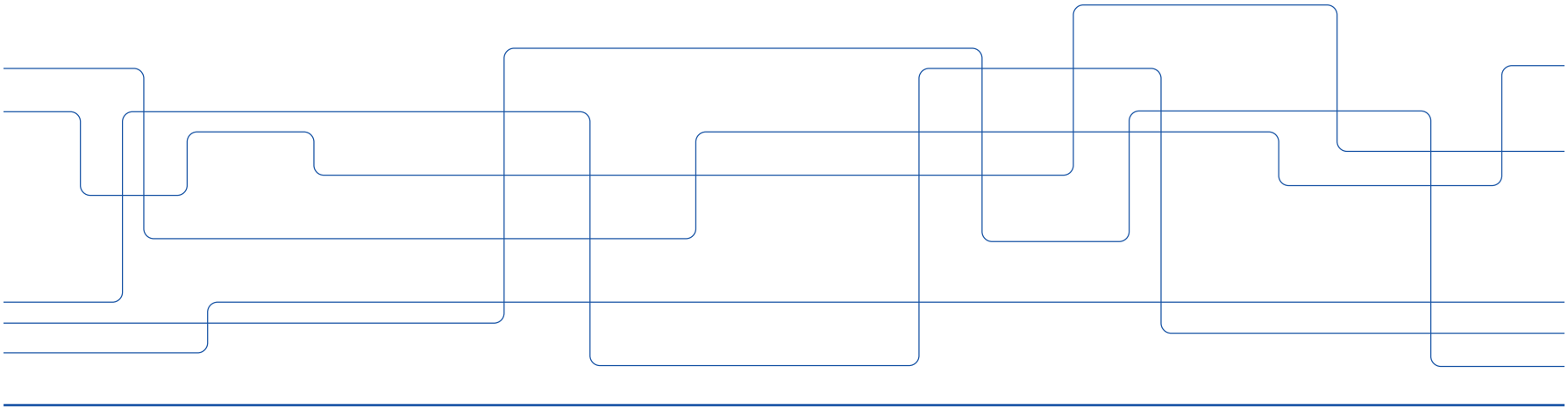
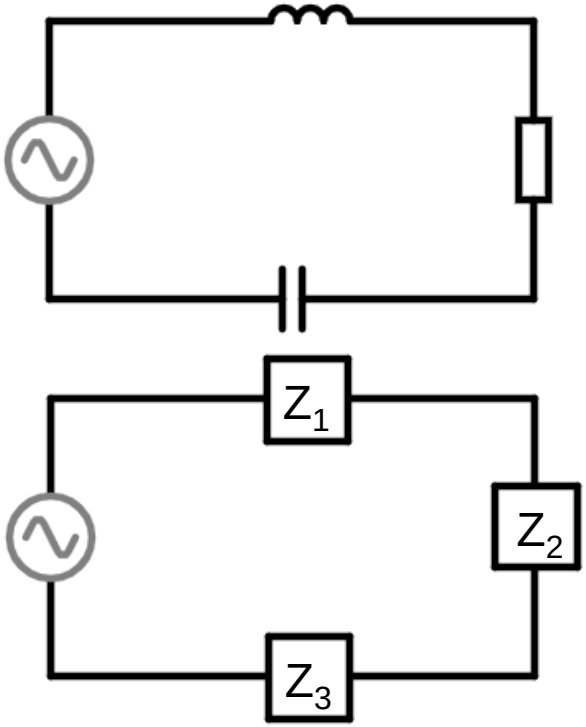
HE1027 Electrical Principals

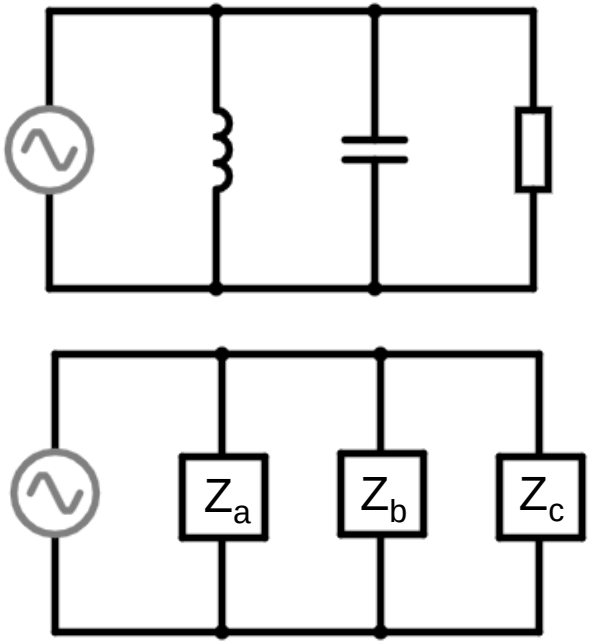
AC Circuits Analysis Methods and Theorems



