Frekans Uzayında Kirchhoff Kanunları

Kirchhoff Voltaj Kanunu: Kapalı bir yoldaki voltajların cebirsel toplamı 0'dır

$$v_1 + v_2 + \cdots + v_n = 0,$$

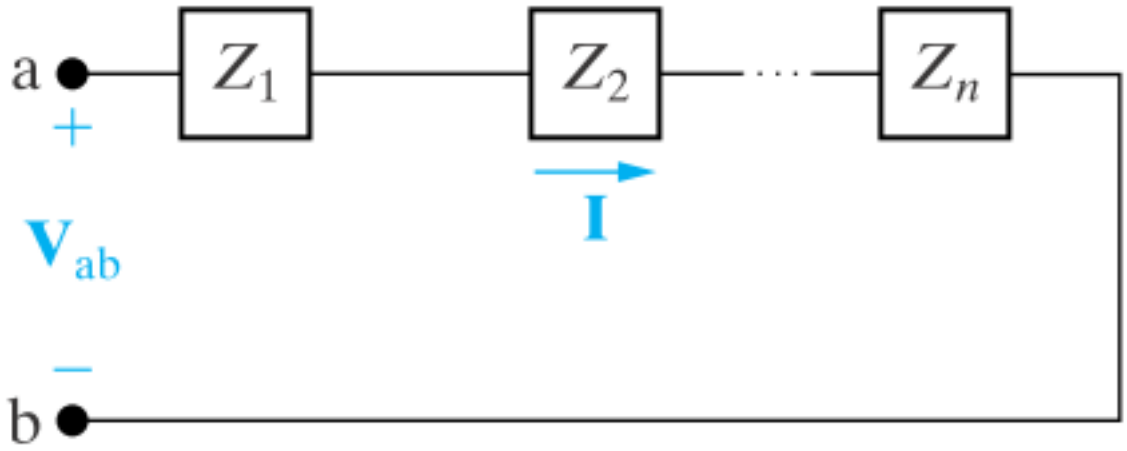
$$\mathbf{V}_1 + \mathbf{V}_2 + \cdots + \mathbf{V}_n = 0,$$

Kirchhoff Akım Kanunu: Bir düğümdeki akımların cebirsel toplamı 0'dır

$$i_1 + i_2 + \cdots + i_n = 0,$$

$$\mathbf{I}_1 + \mathbf{I}_2 + \cdots + \mathbf{I}_n = 0,$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$\begin{aligned}\mathbf{V}_{ab} &= Z_1\mathbf{I} + Z_2\mathbf{I} + \cdots + Z_n\mathbf{I} \\ &= (Z_1 + Z_2 + \cdots + Z_n)\mathbf{I}.\end{aligned}$$

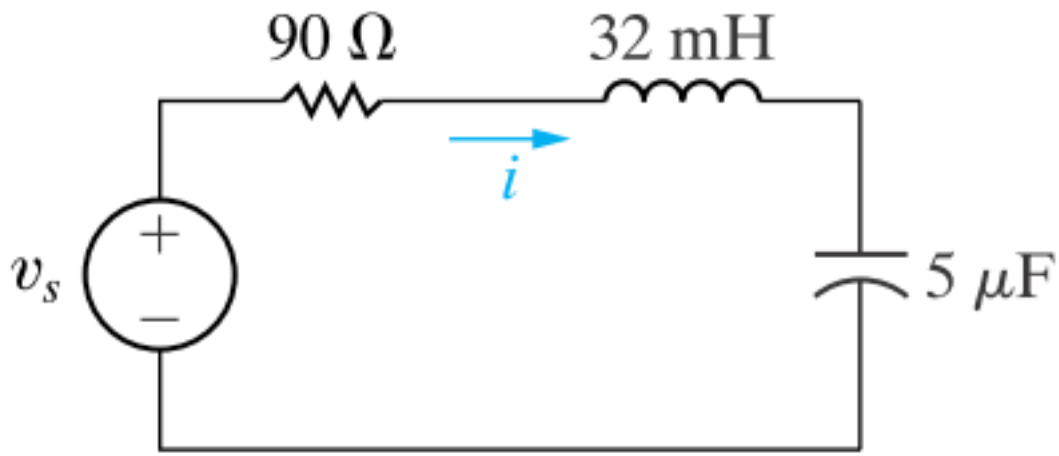
$$Z_{ab} = \frac{\mathbf{V}_{ab}}{\mathbf{I}} = Z_1 + Z_2 + \cdots + Z_n.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

