Electronic Circuits Questions
Elektronik Devreler Soruları

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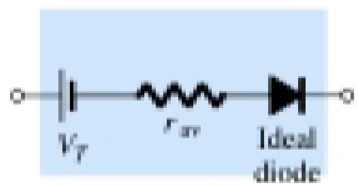
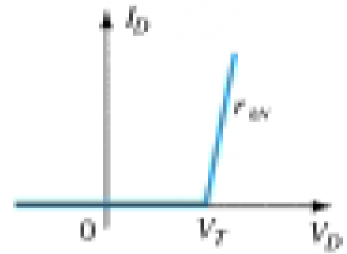
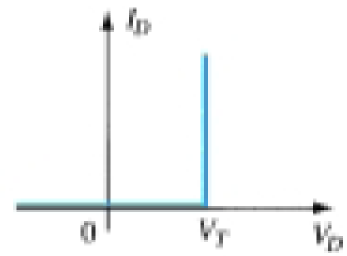
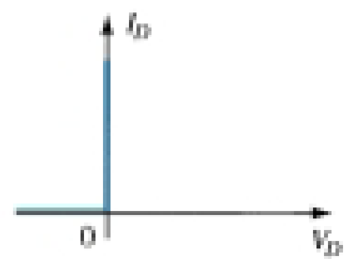
Computer Engineering

Electronic Circuits Questions

TABLE 1.3 Diode Equivalent Circuits (Models)

Type	*Conditions*	*Model*	*Characteristics*
Piecewise-linear model			
Simplified model	$R_{network} \gg r_{av}$		
Ideal device	$R_{network} \gg r_{av}$ $E_{network} \gg V_T$		

For the series diode configuration of Fig. 2.3a employing the diode characteristics of Fig. 2.3b determine:

(a) V_{D_Q} and I_{D_Q}.

(b) V_R.

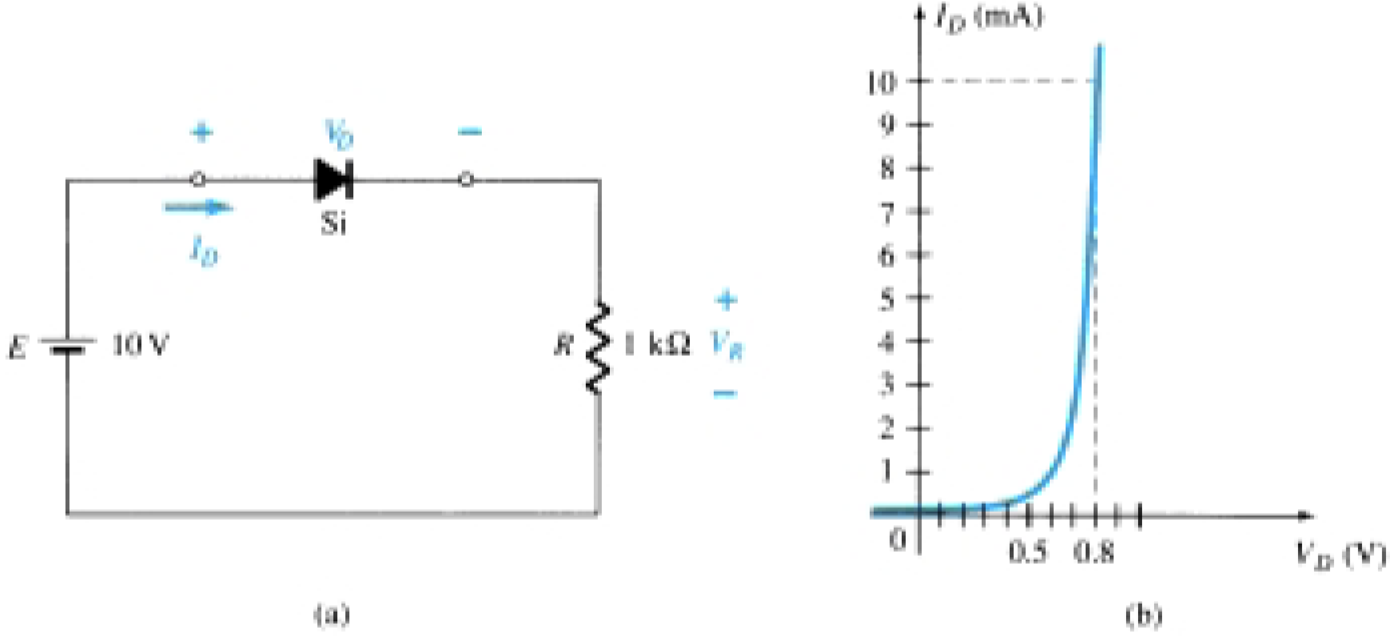


Figure 2.3 (a) Circuit; (b) characteristics.

Solution

(a) Eq. (2.2): $I_D = \left.\frac{E}{R}\right|_{V_D=0\text{ V}} = \frac{10\text{ V}}{2\text{ k}\Omega} = 10\text{ mA}$

Eq. (2.3): $V_D = E|_{I_D=0\text{ A}} = 10\text{ V}$

The resulting load line appears in Fig. 2.4. The intersection between the load line and the characteristic curve defines the Q-point as

$$V_{D_Q} \cong \mathbf{0.78\ V}$$

$$I_{D_Q} \cong \mathbf{9.25\ mA}$$

The level of V_D is certainly an estimate, and the accuracy of I_D is limited by the chosen scale. A higher degree of accuracy would require a plot that would be much larger and perhaps unwieldy.

(b) $V_R = I_R R = I_{D_Q} R = (9.25\text{ mA})(1\text{ k}\Omega) = \mathbf{9.25\ V}$

or $V_R = E - V_D = 10\text{ V} - 0.78\text{ V} = \mathbf{9.22\ V}$

The difference in results is due to the accuracy with which the graph can be read. Ideally, the results obtained either way should be the same.

EXAMPLE 2.6

For the series diode configuration of Fig. 2.16, determine V_D, V_R, and I_D.

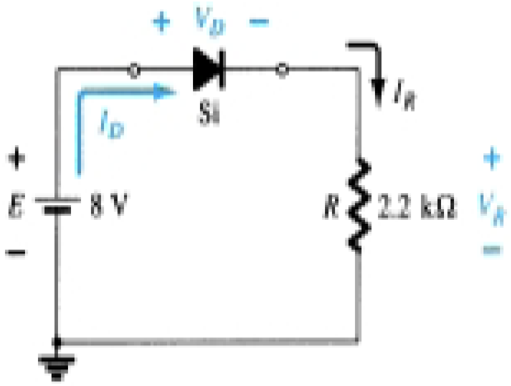


Figure 2.16 Circuit for Example 2.6.

Solution

Since the applied voltage establishes a current in the clockwise direction to match the arrow of the symbol and the diode is in the "on" state,

$$V_D = \mathbf{0.7\ V}$$

$$V_R = E - V_D = 8\text{ V} - 0.7\text{ V} = \mathbf{7.3\ V}$$

$$I_D = I_R = \frac{V_R}{R} = \frac{7.3\text{ V}}{2.2\text{ k}\Omega} \cong \mathbf{3.32\ mA}$$

EXAMPLE 2.9

Determine V_o and I_D for the series circuit of Fig. 2.21.