Total Impedance Z_{Total}



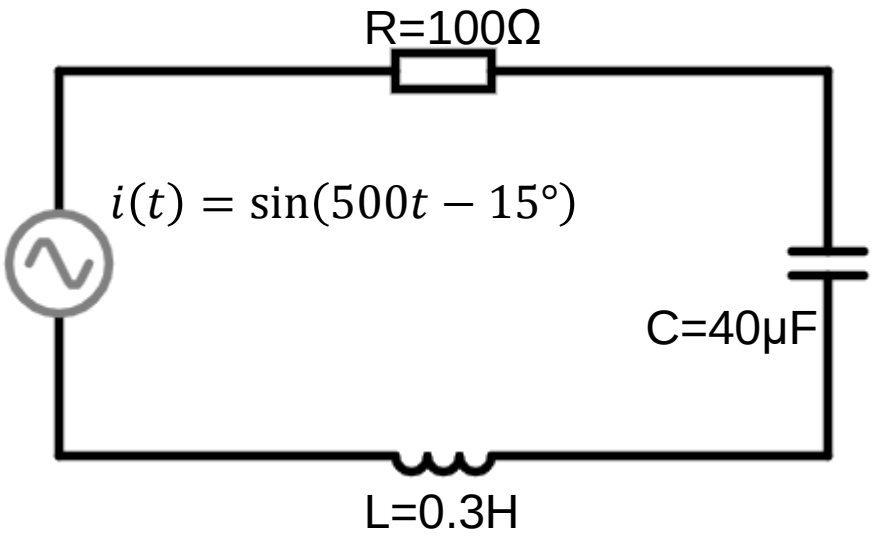
$$Z_{Total} = Z_1 + Z_2 + Z_3$$



$$\frac{1}{Z_{Total}} = \frac{1}{Z_a} + \frac{1}{Z_b} + \frac{1}{Z_c}$$

Example

Determine voltage e(t)



$I=0.707\angle -15°$

$\omega=500\ s^{-1}$

$Z_R=R=100\Omega$

$XC=1/\omega C$

$Z_C=-iX_C=-i/\omega C=-i/500*40^{-6}=-50i\ \Omega$

$Z_L=i\omega L=i*500*0.3=150i\ \Omega$

$Z_{total}=100-50i+150i=100+100i=141.42\angle 45°$

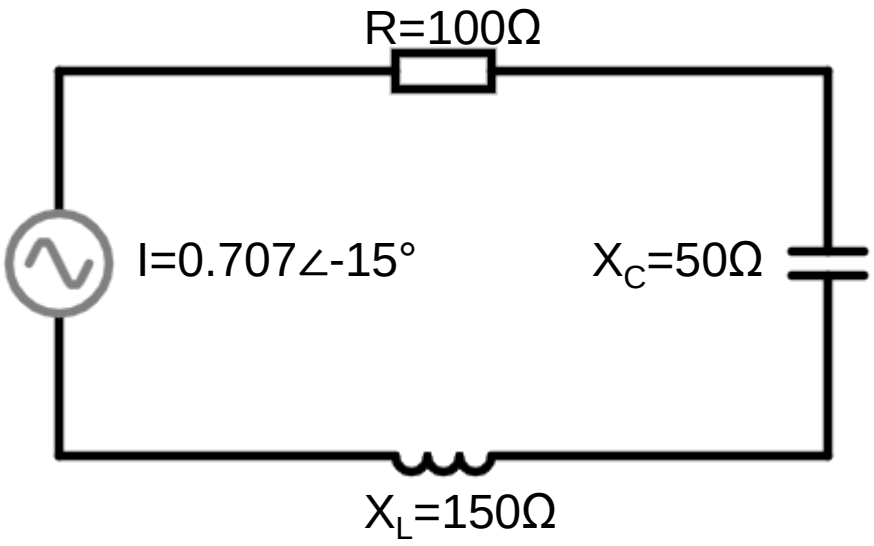
$E=I*Z_{total}=0.707\angle -15°*141.42\angle 45°=100\angle 30°$