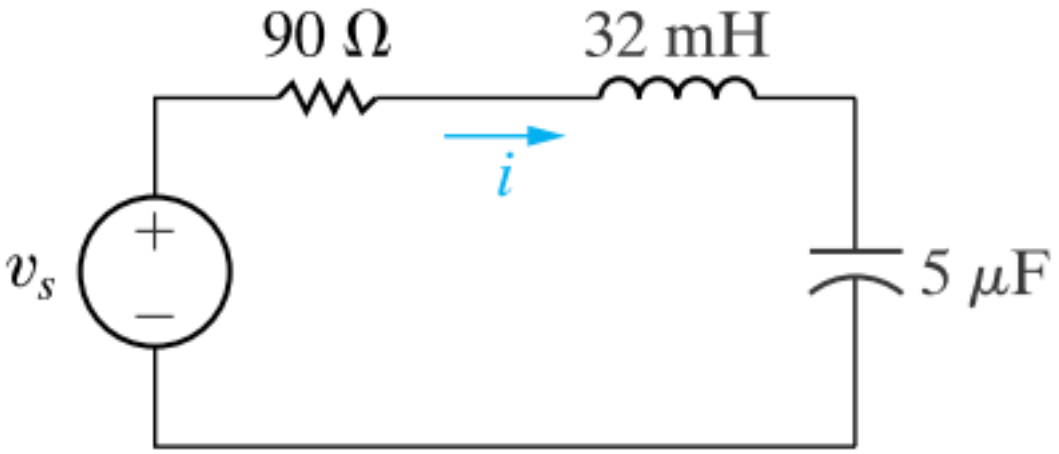
Soru: Verilen devrede $v_s = 750\cos(5000t + 30)$ ise

a) Frekans uzayı eşdeğer devreyi elde ediniz.

b) Kararlı durum $i(t)$ akımını bulunuz.