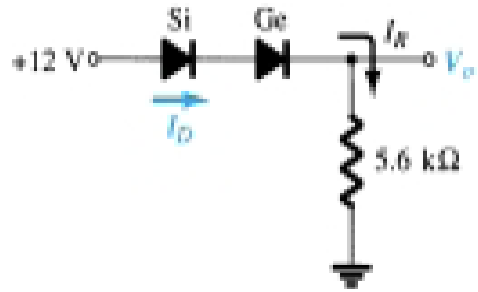


Figure 2.21 Circuit for Example 2.9.

Solution

An attack similar to that applied in Example 2.6 will reveal that the resulting current has the same direction as the arrowheads of the symbols of both diodes, and the network of Fig. 2.22 results because $E = 12\text{ V} > (0.7\text{ V} + 0.3\text{ V}) = 1\text{ V}$. Note the redrawn supply of 12 V and the polarity of V_o across the 5.6-kΩ resistor. The resulting voltage

$$V_o = E - V_{T_1} - V_{T_2} = 12\text{ V} - 0.7\text{ V} - 0.3\text{ V} = \mathbf{11\text{ V}}$$

and

$$I_D = I_R = \frac{V_R}{R} = \frac{V_o}{R} = \frac{11\text{ V}}{5.6\text{ k}\Omega} \cong \mathbf{1.96\text{ mA}}$$

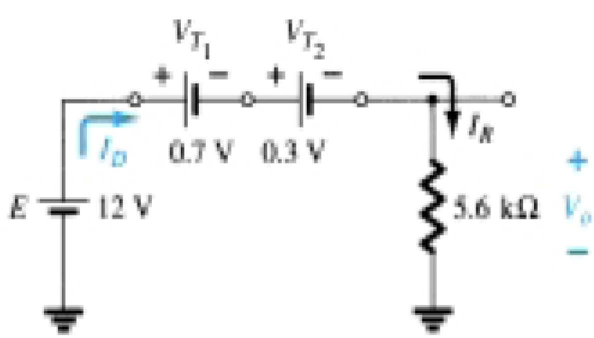


Figure 2.22 Determining the unknown quantities for Example 2.9.

Determine I, V_1, V_2, and V_o for the series dc configuration of Fig. 2.27. *EXAMPLE 2.11*

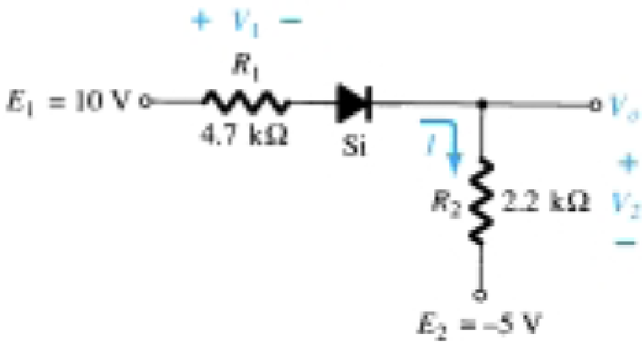


Figure 2.27 Circuit for Example 2.11.

Solution

The sources are drawn and the current direction indicated as shown in Fig. 2.28. The diode is in the "on" state and the notation appearing in Fig. 2.29 is included to indicate this state. Note that the "on" state is noted simply by the additional $V_D = 0.7$ V

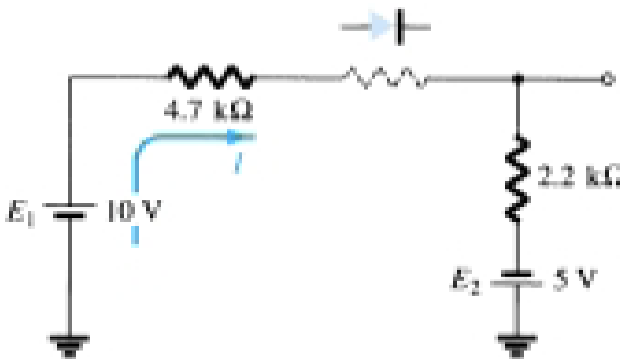


Figure 2.28 Determining the state of the diode for the network of Fig. 2.27.

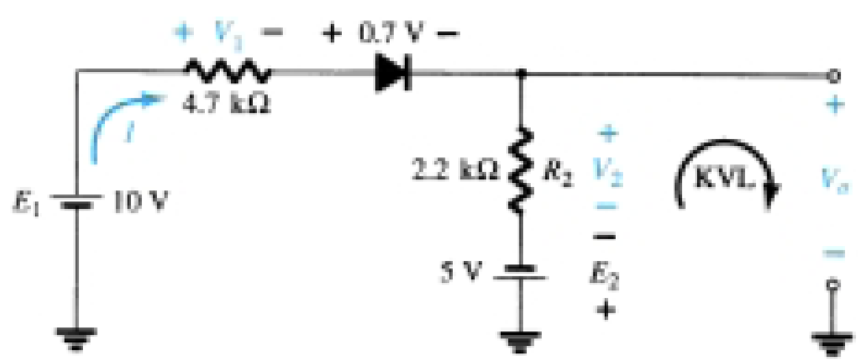
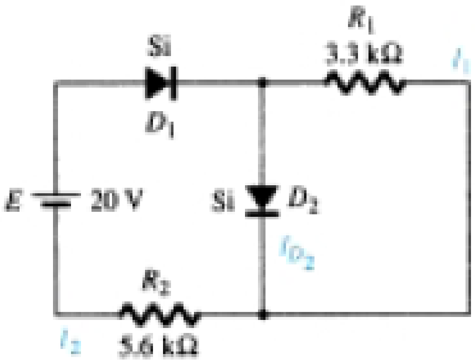


Figure 2.29 Determining the unknown quantities for the network of Fig. 2.27.

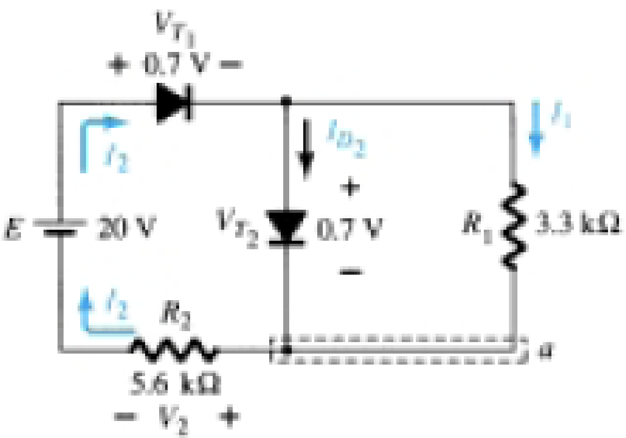
EXAMPLE 2.15 Determine the currents I_1, I_2, and I_{D_2} for the network of Fig. 2.36.