$e(t)=141\sin(500t+30°)$

Same logic as for DC networks

Example

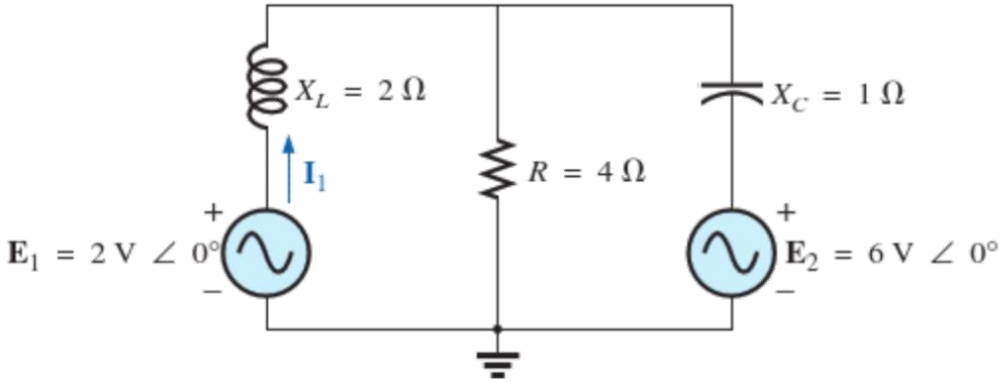
Determine voltage E



$$Z_{total}=100-50i+150i=100+100i=141.42\angle 45°$$

$$E=I*Z_{total}=0.707\angle -15°*141.42\angle 45°=100\angle 30°$$

Mesh analysis



I_1 loop

$$E_1\text{-}Z_L{*}I_1\text{-}Z_R(I_1\text{-}I_2)=0$$

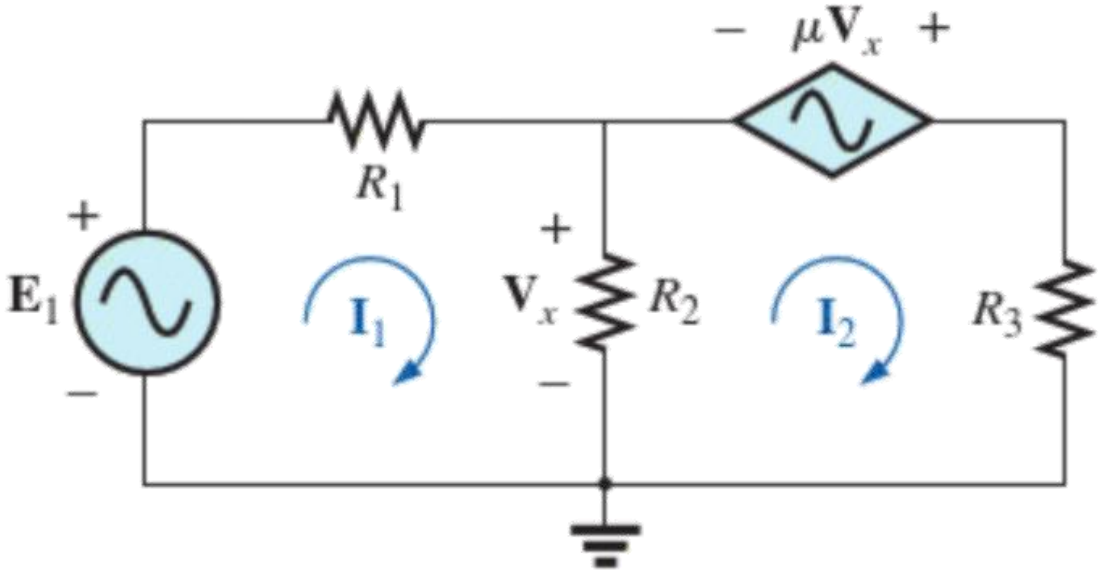
$$2 - 2\angle 90°{*}I_1\text{-}4I_1+4I_2=0$$