Seri, Paralel ve Δ - Y Sadeleştirmeleri

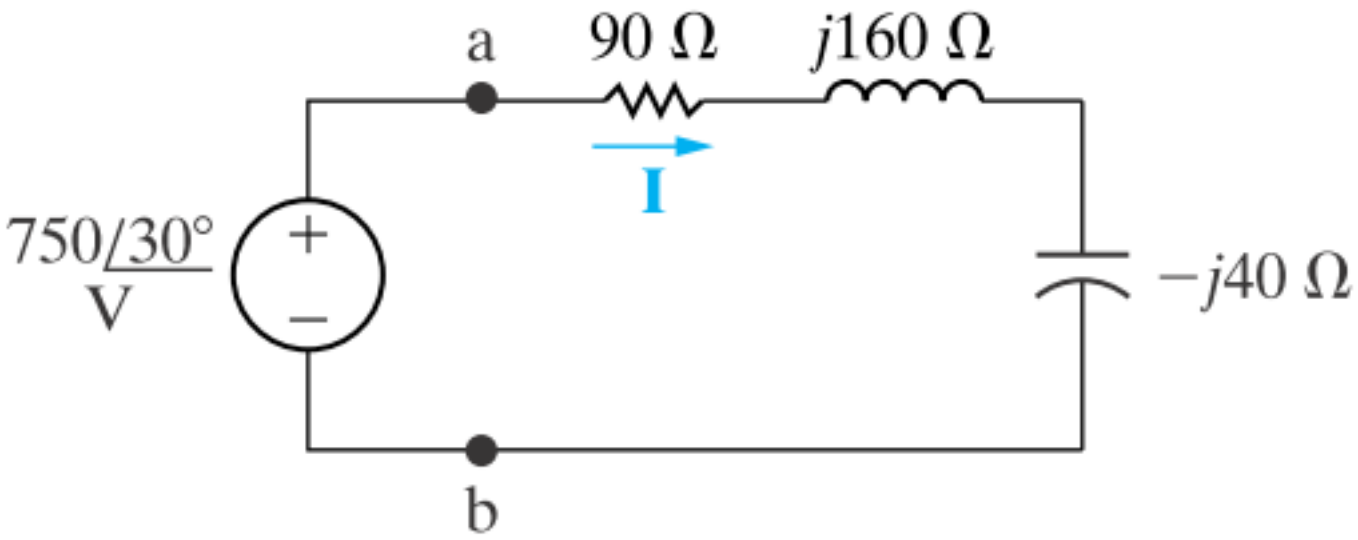


$$\omega = 5000 \text{ rad/s.}$$

$$Z_L = j\omega L = j(5000)(32 \times 10^{-3}) = j160\ \Omega,$$

$$Z_C = j\frac{-1}{\omega C} = -j\frac{10^6}{(5000)(5)} = -j40\ \Omega.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

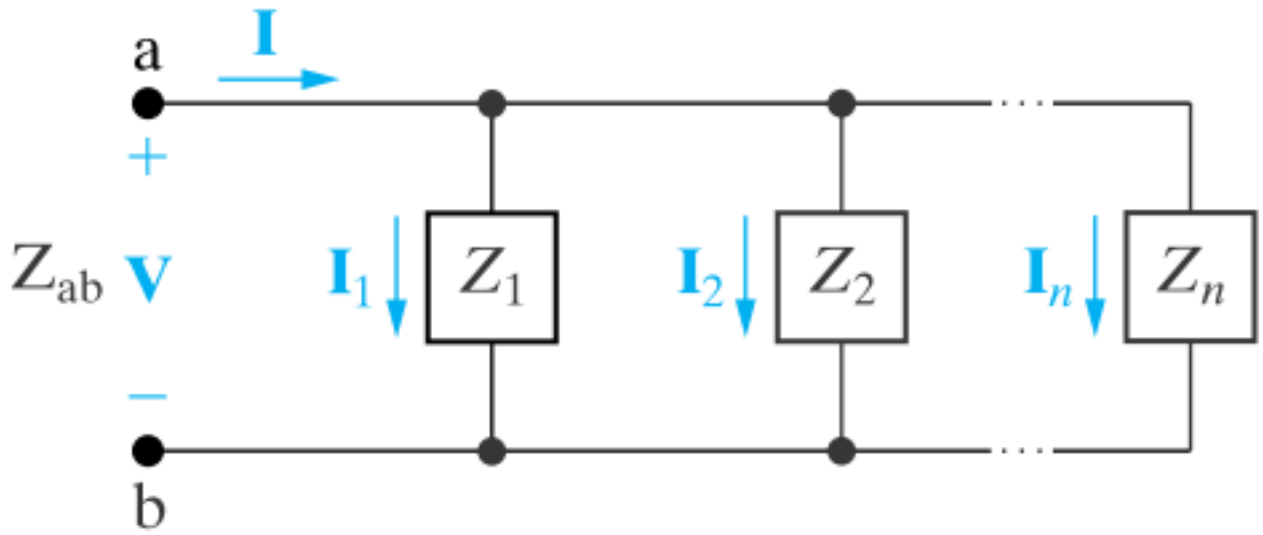


$$Z_{ab} = 90 + j160 - j40$$

$$= 90 + j120 = 150\angle 53.13^\circ\ \Omega.$$

$$\mathbf{I} = \frac{750\angle 30^\circ}{150\angle 53.13^\circ} = 5\angle -23.13^\circ\ \text{A}. \quad i = 5\cos(5000t - 23.13^\circ)\ \text{A}.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