Solution

The applied voltage (pressure) is such as to turn both diodes on, as noted by the resulting current directions in the network of Fig. 2.37. Note the use of the abbreviated notation for "on" diodes and that the solution is obtained through an application of techniques applied to dc series—parallel networks.

$$I_1 = \frac{V_{T_2}}{R_1} = \frac{0.7\text{ V}}{3.3\text{ k}\Omega} = \mathbf{0.212\text{ mA}}$$



Applying Kirchhoff's voltage law around the indicated loop in the clockwise direction yields

$$-V_2 + E - V_{T_1} - V_{T_2} = 0$$

and $$V_2 = E - V_{T_1} - V_{T_2} = 20\text{ V} - 0.7\text{ V} - 0.7\text{ V} = 18.6\text{ V}$$

with $$I_2 = \frac{V_2}{R_2} = \frac{18.6\text{ V}}{5.6\text{ k}\Omega} = \mathbf{3.32\text{ mA}}$$

At the bottom node (a),

$$I_{D_2} + I_1 = I_2$$

and $$I_{D_2} = I_2 - I_1 = 3.32\text{ mA} - 0.212\text{ mA} = \mathbf{3.108\text{ mA}}$$

(a) Sketch the output v_o and determine the dc level of the output for the network of Fig. 2.48.
(b) Repeat part (a) if the ideal diode is replaced by a silicon diode.
(c) Repeat parts (a) and (b) if V_m is increased to 200 V and compare solutions using Eqs. (2.7) and (2.8).

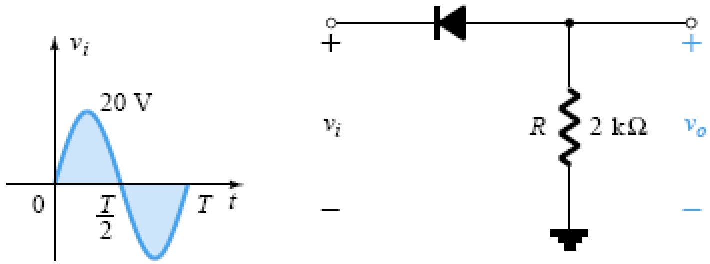


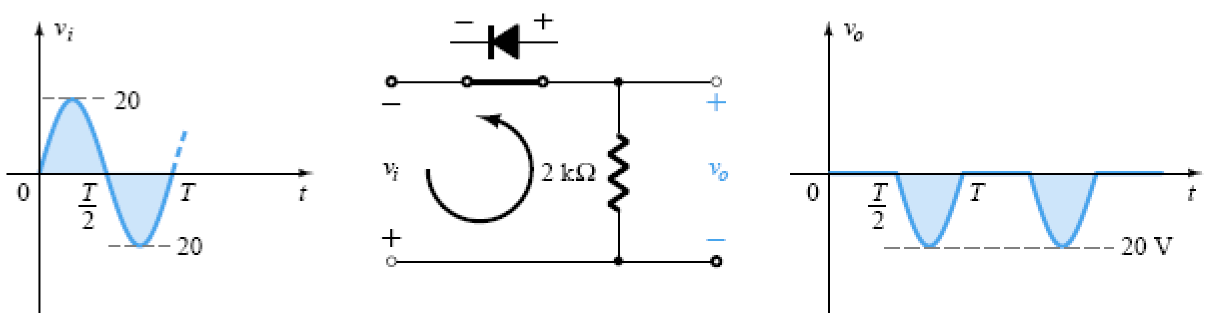
Figure 2.48 Network for Example 2.18.

Solution

(a) In this situation the diode will conduct during the negative part of the input as shown in Fig. 2.49, and v_o will appear as shown in the same figure. For the full period, the dc level is

$$V_{dc} = -0.318V_m = -0.318(20\text{ V}) = \mathbf{-6.36\ V}$$

The negative sign indicates that the polarity of the output is opposite to the defined polarity of Fig. 2.48.



(b) Using a silicon diode, the output has the appearance of Fig. 2.50 and

$$V_{dc} \cong -0.318(V_m - 0.7\text{ V}) = -0.318(19.3\text{ V}) \cong \mathbf{-6.14\text{ V}}$$

The resulting drop in dc level is 0.22 V or about 3.5%.

(c) Eq. (2.7): $V_{dc} = -0.318V_m = -0.318(200\text{ V}) = \mathbf{-63.6\text{ V}}$

Eq. (2.8): $V_{dc} = -0.318(V_m - V_T) = -\,0.318(200\text{ V} - 0.7\text{ V})$

$$= -(0.318)(199.3\text{ V}) = \mathbf{-63.38\text{ V}}$$

which is a difference that can certainly be ignored for most applications. For part c the offset and drop in amplitude due to V_T would not be discernible on a typical oscilloscope if the full pattern is displayed.

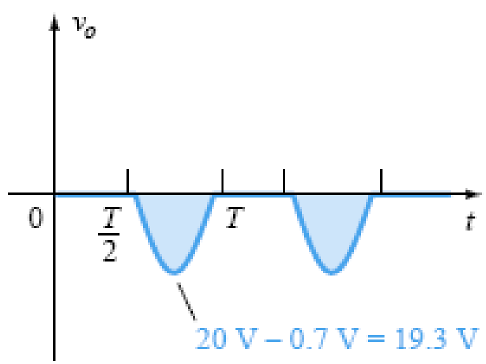


Figure 2.50 Effect of V_T on output of Fig. 2.49.

EXAMPLE 2.19

Determine the output waveform for the network of Fig. 2.63 and calculate the output dc level and the required PIV of each diode.

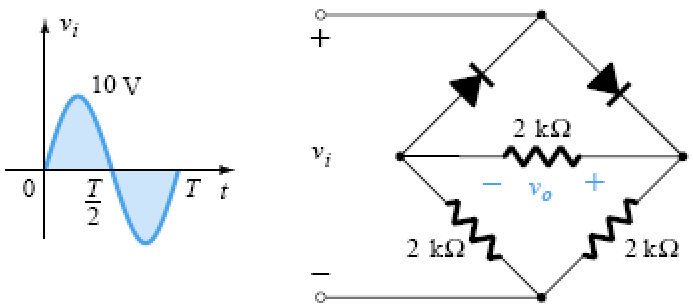


Figure 2.63 Bridge network for Example 2.19.

Solution

The network will appear as shown in Fig. 2.64 for the positive region of the input voltage. Redrawing the network will result in the configuration of Fig. 2.65, where $v_o = \frac{1}{2}v_i$ or $V_{o_{\max}} = \frac{1}{2}V_{i_{\max}} = \frac{1}{2}(10\text{ V}) = 5\text{ V}$, as shown in Fig. 2.65. For the negative part of the input the roles of the diodes will be interchanged and v_o will appear as shown in Fig. 2.66.

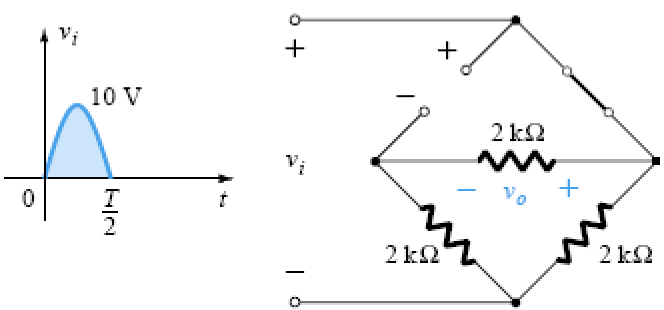


Figure 2.64 Network of Fig. 2.63 for the positive region of v_i.