I_2 loop

$$-Z_R(I_2\text{-}I_1)\text{-}Z_C{*}I2\text{-}E_2=0$$

$$-4I_2+4I_1\text{-}1\angle\text{-}90°{*}I_1\text{-}6=0$$

Mesh analysis with depended source



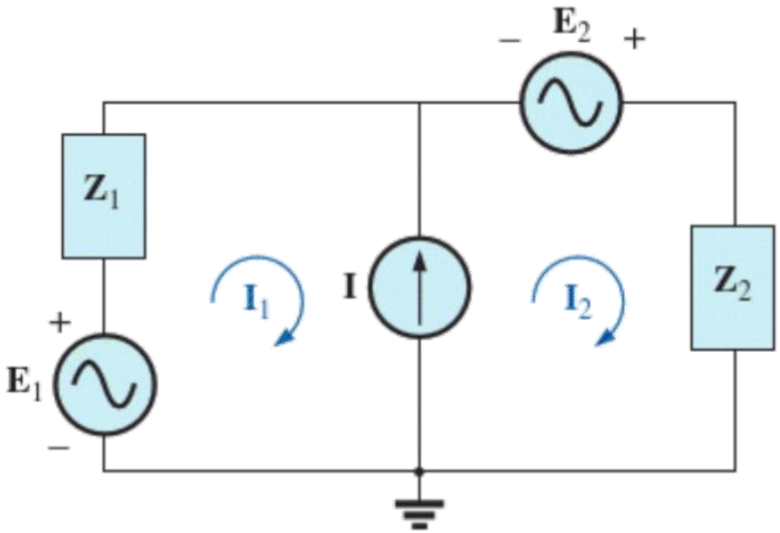
I_1 loop

$E_1-R_1*I_1-R2(I_1-I_2)=0$

I_2 loop

$-R_2(I_2-I_1)+\mu R_2(I_1-I_2)-R_3*I_2=0$

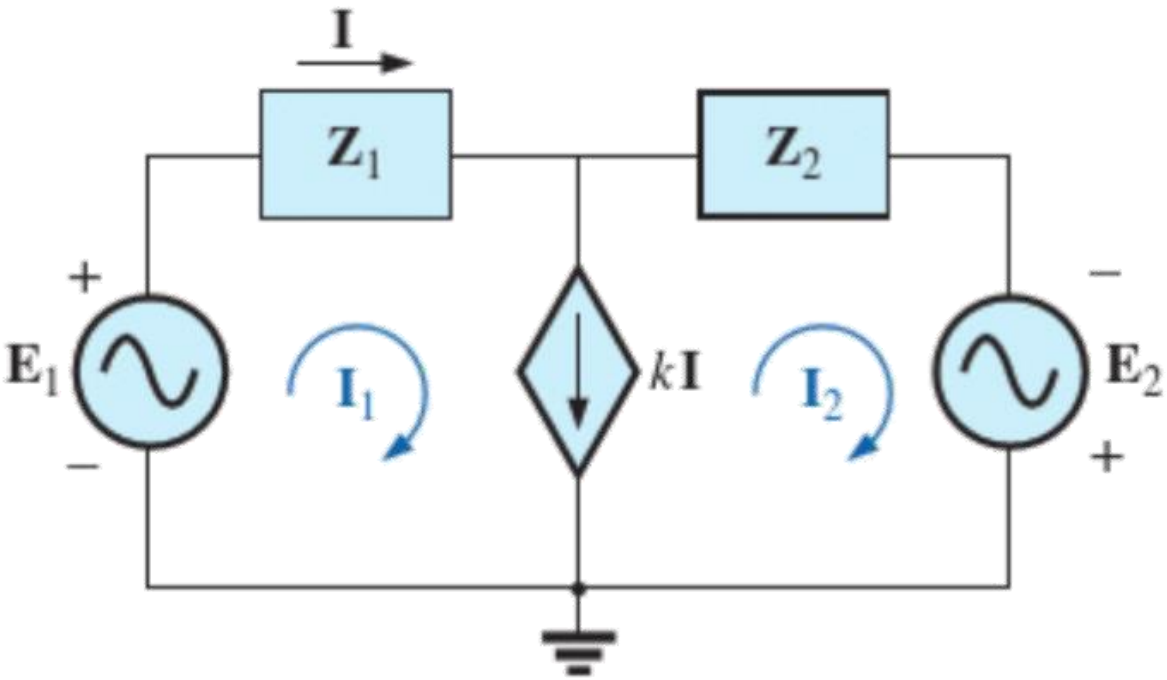
