5 mA, and 1 mA, respectively, and $V_3 = 0$, $V_5 = -2$ V, and $V_7 = 1$ V. For each resistor, select the nearest standard value utilizing the table of standard values for 5% resistors in Appendix J. Now, for $\beta = 100$, find the values of V_3, V_4, V_5, V_6, and V_7.

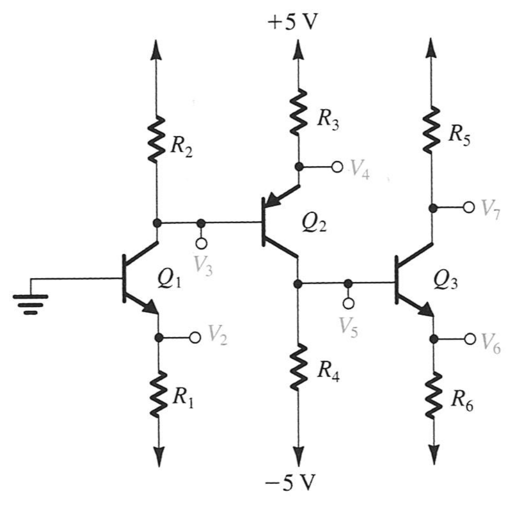

Figure P6.67

*6.68 For the circuit in Fig. P6.68, find V_B and V_E for v_I = 0 V, +2 V, −2.5 V, and −5 V. The BJTs have $\beta = 50$.

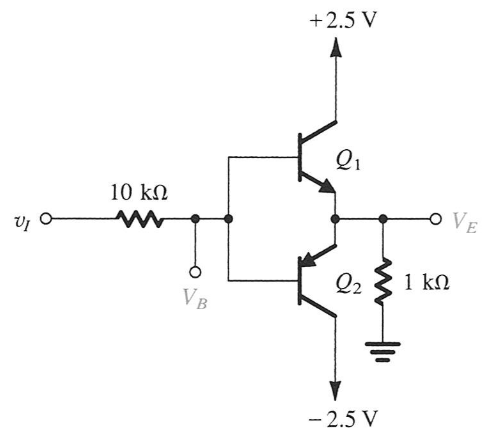

Figure P6.68

**6.69 All the transistors in the circuits of Fig. P6.69 are specified to have a minimum β of 50. Find approximate values for the collector voltages and calculate forced β for each of the transistors. (*Hint:* Initially, assume all transistors are operating in saturation, and verify the assumption.)

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