1.41

(a) $I_{D1} = I_{D2} = 1 \text{ mA}$

(i) $$V_{D1} = V_{D2} = (0.026)\ln\left(\frac{10^{-3}}{10^{-13}}\right) = 0.599 \text{ V}$$

(ii) $$V_{D1} = (0.026)\ln\left(\frac{10^{-3}}{5\times10^{-14}}\right) = 0.617 \text{ V}$$

$$V_{D2} = (0.026)\ln\left(\frac{10^{-3}}{5\times10^{-13}}\right) = 0.557 \text{ V}$$

(b) $V_{D1} = V_{D2}$

(i) $$I_{D1} = I_{D2} = \frac{I_i}{2} = 0.5 \text{ mA}$$

$$V_{D1} = V_{D2} = (0.026)\ln\left(\frac{0.5\times10^{-3}}{10^{-13}}\right) = 0.581 \text{ V}$$

(ii) $$\frac{I_{D1}}{I_{D2}} = \frac{I_{S1}}{I_{S2}} = \frac{5\times10^{-14}}{5\times10^{-13}} = 0.10$$

So $I_{D1} = 0.10 I_{D2}$

$I_{D1} + I_{D2} = 1.1 I_{D2} = 1 \text{ mA}$

So $I_{D2} = 0.909 \text{ mA}, \quad I_{D1} = 0.0909 \text{ mA}$

Now

$$V_{D1} = (0.026)\ln\left(\frac{0.0909\times10^{-3}}{5\times10^{-14}}\right) = 0.554 \text{ V}$$

$$V_{D2} = (0.026)\ln\left(\frac{0.909\times10^{-3}}{5\times10^{-13}}\right) = 0.554 \text{ V}$$

1.42

(a) $$I_{D3} = \left(6\times10^{-14}\right)\exp\left(\frac{0.635}{0.026}\right) \Rightarrow 2.426 \text{ mA}$$

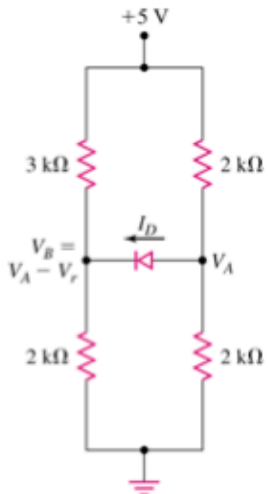
$$I_R = \frac{0.635}{1} = 0.635 \text{ mA}$$

$$I_{D1} = I_{D2} = 2.426 + 0.635 = 3.061 \text{ mA}$$

$$V_{D1} = V_{D2} = (0.026)\ln\left(\frac{3.061\times10^{-3}}{6\times10^{-14}}\right) = 0.641 \text{ V}$$

$$V_I = 2(0.641) + 0.635 = 1.917 \text{ V}$$

1.44



At node V_A:

(1) $\dfrac{5-V_A}{2} = I_D + \dfrac{V_A}{2}$

At node $V_B = V_A - V_\gamma$

(2) $\dfrac{5-(V_A - V_\gamma)}{2} + I_D = \dfrac{(V_A - V_\gamma)}{2}$

So $\dfrac{5-(V_A - V_\gamma)}{3} + \left[\dfrac{5-V_A}{2} - \dfrac{V_A}{2}\right] = \dfrac{V_A - V_\gamma}{2}$

Multiply by 6:

$$10 - 2(V_A - V_\gamma) + 15 - 6V_A = 3(V_A - V_\gamma)$$

$$25 + 2V_\gamma + 3V_\gamma = 11V_A$$

If the diode is assumed ON (conducting),

$$V_D = V_\gamma = V_A - V_B = 0\ V$$

$$V_A = \frac{25\ V}{11} = 2.273\ V$$

$$I_D = \frac{5\ V - V_A}{2\ k\Omega} - \frac{V_A}{2\ k\Omega} = 2.5\ mA - \frac{2.273\ V}{1\ k\Omega} = 227\ \mu A$$

Since $I_D > 0$ A, the diode is ON, as assumed.

Comment: A more efficient solution approach involves connecting the appropriate Thevenin equivalent circuit (voltage source and resistance) to each side of the diode. This results in a single-loop circuit that can be analyzed to determine the diode's voltage and current.

1.47

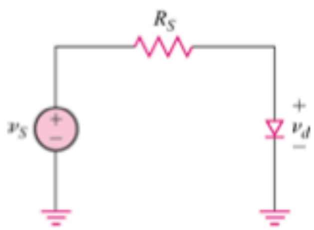
(a) (i) $I = \frac{5-0.7}{20} = 0.215$ mA, $V_O = 0.7$ V

(b) (i) $I = \frac{5-0.7-(-5)}{40} = 0.2325$ mA, $V_O = (0.2325)(20) - 5 = -0.35$ V

(c) (i) $I = \frac{2-0.7-(-8)}{25} = 0.372$ mA, $V_O = 2 - (0.372)(5) = 0.14$ V

(d) (i) $I = 0$, $V_O = -5$ V

1.53



a. diode resistance $r_d = V_T/I$

$$v_d = \left(\frac{r_d}{r_d + R_S}\right) v_S = \left(\frac{V_T/I}{\frac{V_T}{I} + R_S}\right) v_S$$

$$v_d = \left(\frac{V_T}{V_T + IR_S}\right) v_s = v_o$$

b. $R_S = 260\Omega$

$I = 1$ mA, $\frac{v_0}{v_S} = \left(\frac{V_T}{V_T + IR_S}\right) = \frac{0.026}{0.026 + (1)(0.26)} \Rightarrow \underline{\frac{v_0}{v_S} = 0.0909}$