Supermesh



Supermesh: $I_1+I=I_2$

$E_1-Z_1*I_1+E_2-Z_2*I_2=0$

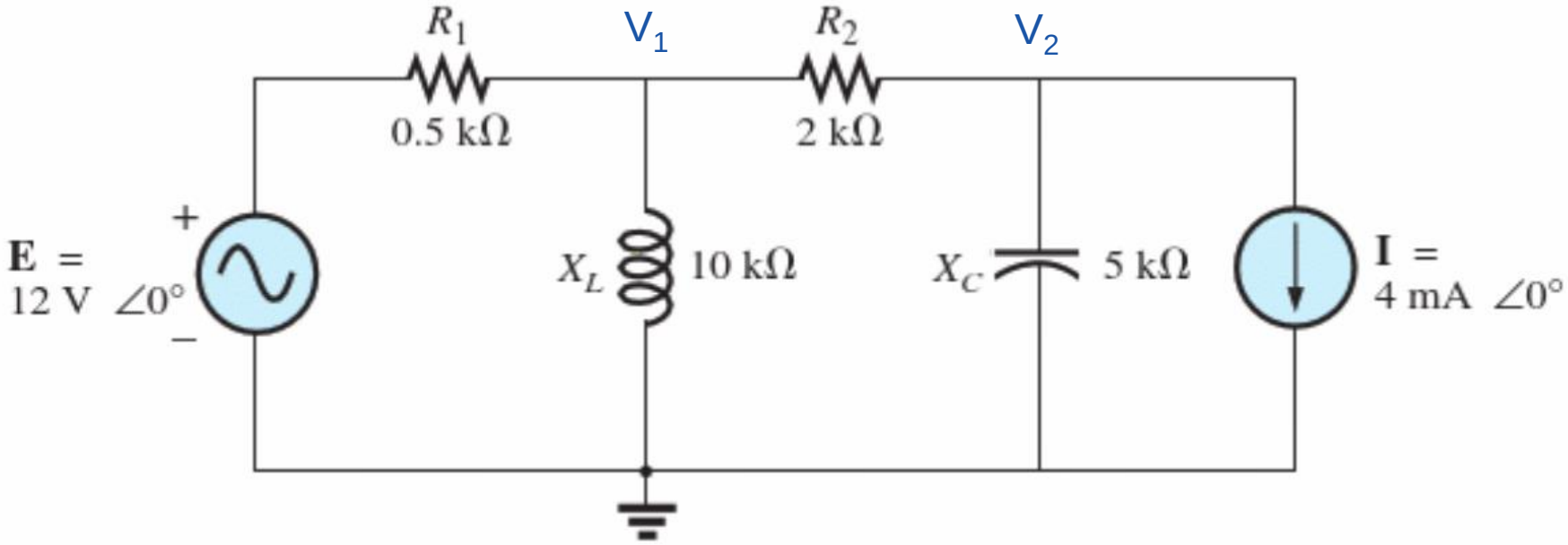
Supermesh with depended source



Supermesh: I_1-I_2=kI=kI_1

E_1-Z_1*I_1-Z_2*I_2+E_2=0

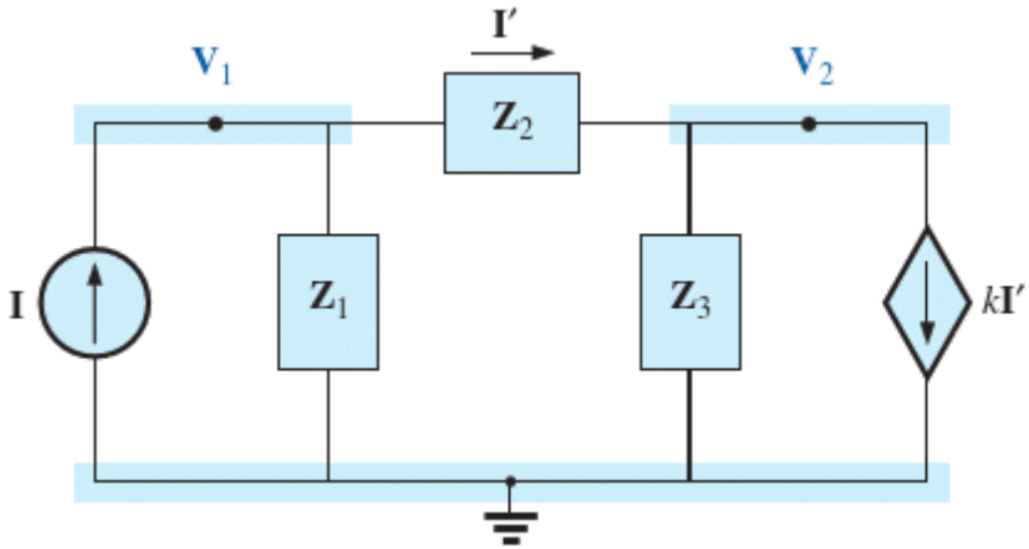
Nodal analysis



$$-\frac{V_1 - E}{R_1} - \frac{V_1}{Z_L} - \frac{V_1 - V_2}{R_2} = 0$$