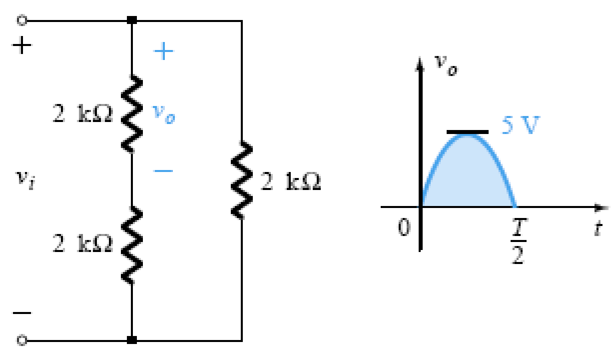


Figure 2.65 Redrawn network of Fig. 2.64.

The effect of removing two diodes from the bridge configuration was therefore to reduce the available dc level to the following:

$$V_{dc} = 0.636(5\text{ V}) = \mathbf{3.18\ V}$$

or that available from a half-wave rectifier with the same input. However, the PIV as determined from Fig. 2.58 is equal to the maximum voltage across R, which is 5 V or half of that required for a half-wave rectifier with the same input.

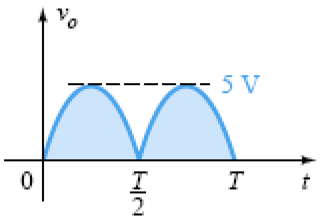
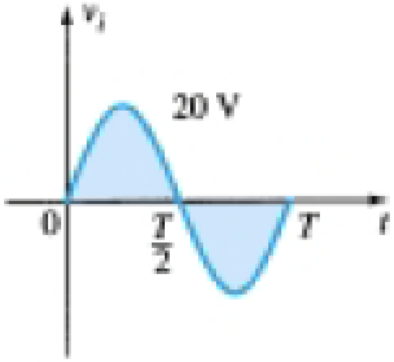


Figure 2.66 Resulting output for Example 2.19.

Determine the output waveform for the network of Fig. 2.74.



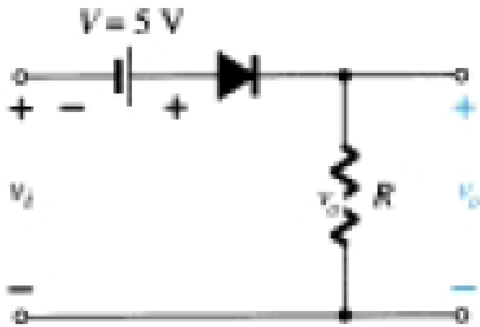


Figure 2.74 Series clipper for Example 2.20.

Solution

Past experience suggests that the diode will be in the "on" state for the positive region of v_i—especially when we note the aiding effect of $V = 5$ V. The network will then appear as shown in Fig. 2.75 and $v_o = v_i + 5$ V. Substituting $i_d = 0$ at $v_d = 0$ for the transition levels, we obtain the network of Fig. 2.76 and $v_i = -5$ V.

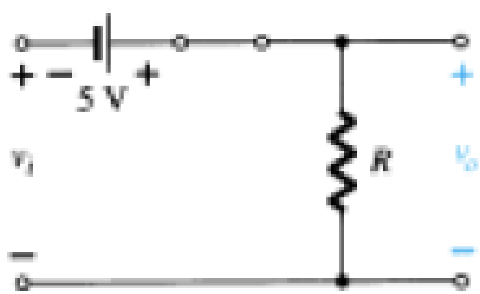


Figure 2.75 v_o with diode in the "on" state.

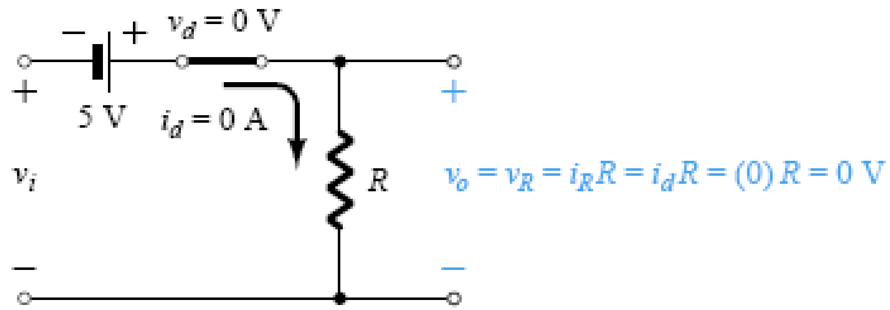


Figure 2.76 Determining the transition level for the clipper of Fig. 2.74.

For v_i more negative than -5 V the diode will enter its open-circuit state, while for voltages more positive than -5 V the diode is in the short-circuit state. The input and output voltages appear in Fig. 2.77.

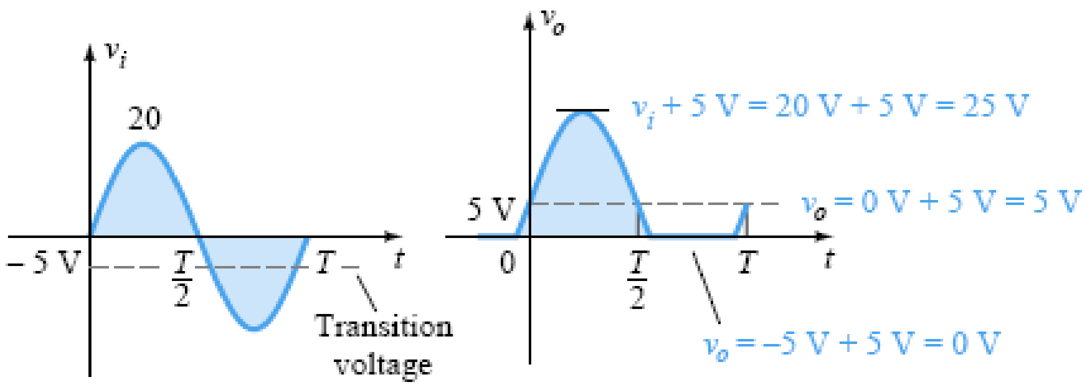


Figure 2.77 Sketching v_o for Example 2.20.

(a) For the Zener diode network of Fig. 2.109, determine V_L, V_R, I_Z, and P_Z.
(b) Repeat part (a) with $R_L = 3\ \text{k}\Omega$.

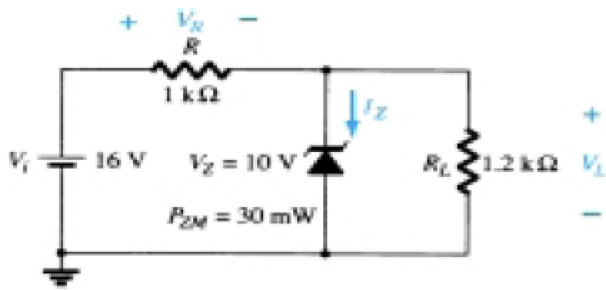


Figure 2.109 Zener diode regulator for Example 2.26.