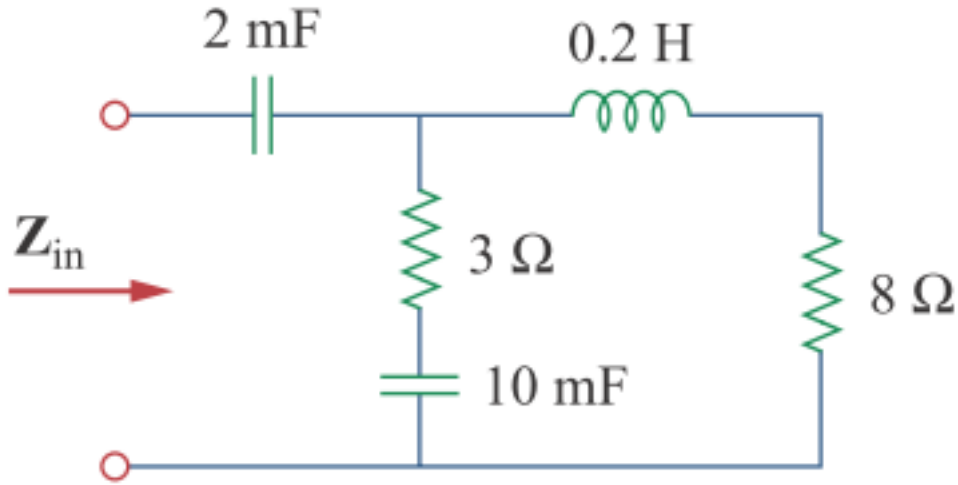
$$\frac{1}{Z_{ab}} = \frac{1}{Z_1} + \frac{1}{Z_2} + \cdots + \frac{1}{Z_n}.$$

Paralel iki empedans için: $$Z_{ab} = \frac{Z_1 Z_2}{Z_1 + Z_2}.$$

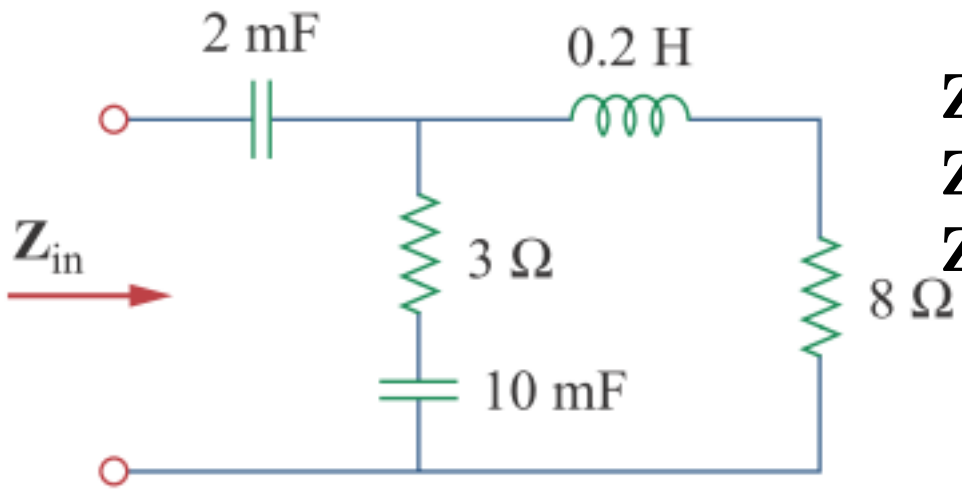
$$Y_{ab} = Y_1 + Y_2 + \cdots + Y_n.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

Soru: $\omega = 50$ rad/s ise şekildeki devrenin input empedansını bulunuz.