$$\frac{V_1 - V_2}{R_2} - \frac{V_2}{Z_C} - I = 0$$

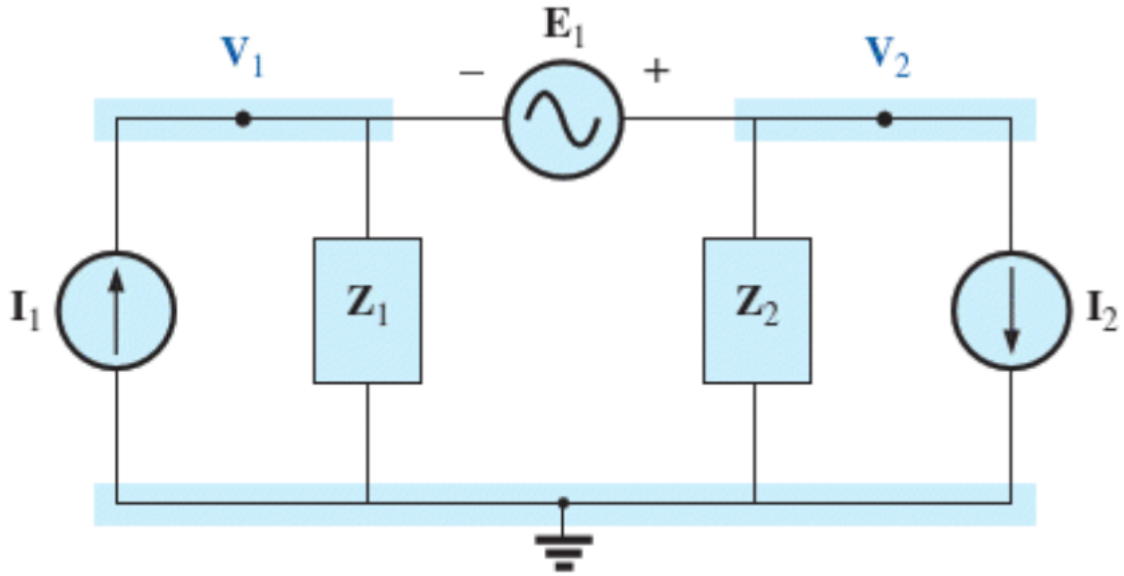
Nodal analysis with depended source



$$I - \frac{V_1}{Z_1} - \frac{V_1 - V_2}{Z_2} = 0$$

$$\frac{V_1 - V_2}{Z_2} - \frac{V_2}{Z_3} - k\frac{V_1 - V_2}{Z_2} = 0$$

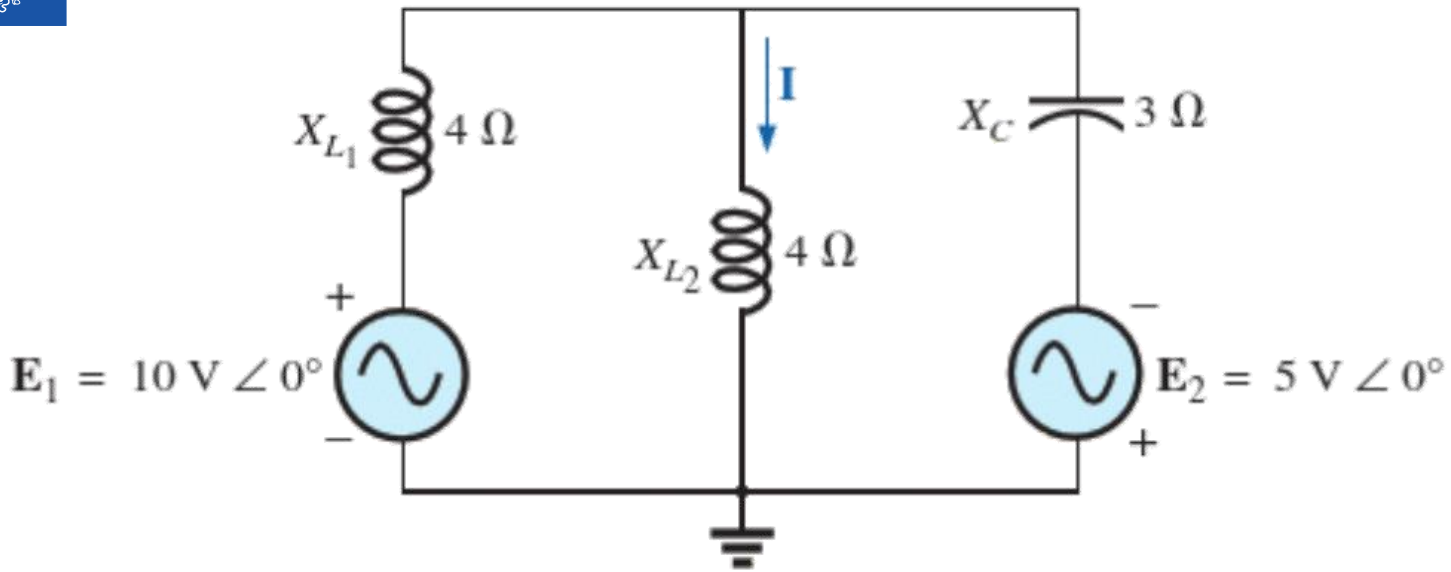
