Chapter 11, Solution 12.

For the circuit shown in Fig. 11.44, determine the load impedance Z for maximum power transfer (to Z). Calculate the maximum power absorbed by the load.

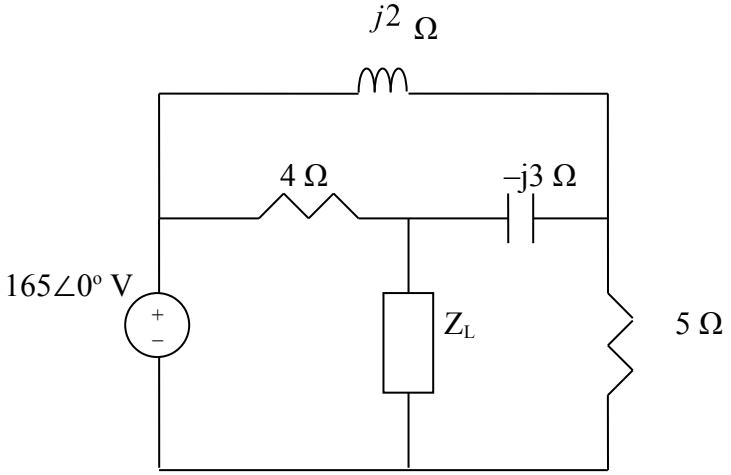
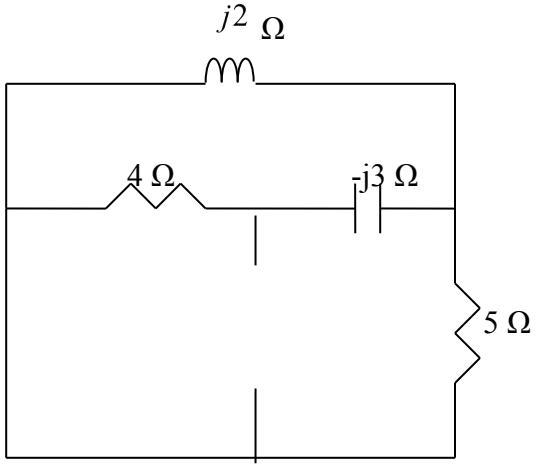


Figure 11.44
For Prob. 11.12.

Solution

We find the Thevenin impedance using the circuit below.

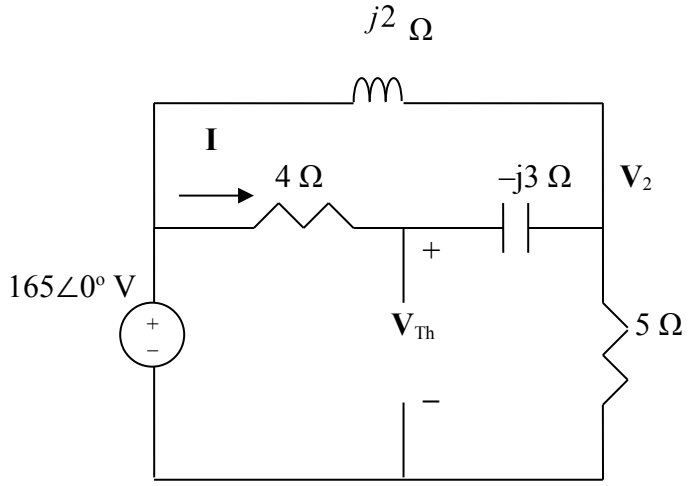


We note that the inductor is in parallel with the 5-Ω resistor and the combination is in series with the capacitor. That whole combination is in parallel with the 4-Ω resistor. Thus,

$$Z_{Thev} = \frac{4\left(-j3 + \frac{5xj2}{5+j2}\right)}{4 - j3 + \frac{5xj2}{5+j2}} = \frac{4(0.6896 - j1.2758)}{4.69 - j1.2758} = \frac{4(1.4502\angle -61.61°)}{4.86\angle -15.22°}$$
$$= 1.1936\angle -46.39°$$

$Z_{Thev} = 0.8233 - j0.8642$ or $Z_L =$ **[823.3 + j864.2] mΩ**.

We obtain V_{Th} using the circuit below. We apply nodal analysis.



$$\frac{V_2 - 165}{4 - j3} + \frac{V_2 - 165}{j2} + \frac{V_2 - 0}{5} = 0$$
$$(0.16 + j0.12 - j0.5 + 0.2)V_2 = (0.16 + j0.12 - j0.5)165$$
$$(0.5235\angle -46.55°)V_2 = (0.4123\angle -67.17°)165 \qquad 4.125$$

Thus, $V_2 = 129.94\angle -20.62°V = 121.62 - j45.76$

$I = (165 - V_2)/(4 - j3) = (165 - 121.62 + j45.76)/(4 - j3)$
$= (63.06\angle 46.52°)/(5\angle -36.87°) = 12.613\angle 83.39° = 1.4519 + j12.529$

$V_{Thev} = 165 - 4I = 165 - 5.808 - j50.12 = [159.19 - j50.12]$ V
$= 166.89\angle -17.48°V$

We can check our value of V_{Thev} by letting $V_1 = V_{Thev}$. Now we can use nodal analysis to solve for V_1.

At node 1,

$$\frac{V_1 - 165}{4} + \frac{V_1 - V_2}{-j3} + \frac{V_2 - 0}{5} = 0 \rightarrow (0.25 + j0.3333)V_1 + (0.2 - j0.3333)V_2 = 41.25$$

At node 2,

$$\frac{V_2 - V_1}{-j3} + \frac{V_2 - 165}{j2} = 0 \rightarrow -j0.3333V_1 + (-j0.1667)V_2 = -j82.5$$

```
>> Y=[(0.25+0.3333i),-0.3333i;-0.3333i,(0.2-0.1667i)]

Y =

  0.2500 + 0.3333i        0 - 0.3333i
      0 - 0.3333i   0.2000 - 0.1667i

>> I=[41.25;–82.5i]

I =

  41.2500
       0 -20.0000i

>> V=inv(Y)*I

V =

  159.2221 – 50.1018i
  121.6421–45.7677i
```

Please note, these values check with the ones obtained above.

To calculate the maximum power to the load,

$|I_L| = (166.89/(2x0.8233)) = 101.34$ A

$P_{avg} = [(|I_L|_{rms})^2 0.8233]/2 =$ **4.228 mW**.