Solution

(a) Following the suggested procedure the network is redrawn as shown in Fig. 2.110. Applying Eq. (2.16) gives

$$V = \frac{R_L V_i}{R + R_L} = \frac{1.2\ \text{k}\Omega(16\ \text{V})}{1\ \text{k}\Omega + 1.2\ \text{k}\Omega} = 8.73\ \text{V}$$

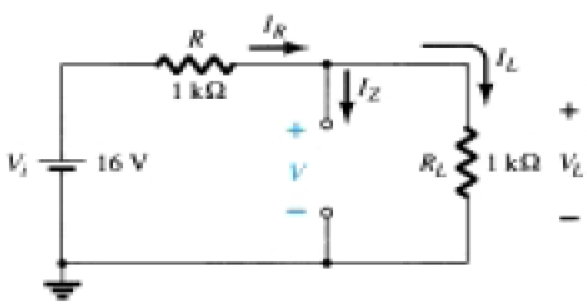


Figure 2.110 Determining V for the regulator of Fig. 2.109.

Since $V = 8.73$ V is less than $V_Z = 10$ V, the diode is in the "off" state as shown on the characteristics of Fig. 2.111. Substituting the open-circuit equivalent will result in the same network as in Fig. 2.110, where we find that

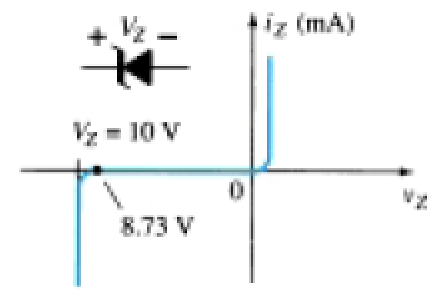


Figure 2.111 Resulting operating point for the network of Fig. 2.109.

$$V_L = V = \mathbf{8.73\ V}$$

$$V_R = V_i - V_L = 16\ V - 8.73\ \text{V} = \mathbf{7.27\ V}$$

$$I_Z = \mathbf{0\ A}$$

and $$P_Z = V_Z I_Z = V_Z(0\ \text{A}) = \mathbf{0\ W}$$

(b) Applying Eq. (2.16) will now result in

$$V = \frac{R_L V_i}{R + R_L} = \frac{3\ \text{k}\Omega(16\ \text{V})}{1\ \text{k}\Omega + 3\ \text{k}\Omega} = 12\ \text{V}$$

Since $V = 12$ V is greater than $V_Z = 10$ V, the diode is in the "on" state and the network of Fig. 2.112 will result. Applying Eq. (2.17) yields

$$V_L = V_Z = \mathbf{10\ V}$$

and $$V_R = V_i - V_L = 16\ \text{V} - 10\ \text{V} = \mathbf{6\ V}$$

with $$I_L = \frac{V_L}{R_L} = \frac{10\ \text{V}}{3\ \text{k}\Omega} = 3.33\ \text{mA}$$

and $$\text{I}_R = \frac{V_R}{R} = \frac{6\ \text{V}}{1\ \text{k}\Omega} = 6\ \text{mA}$$

so that $$I_Z = I_R - I_L\ [\text{Eq. (2.18)}]$$

$$= 6\ \text{mA} - 3.33\ \text{mA}$$

$$= \mathbf{2.67\ mA}$$

The power dissipated,

$$P_Z = V_Z I_Z = (10\ \text{V})(2.67\ \text{mA}) = \mathbf{26.7\ mW}$$

which is less than the specified $P_{ZM} = 30$ mW.

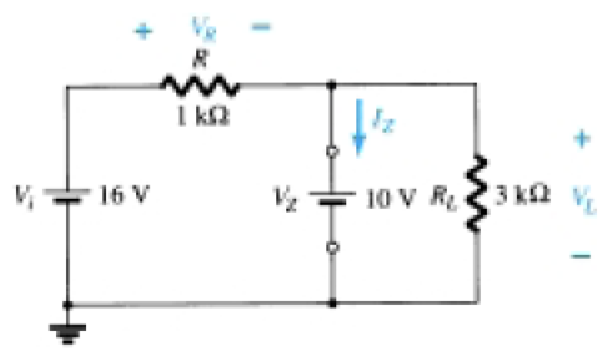


Figure 2.112 Network of Fig. 2.109 in the "on" state.

(a) For the network of Fig. 2.113, determine the range of R_L and I_L that will result in V_{R_L} being maintained at 10 V.
(b) Determine the maximum wattage rating of the diode.

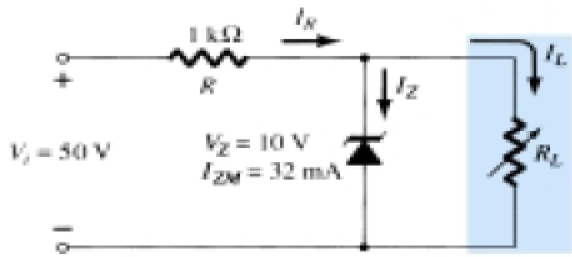


Figure 2.113 Voltage regu
for Example 2.27.

Solution

(a) To determine the value of R_L that will turn the Zener diode on, apply Eq. (2.

$$R_{L_{\min}} = \frac{RV_Z}{V_i - V_Z} = \frac{(1\ \text{k}\Omega)(10\ \text{V})}{50\ \text{V} - 10\ \text{V}} = \frac{10\ \text{k}\Omega}{40} = \mathbf{250\ \Omega}$$

The voltage across the resistor R is then determined by Eq. (2.22):

$$V_R = V_i - V_Z = 50\ \text{V} - 10\ \text{V} = \mathbf{40\ V}$$

and Eq. (2.23) provides the magnitude of I_R:

$$I_R = \frac{V_R}{R} = \frac{40\ \text{V}}{1\ \text{k}\Omega} = \mathbf{40\ mA}$$

The minimum level of I_L is then determined by Eq. (2.25):

$$I_{L_{\min}} = I_R - I_{ZM} = 40\ \text{mA} - 32\ \text{mA} = \mathbf{8\ mA}$$

with Eq. (2.26) determining the maximum value of R_L:

$$R_{L_{\max}} = \frac{V_Z}{I_{L_{\min}}} = \frac{10\ \text{V}}{8\ \text{mA}} = \mathbf{1.25\ k\Omega}$$

A plot of V_L versus R_L appears in Fig. 2.114a and for V_L versus I_L in Fig. 2.