Supernode

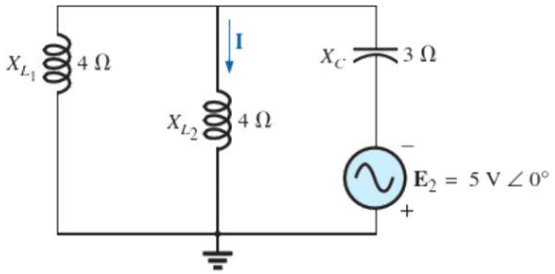


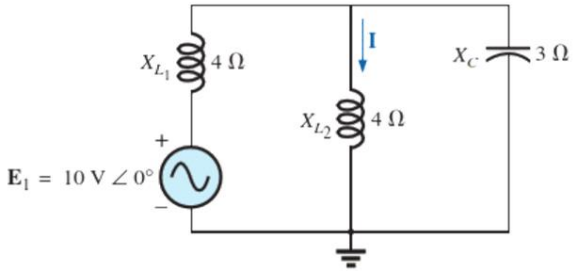
Supernode: V_2-V_1=E_1

$$I_1 - \frac{V_1}{Z_1} - \frac{V_2}{Z_2} - I_2 = 0$$

Superposition

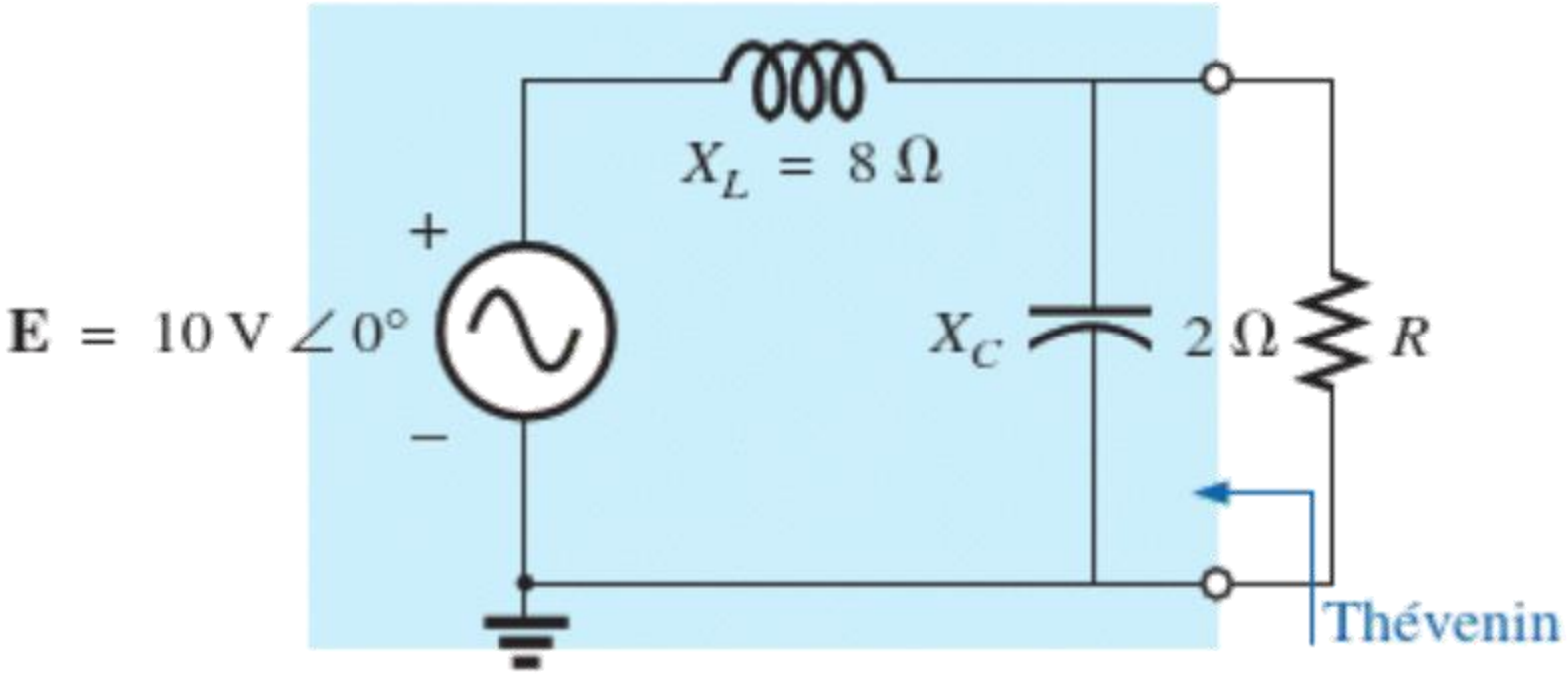






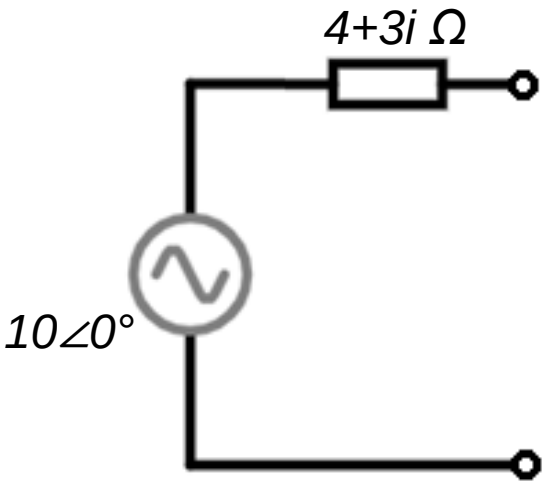
$$I_{Total} = \frac{E_2}{Z_{L_1}//Z_{L_2} + Z_C}$$