Seri, Paralel ve Δ - Y Sadeleştirmeleri



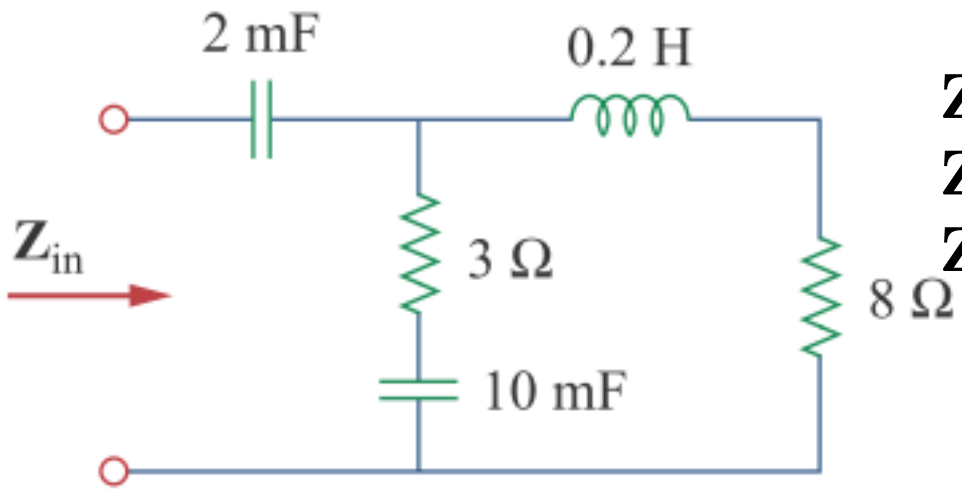
$\mathbf{Z_1}$: 2mF kapasitör olsun,
$\mathbf{Z_2}$: Seri 3 Ω ve 10 mF kapasitör olsun.
$\mathbf{Z_3}$: Seri 8 Ω ve 0.2 H bobin olsun.

$$\mathbf{Z}_1 = \frac{1}{j\omega C} = \frac{1}{j50 \times 2 \times 10^{-3}} = -j10\ \Omega$$

$$\mathbf{Z}_2 = 3 + \frac{1}{j\omega C} = 3 + \frac{1}{j50 \times 10 \times 10^{-3}} = (3 - j2)\ \Omega$$

$$\mathbf{Z}_3 = 8 + j\omega L = 8 + j50 \times 0.2 = (8 + j10)\ \Omega$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$\mathbf{Z_1}$: 2mF kapasitör olsun,
$\mathbf{Z_2}$: Seri 3 Ω ve 10 mF kapasitör olsun.
$\mathbf{Z_3}$: Seri 8 Ω ve 0.2 H bobin olsun.

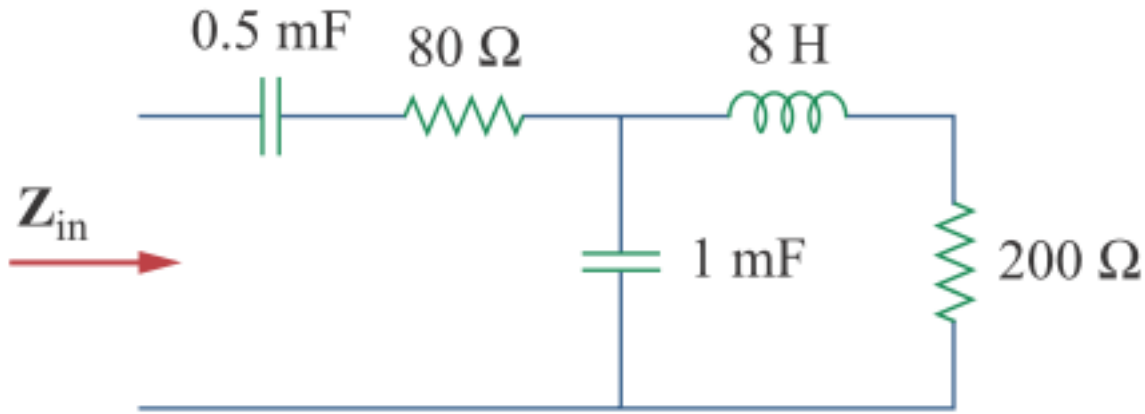
$$\mathbf{Z}_{\text{in}} = \mathbf{Z}_1 + \mathbf{Z}_2 \| \mathbf{Z}_3 = -j10 + \frac{(3 - j2)(8 + j10)}{11 + j8}$$