(b) $P_{\max} = V_Z I_{ZM}$
$= (10\ \text{V})(32\ \text{mA}) = \mathbf{320\ mW}$

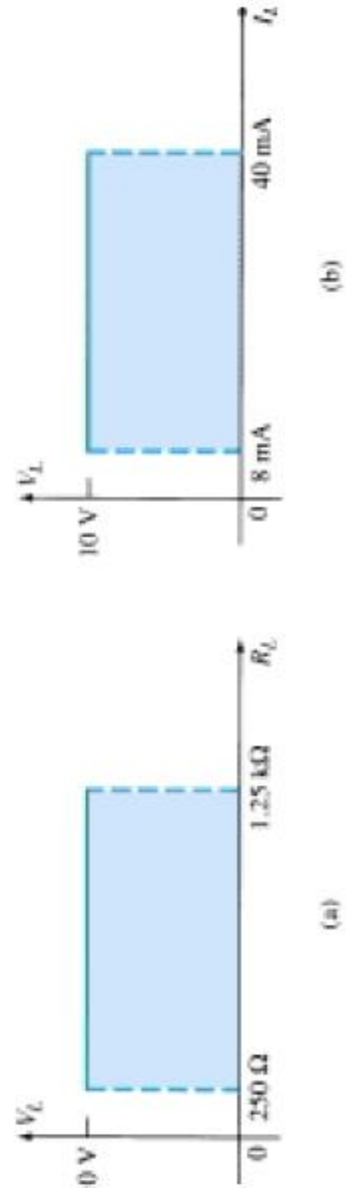


Figure 2.114 V_L versus R_L and I_L for the regulator of Fig. 2.113.

Determine the following for the fixed-bias configuration of Fig. 4.7.

(a) I_{B_Q} and I_{C_Q}.

(b) V_{CE_Q}.

(c) V_B and V_C.

(d) V_{BC}.

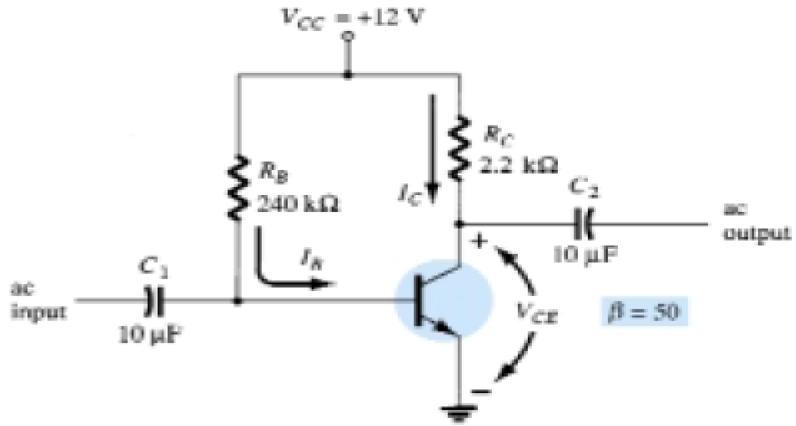


Figure 4.7 dc fixed-bias circuit for Example 4.1.

Solution

(a) Eq. (4.4): $I_{B_Q} = \dfrac{V_{CC} - V_{BE}}{R_B} = \dfrac{12\text{ V} - 0.7\text{ V}}{240\text{ k}\Omega} = \mathbf{47.08\ \mu A}$

Eq. (4.5): $I_{C_Q} = \beta I_{B_Q} = (50)(47.08\ \mu\text{A}) = \mathbf{2.35\ mA}$

(b) Eq. (4.6):
$$\begin{aligned} V_{CE_Q} &= V_{CC} - I_C R_C \\ &= 12\text{ V} - (2.35\text{ mA})(2.2\text{ k}\Omega) \\ &= \mathbf{6.83\ V} \end{aligned}$$

(c) $V_B = V_{BE} = \mathbf{0.7\ V}$

$V_C = V_{CE} = \mathbf{6.83\ V}$

(d) Using double-subscript notation yields

$$\begin{aligned} V_{BC} &= V_B - V_C = 0.7\text{ V} - 6.83\text{ V} \\ &= \mathbf{-6.13\ V} \end{aligned}$$

with the negative sign revealing that the junction is reversed-biased, as it should be for linear amplification.

For the emitter bias network of Fig. 4.22, determine:
(a) I_B.
(b) I_C.
(c) V_{CE}.
(d) V_C.
(e) V_E.
(f) V_B.
(g) V_{BC}.

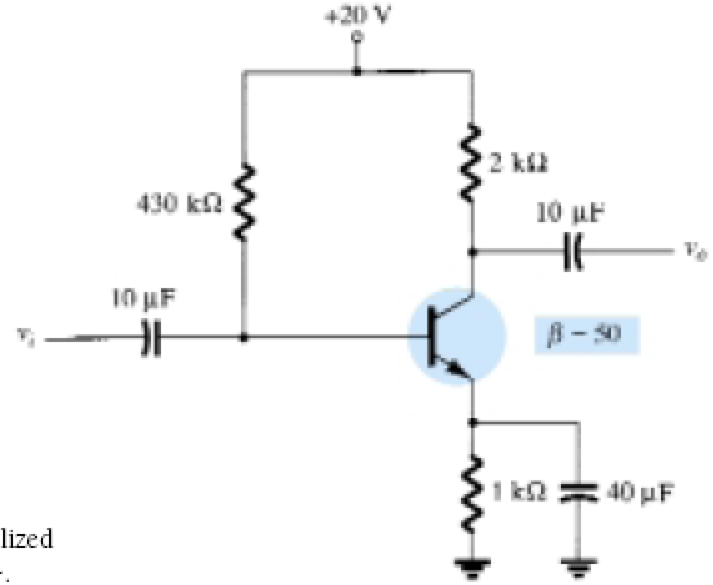


Figure 4.22 Emitter-stabilized bias circuit for Example 4.4.

Solution

(a) Eq. (4.17): $I_B = \dfrac{V_{CC} - V_{BE}}{R_B + (\beta + 1)R_E} = \dfrac{20\text{ V} - 0.7\text{ V}}{430\text{ k}\Omega + (51)(1\text{ k}\Omega)}$

$$= \frac{19.3\text{ V}}{481\text{ k}\Omega} = \mathbf{40.1\ \mu A}$$

(b) $I_C = \beta I_B$

$= (50)(40.1\ \mu\text{A})$

$\cong \mathbf{2.01\ mA}$

(c) Eq. (4.19): $V_{CE} = V_{CC} - I_C(R_C + R_E)$

$= 20\text{ V} - (2.01\text{ mA})(2\text{ k}\Omega + 1\text{ k}\Omega) = 20\text{ V} - 6.03\text{ V}$

$= \mathbf{13.97\ V}$

(d) $V_C = V_{CC} - I_C R_C$

$= 20\text{ V} - (2.01\text{ mA})(2\text{ k}\Omega) = 20\text{ V} - 4.02\text{ V}$

$= \mathbf{15.98\ V}$

(e) $V_E = V_C - V_{CE}$

$= 15.98\text{ V} - 13.97\text{ V}$

$= \mathbf{2.01\ V}$

or $V_E = I_E R_E \cong I_C R_E$

$= (2.01\text{ mA})(1\text{ k}\Omega)$

$= \mathbf{2.01\ V}$

(f) $V_B = V_{BE} + V_E$

$= 0.7\text{ V} + 2.01\text{ V}$

$= \mathbf{2.71\ V}$

(g) $V_{BC} = V_B - V_C$

$= 2.71\text{ V} - 15.98\text{ V}$

$= \mathbf{-13.27\ V}$ (reverse-biased as required)

Determine the dc bias voltage V_{CE} and the current I_C for the voltage-divider configuration of Fig. 4.31.