Thevenin Theorem

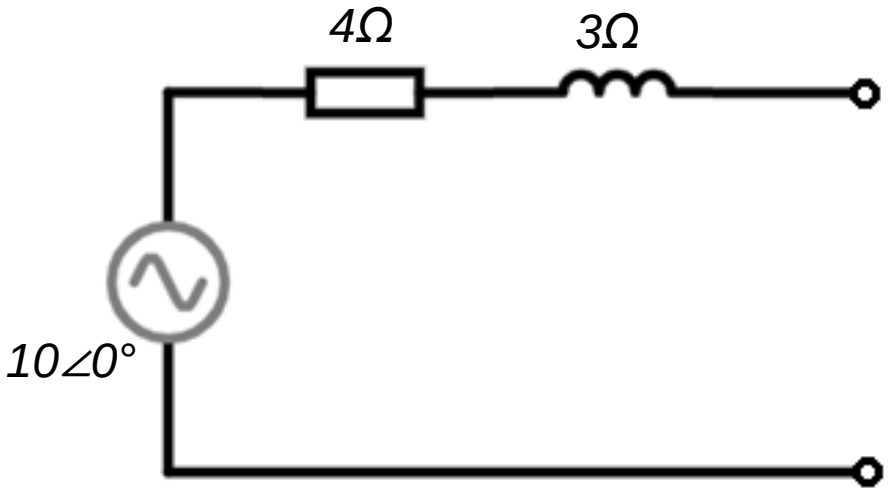


Example

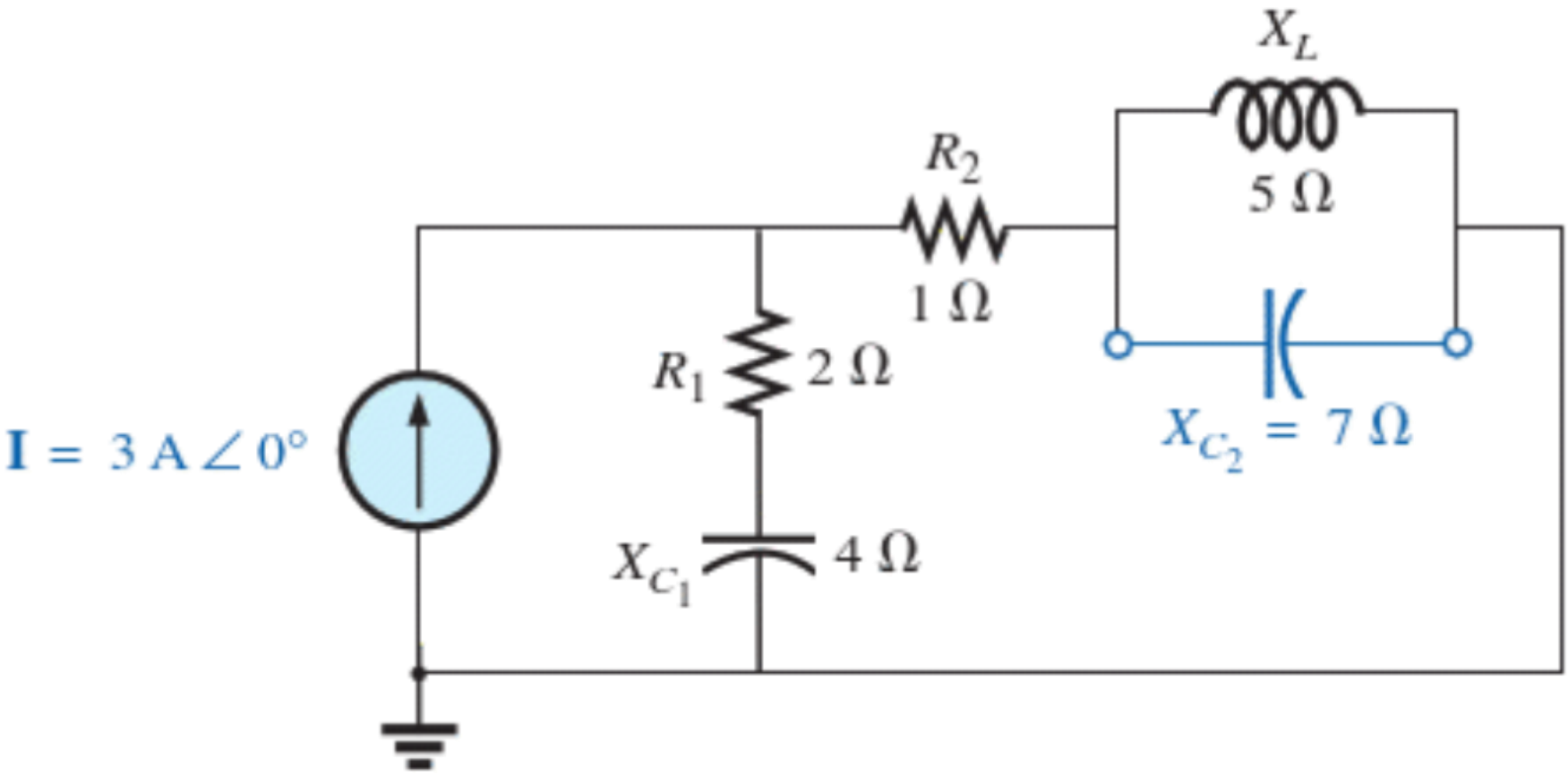
Draw a Thevenin equation circuit if E=10∠0° and RTh=4+3i Ω



OR



Norton's Theorem



Suggested reading

Introductory Circuit Analysis

- Kap 15: 15.1, **15.2 - 15.4**, 15.5, **15.6 - 15.10**
- Kap 16: **16.1 - 16.8**
- Kap 17: **17.2 - 17.3**
- Kap 18: **18.2 - 18.6**
- Kap 19: **19.2 - 19.5**

*suggestions in bold are more important

Suggested exercises

- Kap 15: 15, 19, 21, 33
- Kap 16: 9, 12
- Kap 17: 1, 5, 7
- Kap 18: 5, 9, 14, 19, 21, 25
- Kap 19: 1, 7, 13, 15, 17, 27, 35, 43, 47, 49