$$= -j10 + \frac{(44 + j14)(11 - j8)}{11^2 + 8^2} = -j10 + 3.22 - j1.07\ \Omega$$

$$\mathbf{Z}_{\text{in}} = 3.22 - j11.07\ \Omega$$

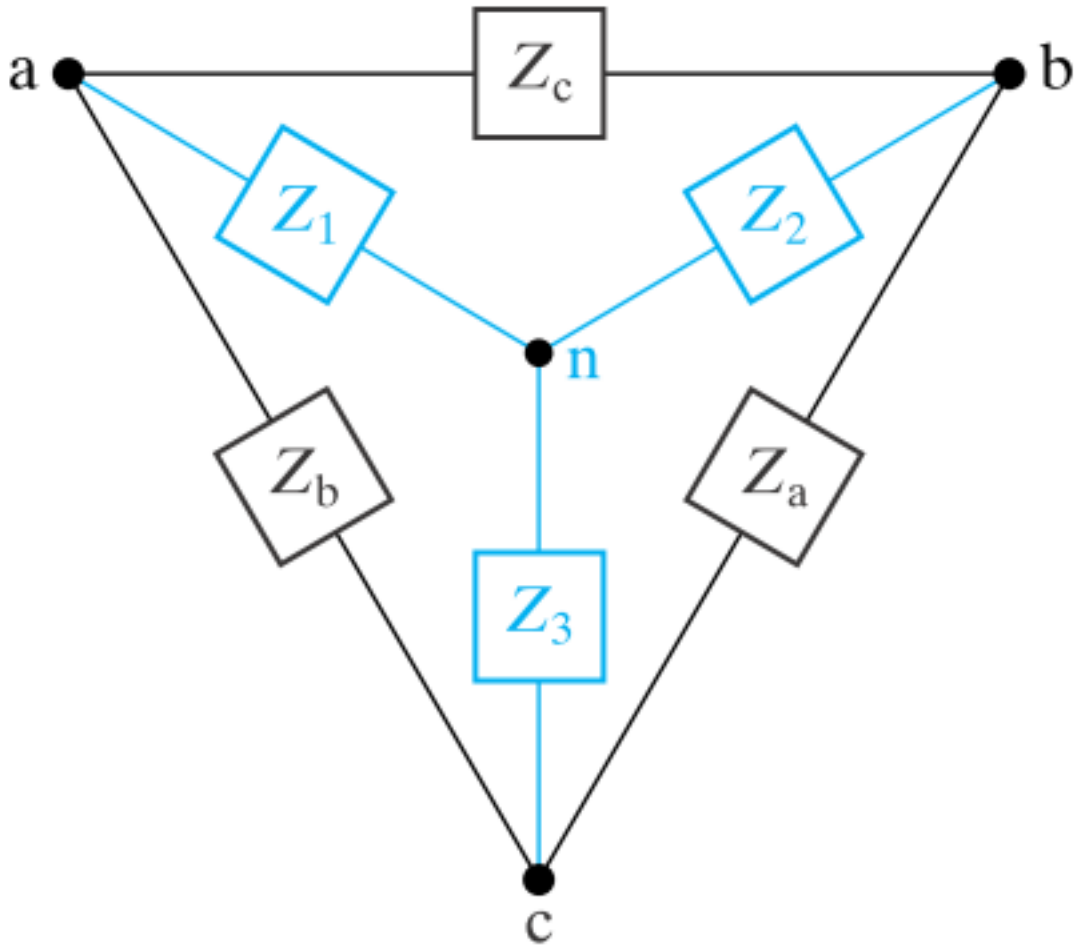
Seri, Paralel ve Δ - Y Sadeleştirmeleri

Ödev: $\omega = 10$ rad/s ise şekildeki devrenin input empedansını bulunuz.