$I = 0.1$ mA, $\frac{v_0}{v_s} = \frac{0.026}{0.026 + (0.1)(0.26)} \Rightarrow \underline{\frac{v_0}{v_S} = 0.50}$

$I = 0.01$ mA. $\frac{v_0}{v_S} = \frac{0.026}{0.026 + (0.01)(0.26)} \Rightarrow \underline{\frac{v_0}{v_S} = 0.909}$

1.58

(a) $I_Z = \dfrac{10-6.8}{0.5} = 6.4 \text{ mA}$

$P = I_Z V_Z = (6.4)(6.8) = 43.5 \text{ mW}$

(b) $I_Z = (0.1)(6.4) = 0.64 \text{ mA}$

$I_L = 6.4 - 0.64 = 5.76 \text{ mA}$

$I_L = \dfrac{V_Z}{R_L} \Rightarrow R_L = \dfrac{V_Z}{I_Z} = \dfrac{6.8}{5.76} = 1.18 \text{ k}\Omega$

2.3

(a) $\upsilon_S = 120\sqrt{2}\left(\dfrac{1}{10}\right) = 16.97 \text{ V (peak)}$

$\upsilon_O(peak) = 16.27 \text{ V}$

(b) $i_D(peak) = \dfrac{16.27}{2} = 8.14 \text{ mA}$

(c) $\upsilon_O = 16.97 \sin \omega t - 0.7$

$$\sin(\omega t)_1 = \frac{0.7}{16.97} = 0.04125 \Rightarrow (\omega t)_1 = 2.364°$$

$$(\omega t)_2 = 180 - 2.364 = 177.64°$$

$$\% = \left(\frac{177.64 - 2.364}{360}\right) \times 100\% = 48.7\%$$

(d)

$$\upsilon_O(avg) = \frac{1}{2\pi} \int_{0.01313\pi}^{0.9869\pi} [16.97 \sin x - 0.7]dx$$

$$= \frac{1}{2\pi}\left[(-16.97)\cos x \Big|_{0.01313\pi}^{0.9869\pi} - 0.7x \Big|_{0.01313\pi}^{0.9869\pi}\right]$$

$$= \frac{1}{2\pi}[(-16.97)(-0.99915 - 0.99915) - 0.7(0.9738\pi)]$$

$$\upsilon_O(avg) = 5.06 \text{ V}$$

(e) $i_D(avg) = \dfrac{\upsilon_O(avg)}{2} = \dfrac{5.06}{2} = 2.53 \text{ mA}$

2.6

(a) $\upsilon_S(peak) = 12 + 0.7 = 12.7\text{ V}$

$$\frac{N_1}{N_2} = \frac{120\sqrt{2}}{12.7} = 13.4$$

(b) $R = \dfrac{12}{0.2} = 60\,\Omega$

$$C = \frac{V_M}{2fRV_r} = \frac{12}{2(60)(60)(0.25)} \Rightarrow 6667\ \mu\text{F}$$

(c) $PIV = 2\upsilon_S(\max) - V_\gamma = 2(12.7) - 0.7 = 24.7\text{ V}$

2.8

(a)

$$v_s(\max) = 12 + 2(0.7) = 13.4\text{ V}$$

$$v_s(\text{rms}) = \frac{13.4}{\sqrt{2}} \Rightarrow \underline{v_s(\text{rms}) = 9.48\text{ V}}$$

(b)

$$V_r = \frac{V_M}{2f\ R_C} \Rightarrow C = \frac{V_M}{2f\ V_r R}$$

$$C = \frac{12}{2(60)(0.3)(150)} \Rightarrow \underline{C = 2222\ \mu\text{F}}$$

(c)

$$i_d,\text{ peak} = \frac{V_M}{R}\left[1 + \pi\sqrt{\frac{2V_M}{V_r}}\right]$$

$$= \frac{12}{150}\left[1 + \pi\sqrt{\frac{2(12)}{0.3}}\right]$$

$$\underline{i_d,\text{ peak} = 2.33\text{ A}}$$

2.16

(a) $\upsilon_S = 9 + 2(0.8) = 10.6\text{ V}$

$$\frac{N_1}{N_2} = \frac{120\sqrt{2}}{10.6} = 16$$

(b)

$$R = \frac{V_O}{I_L} = \frac{(9-0.1)V}{100\,mA} = 89\,\Omega$$

$$C = \frac{V_M}{2fRV_r} = \frac{9}{2(60)(89)(0.2)} \Rightarrow 4.21\,mF$$

(c) $i_D(peak) = \frac{V_M}{R}\left(1 + \pi\sqrt{\frac{2V_M}{V_r}}\right) = \frac{9}{89}\left(1 + \pi\sqrt{\frac{2(9)}{0.2}}\right) = 3.11\,A$

(a) $i_D(avg) = \frac{1}{\pi}\sqrt{\frac{2V_r}{V_M}} \cdot \frac{V_M}{R}\left(1 + \frac{\pi}{2}\sqrt{\frac{2V_M}{V_r}}\right) = \frac{1}{\pi}\sqrt{\frac{2(0.2)}{9}}\left(\frac{9}{89}\right)\left(1 + \frac{\pi}{2}\sqrt{\frac{2(9)}{0.2}}\right)$

$$i_D(avg) = 0.108\text{ A}$$

(e) PIV $= \upsilon_S(\max) - V_\gamma = 10.6 - 0.8 = 9.8\text{ V}$