1. *(Reading Assignment)*

Sections 6.2, 6.3, 6.6 and 6.8 of Chapter 6 as well as sections 11.1 and 11.2 of Chapter 11: Hambley 3rd edition.

2. Problem 5.53

Since the reactance is negative, the load is capacitive

Power delivered is $P_d = I_{rms}{}^2 \times R = (15)^2 \times 100 = 22.5kW$

Reactive power is $P_r = I_{rms}{}^2 \times X = (15)^2 \times (-50) = -11.25kVAR$

Power factor is

$$P_f = \cos(q) = \cos\left[\tan^{-1}\left(\frac{P_r}{P_d}\right)\right] = \cos\left[\tan^{-1}(-0.5)\right] = \cos[26.57°] = 89.44\%$$

3. Problem 5.56

First let us compute the rms current (I_{rms})

$$I = \frac{240\sqrt{2}\angle 50° - 220\sqrt{2}\angle 30°}{1+j2} = 52.\angle 52.71° \Rightarrow I_{rms} = 36.8A$$

Knowing the current (I_{rms}), we can now compute the power for each source (absorbed or delivered)

- Power delivered by source A

  $P_A = 240 I_{rms} \times \cos(50 - 52.71) = 8.8kW$

  $Q_A = 240 I_{rms} \times \sin(50 - 52.71) = -0.42KVAR$

- Power dissipated/absorbed by source B

  $P_B = 220 I_{rms} \times \cos(30 - 52.71) = 7.5kW$

  $Q_B = 220 I_{rms} \times \sin(30 - 52.71) = -3.1KVAR$

- Power dissipated/absorbed by the resistor

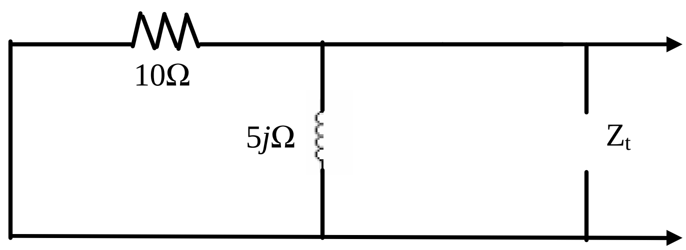
  $P_R = I_{rms}{}^2 \times R = (36.8)^2 \times 1\Omega = 1.35kW$

- Power dissipated/absorbed by the inductor

  $P_r = I_{rms}{}^2 \times X = (36.8)^2 \times (2\Omega) = 2.7kVAR$

4. Problem 5.68

We are asked to find the Thevenin and Norton of the circuit given:
After Zeroing the sources, we have:



Now we can compute the Thevenin impedance as follow:

$$Z_t = \frac{1}{1/10 + 1/\,j5} = 4.472\angle 63.43° = 2 + j4$$

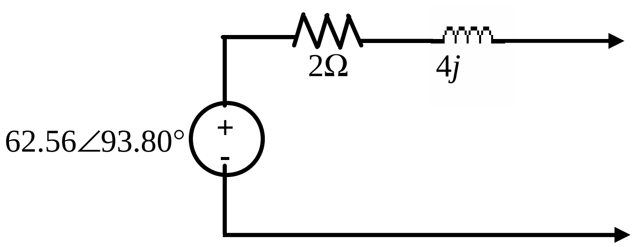
Using KCL to compute for the current flowing at the upper end of the current source under open circuit conditions, we get:

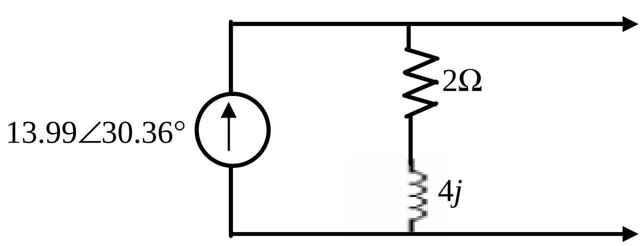
$\frac{V_{OC} - 100\angle 45°}{10} + \frac{V_{OC}}{j5} = 5$, Solving for V_{OC}, we get

$$V_t = V_{OC} = 62.56\angle 93.80°$$

And $I_t = \frac{V_t}{Z_t} = 13.99\angle 30.36°$

Therefore, the Thevenin and Norton equivalences are given by:





- The maximum power that this circuit can deliver to a load with complex impedance is computed as follow:

$$P_{load} = I_{rms-load}^{\ 2} \times Z_{load}$$

Given $Z_{load} = 2 - j4$ and $I_{load} = \frac{V_t}{Z_t + Z_{load}} = \frac{62.56\angle 93.80°}{2 + j4 + 2 - j4} = 15.64\angle 93.80°$

$$P_{load} = I_{rms-load}^{\ 2} \times Z_{load} = 244.6W$$

- The maximum power that this circuit can deliver to a load with complex impedance is computed as follow:

$$P_{load} = I_{rms-load}{}^2 \times Z_{load}$$

Given $Z_{load} = R_{load} = 4.472$ & $I_{load} = \dfrac{V_t}{Z_t + Z_{load}} = \dfrac{62.56\angle 93.80°}{2 + j4 + 4.472} = 8.223\angle -62.08°$

$$P_{load} = I_{rms-load}{}^2 \times R_{load} = 151.2W$$

5. Problem 6.9

The phasors for the steady state input and output of this filter are given as follow:
$V_{in} = 2\angle -25°$ and $V_{out} = 1\angle 20°$
Therefore, the complex value of the filter transfer function at f=5,000Hz will be given as:

$$H(5{,}000) = \frac{V_{out}}{V_{in}} = 0.5\angle 45°$$

6. Problem 6.12

Given the input signal provided as
$V_{in}(t) = 1 + 2\cos(2000pt) + 3\sin(3000pt) + 4\cos(4000pt)$
One can extract the following frequency components: 0, 1000, 1500 and 2000 Hz
The transfer function for each of these frequencies is compute by dividing the corresponding output to the input. This results in the following:

$$H(0) = \frac{3}{1} = 3, \qquad H(1{,}000) = \frac{4\angle 30°}{2\angle 0°} = 2\angle 30°$$

$$H(1{,}500) = \frac{3\angle 0°}{3\angle -90°} = 1\angle 90°, \quad H(2{,}000) = \frac{0}{4\angle 0°} = 0$$

7. Problem 6.19

Given the input signal to be $V_{in}(t) = 1 + 2\cos(2000pt) + 3\sin(3000pt) + 4\cos(4000pt)$ with frequencies components of 250, 500 and 1000 Hz

The half power of the filter frequency is $f_b = \frac{1}{2pRC} = 500Hz$

The transfer function is given by equation 6.9 in the text book $H(f) = \frac{1}{1 + \left(f / f_b\right)}$

After computing the transfer function for the different component frequencies of V_{in}, we get the following:

$$H(250) = \frac{1}{1 + j(250/500)} = 0.89\angle -26.57°$$

$$H(500) = \frac{1}{1 + j(500/500)} = 0.707\angle -45°$$

$$H(1000) = \frac{1}{1 + j(1000/500)} = 0.44\angle -63.43°$$

Applying the appropriate value of the transfer function to each of these component of the input signal allows us to an expression for the output signal which results to:

$$V_{out}(t) = 4.472\cos(500pt - 26.57°) + 3.535\cos(1000pt - 45°) + 2.236\cos(2000pt - 63.43°)$$

8. Problem 6.33

To convert to decibels, we need to take 20 times the common logarithm of a transfer function. Therefore, we have:

$20\log(0.5) = -6.021dB$ and $20\log(2) = +6.021dB$