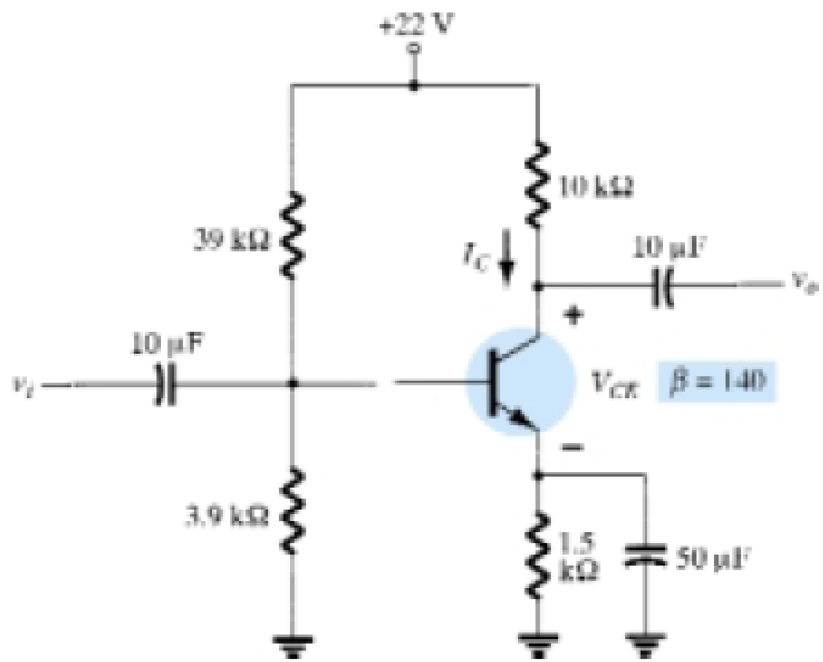


Figure 4.31 Beta-stabilized circuit for Example 4.7.

Solution

Eq. (4.28): $R_{\mathrm{Th}} = R_1 \| R_2$

$$= \frac{(39\ \mathrm{k}\Omega)(3.9\ \mathrm{k}\Omega)}{39\ \mathrm{k}\Omega + 3.9\ \mathrm{k}\Omega} = 3.55\ \mathrm{k}\Omega$$

Eq. (4.29): $E_{\mathrm{Th}} = \dfrac{R_2 V_{CC}}{R_1 + R_2}$

$$= \frac{(3.9\ \mathrm{k}\Omega)(22\ \mathrm{V})}{39\ \mathrm{k}\Omega + 3.9\ \mathrm{k}\Omega} = 2\ V$$

Eq. (4.30): $I_B = \dfrac{E_{\mathrm{Th}} - V_{BE}}{R_{\mathrm{Th}} + (\beta + 1)R_E}$

$$= \frac{2\ \mathrm{V} - 0.7\ \mathrm{V}}{3.55\ \mathrm{k}\Omega + (141)(1.5\ \mathrm{k}\Omega)} = \frac{1.3\ \mathrm{V}}{3.55\ \mathrm{k}\Omega + 211.5\ \mathrm{k}\Omega}$$

$$= 6.05\ \mu A$$

$$I_C = \beta I_B$$

$$= (140)(6.05\ \mu\mathrm{A})$$

$$= \mathbf{0.85\ mA}$$

Eq. (4.31): $V_{CE} = V_{CC} - I_C(R_C + R_E)$

$$= 22\ \mathrm{V} - (0.85\ \mathrm{mA})(10\ \mathrm{k}\Omega + 1.5\ \mathrm{k}\Omega)$$

$$= 22\ \mathrm{V} - 9.78\ \mathrm{V}$$

$$= \mathbf{12.22\ V}$$

Determine the dc level of I_B and V_C for the network of Fig. 4.38.

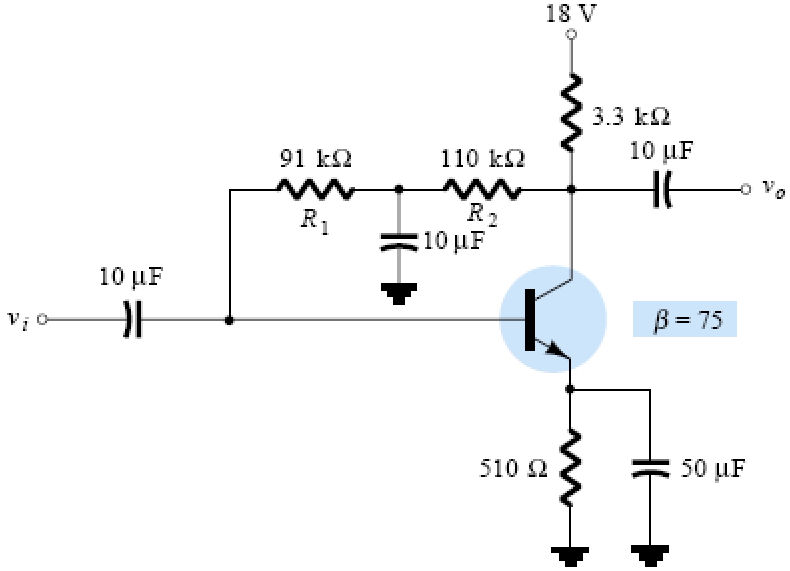


Figure 4.38 Network for Example 4.13.

Solution

In this case, the base resistance for the dc analysis is composed of two resistors with a capacitor connected from their junction to ground. For the dc mode, the capacitor assumes the open-circuit equivalence and $R_B = R_1 + R_2$.

Solving for I_B gives

$$\begin{aligned}
I_B &= \frac{V_{CC} - V_{BE}}{R_B + \beta(R_C + R_E)} \\
&= \frac{18\text{ V} - 0.7\text{ V}}{(91\text{ k}\Omega + 110\text{ k}\Omega) + (75)(3.3\text{ k}\Omega + 0.51\text{ k}\Omega)} \\
&= \frac{17.3\text{ V}}{201\text{ k}\Omega + 285.75\text{ k}\Omega} = \frac{17.3\text{ V}}{486.75\text{ k}\Omega} \\
&= \mathbf{35.5\ \boldsymbol{\mu}A} \\
I_C &= \beta I_B \\
&= (75)(35.5\ \mu\text{A}) \\
&= 2.66\text{ mA} \\
V_C &= V_{CC} - I_C' R_C \cong V_{CC} - I_C R_C \\
&= 18\text{ V} - (2.66\text{ mA})(3.3\text{ k}\Omega) \\
&= 18\text{ V} - 8.78\text{ V} \\
&= \mathbf{9.22\ V}
\end{aligned}$$

For the network of Fig. 4.39:

(a) Determine I_{C_Q} and V_{CE_Q}.

(b) Find V_B, V_C, V_E, and V_{BC}.

