Practice problems

–P5.63, P5.68, P5.77, P5.85
–P6.23, P6.26
–P10.7, P10.8, P10.37

P5.63* $\mathbf{I} = \frac{1000\sqrt{2}\angle 0^\circ}{100} + \frac{1000\sqrt{2}\angle 0^\circ}{-j265.3} = 14.14 + j5.331 = 15.11\angle 20.66^\circ$

$P = V_{rms} I_{rms} \cos\theta = 10 \text{ kW}$

$Q = V_{rms} I_{rms} \sin\theta = -3.770 \text{ kVAR}$

$\text{Apparent power} = V_{rms} I_{rms} = 10.68 \text{ kVA}$

$\text{Power factor} = \cos(20.66^\circ) = 0.9357 = 93.57\% \text{ leading}$

P5.68 This is a capacitive load because the reactance is negative.

$Z = 40 - j30 = 50\angle -36.87^\circ \quad I = \frac{\mathbf{V}}{Z} = \frac{1500\sqrt{2}\angle 30^\circ}{50\angle -36.87^\circ} = 30\sqrt{2}\angle 66.87^\circ$

$\mathbf{S} = \frac{1}{2}\mathbf{VI^*} = 45\angle -36.87^\circ = 36 - j27 \text{ kVA}$

$P = I_{rms}^2 R = (30)^2 40 = 36 \text{ kW}$

$Q = I_{rms}^2 X = (30)^2(-30) = -27 \text{ kVAR}$

$\theta = -36.87^\circ$

$\text{power factor} = \cos(\theta) = 80\%$

$\text{apparent power} = V_{rms} I_{rms} = 1500 \times 30 = 45 \text{ KVA}$

P5.77 $P = \frac{(V_{rms})^2}{R} = \frac{1500^2}{25} = 90 \text{ kW}$

$Q = Q_L + Q_C = \frac{(V_{rms})^2}{X_L} + \frac{(V_{rms})^2}{X_C} = \frac{1500^2}{100} + \frac{1500^2}{(-250)}$

$Q = 13.5 \text{ kVAR}$

$\text{Apparent power} = \sqrt{P^2 + Q^2} = 91.01 \text{ kVA}$

$\text{Power factor} = \frac{P}{\text{Apparent power}} = 98.89\% \text{ lagging}$

P5.85 Under open-circuit conditions, we have

$$\mathbf{V}_t = \mathbf{V}_{ab-oc} = 10.00\angle 0^\circ \text{ V}$$

With the source zeroed, we look back into the terminals and see

$$Z_t = 4 - j3 \ \Omega$$

Next, the Norton current is

$$\mathbf{I}_n = \frac{\mathbf{V}_t}{Z_t} = 2\angle -36.87^\circ \text{ A}$$

P6.23 The time constant is given by $\tau = RC$ and the half-power frequency is $f_B = \dfrac{1}{2\pi RC}$. Thus, we have $f_B = \dfrac{1}{2\pi\tau}$.

P6.26* The half-power frequency of the filter is

$$f_B = \frac{1}{2\pi RC} = 500 \text{ Hz}$$

The transfer function is given by Equation 6.9 in the text:

$$H(f) = \frac{1}{1 + j(f/f_B)}$$

The given input signal is

$$v_{in}(t) = 5\cos(500\pi t) + 5\cos(1000\pi t) + 5\cos(2000\pi t)$$

which has components with frequencies of 250, 500, and 1000 Hz.

Evaluating the transfer function for these frequencies yields:

$$H(250) = \frac{1}{1 + j(250/500)} = 0.8944\angle -26.57^\circ$$

$$H(500) = 0.7071\angle -45^\circ$$

$$H(1000) = 0.4472\angle -63.43^\circ$$

Applying the appropriate value of the transfer function to each component of the input signal yields the output:

$$v_{out}(t) = 4.472\cos(500\pi t - 26.57^\circ) + 3.535\cos(1000\pi t - 45^\circ)$$
$$+ 2.236\cos(2000\pi t - 63.43^\circ)$$

P10.7* The approximate form of the Shockley Equation is $i_D = I_s \exp(v_D / nV_T)$.

Taking the ratio of currents for two different voltages, we have

$$\frac{i_{D1}}{i_{D2}} = \frac{\exp(v_{D1}/nV_T)}{\exp(v_{D2}/nV_T)} = \exp\left[(v_{D1} - v_{D2})/nV_T\right]$$

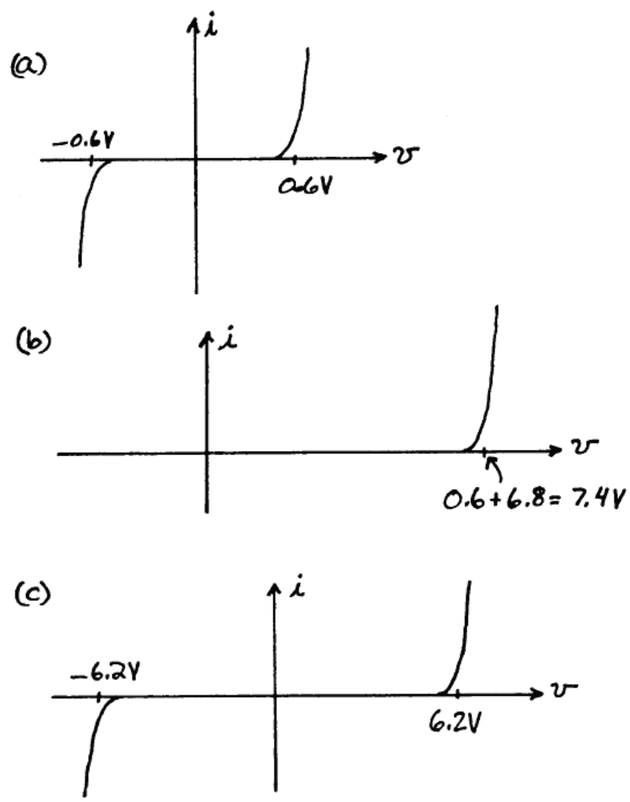
Solving for n we obtain:

$$n = \frac{v_{D1} - v_{D2}}{V_T \ln(i_{D1}/i_{D2})} = \frac{0.600 - 0.680}{0.026 \ln(1/10)} = 1.336$$

Then, we have

$$I_s = \frac{i_{D1}}{\exp(v_{D1}/nV_T)} = 3.150 \times 10^{-11}\ A$$

P10.8*



P10.37 (a) The diode is on, $V = 0$ and $I = \frac{10}{5000} = 2\text{ mA}$.

(b) The diode is off, $I = 0$ and $V = 5\text{ V}$.

(c) The diode is on, $V = 0$ and $I = \frac{6}{3000} = 2\text{ mA}$.

(d) The diode is on, $I = 3\text{ mA}$ and $V = 6\text{ V}$.