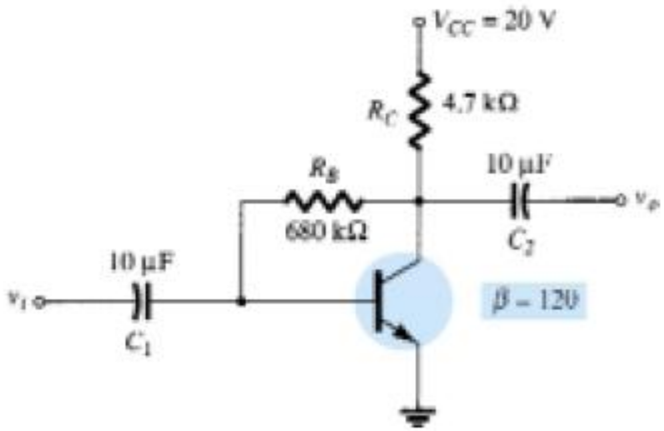


Figure 4.39 Collector feedback with $R_E = 0\ \Omega$.

Solution

(a) The absence of R_E reduces the reflection of resistive levels to simply that of R_C and the equation for I_B reduces to

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + \beta R_C}$$

$$= \frac{20\text{ V} - 0.7\text{ V}}{680\text{ k}\Omega + (120)(4.7\text{ k}\Omega)} = \frac{19.3\text{ V}}{1.244\text{ M}\Omega}$$

$$= 15.51\ \mu\text{A}$$

$$I_{C_Q} = \beta I_B = (120)(15.51\ \mu\text{A})$$

$$= \mathbf{1.86\ mA}$$

$$V_{CE_Q} = V_{CC} - I_C R_C$$

$$= 20\text{ V} - (1.86\text{ mA})(4.7\text{ k}\Omega)$$

$$= \mathbf{11.26\ V}$$

$$V_B = V_{BE} = \mathbf{0.7\ V}$$

$$V_C = V_{CE} = \mathbf{11.26\ V}$$

$$V_E = \mathbf{0\ V}$$

$$V_{BC} = V_B - V_C = 0.7\text{ V} - 11.26\text{ V}$$

$$= \mathbf{-10.56\ V}$$

Given that $I_{C_Q} = 2$ mA and $V_{CE_Q} = 10$ V, determine R_1 and R_C for the network of Fig. 4.48.

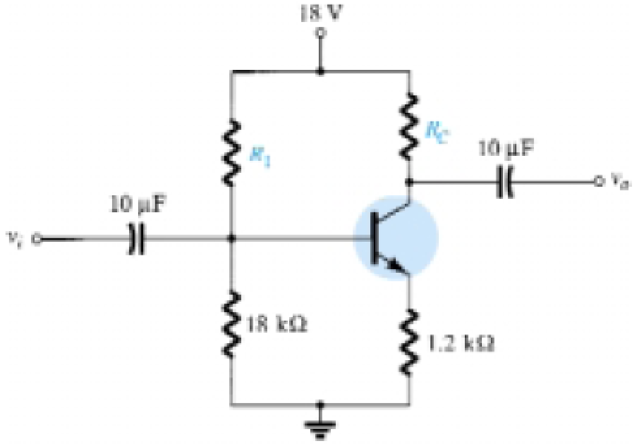


Figure 4.48 Example 4.20

Solution

$$V_E = I_E R_E \cong I_C R_E$$
$$= (2\text{ mA})(1.2\text{ k}\Omega) = 2.4\text{ V}$$
$$V_B = V_{BE} + V_E = 0.7\text{ V} + 2.4\text{ V} = 3.1\text{ V}$$
$$V_B = \frac{R_2 V_{CC}}{R_1 + R_2} = 3.1\text{ V}$$

and

$$\frac{(18\text{ k}\Omega)(18\text{ V})}{R_1 + 18\text{ k}\Omega} = 3.1\text{ V}$$
$$324\text{ k}\Omega = 3.1R_1 + 55.8\text{ k}\Omega$$
$$3.1R_1 = 268.2\text{ k}\Omega$$
$$R_1 = \frac{268.2\text{ k}\Omega}{3.1} = \mathbf{86.52\text{ k}\Omega}$$

Eq. (4.44): $$R_C = \frac{V_{R_C}}{I_C} = \frac{V_{CC} - V_C}{I_C}$$

with

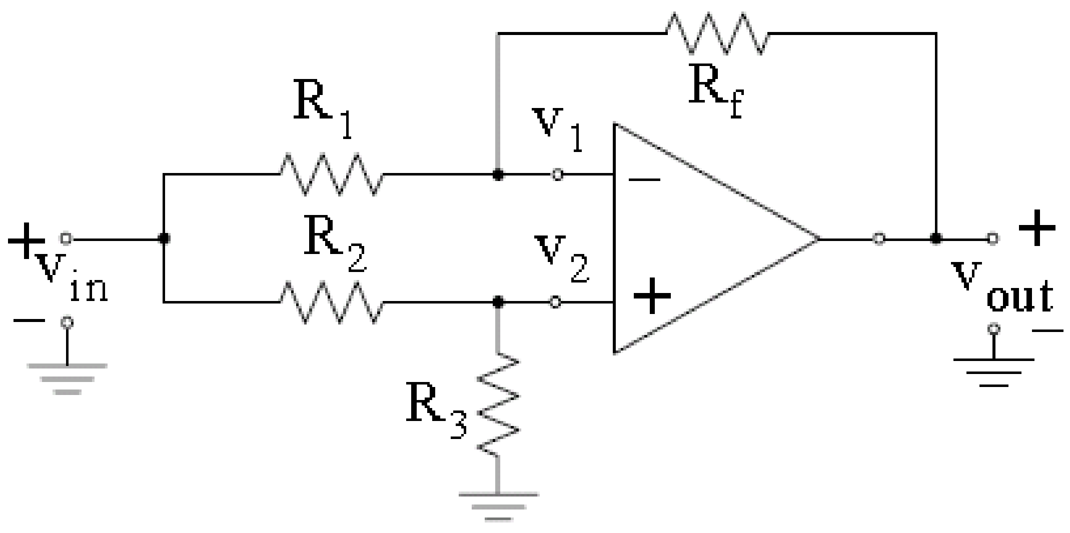
$$V_C = V_{CE} + V_E = 10\text{ V} + 2.4\text{ V} = 12.4\text{ V}$$

and

$$R_C = \frac{18\text{ V} - 12.4\text{V}}{2\text{mA}}$$
$$= \mathbf{2.8\text{ k}\Omega}$$

The nearest standard commercial values to R_1 are 82 and 91 kΩ. However, using the series combination of standard values of 82 kΩ and 4.7 kΩ = 86.7 kΩ would result in a value very close to the design level.

Yandaki devre verildiğine göre;
devrenin kazancını (A_v), R_1, R_2, R_3 ve R_f cinsinden bulunuz



Yandaki tranzistörlü devrede **R_B= 470 kΩ** , **R_C = 3 kΩ** , **β = 100** ve **r_0 = 50 kΩ** olarak verildiğine göre;

(a) **I_B**, **I_E** ve **r_e** değerlerini bulunuz.
(b) Giriş direncini (**Z_i**) bulunuz.
(c) Çıkış direncini (**Z_o**) bulunuz.
(b) Devrenin kazancını (**A_v**) bulunuz.