$$(129.52 - j295)$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

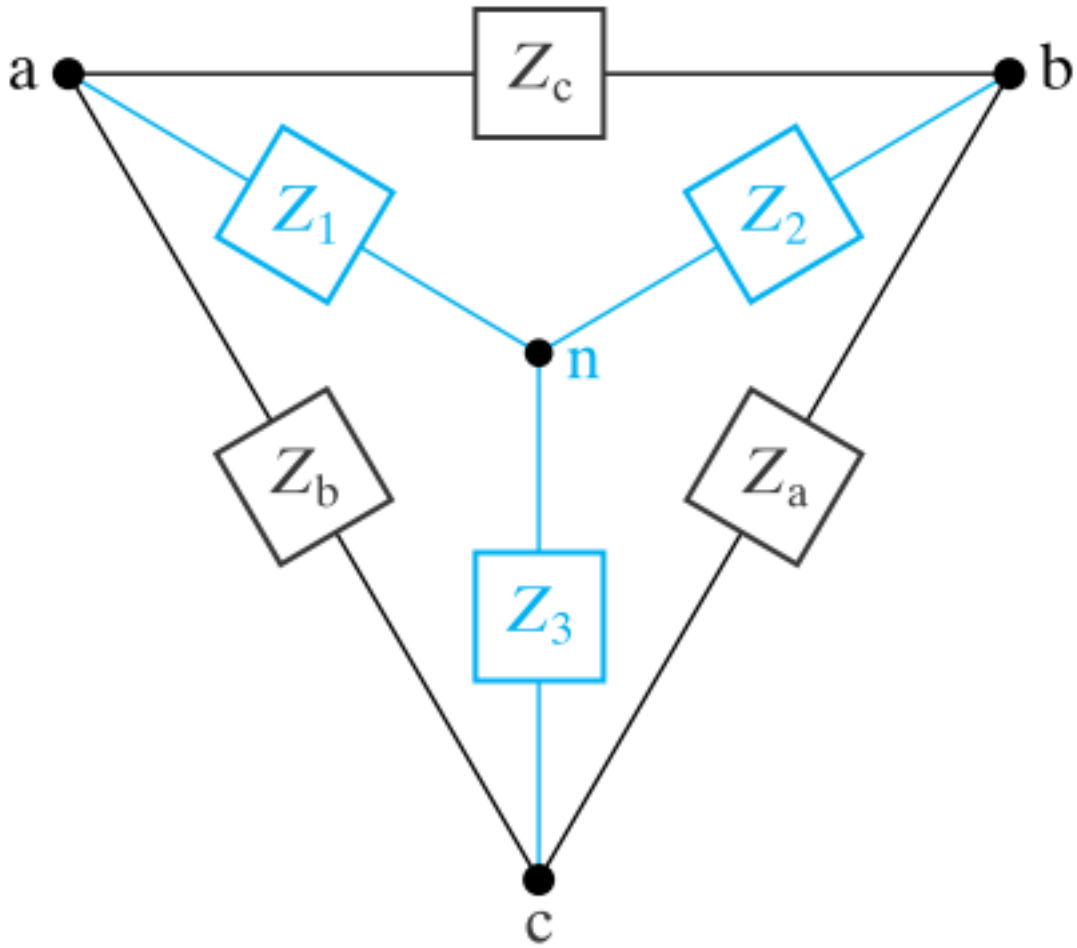


$$Z_1 = \frac{Z_b Z_c}{Z_a + Z_b + Z_c},$$

$$Z_2 = \frac{Z_c Z_a}{Z_a + Z_b + Z_c},$$

$$Z_3 = \frac{Z_a Z_b}{Z_a + Z_b + Z_c}.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



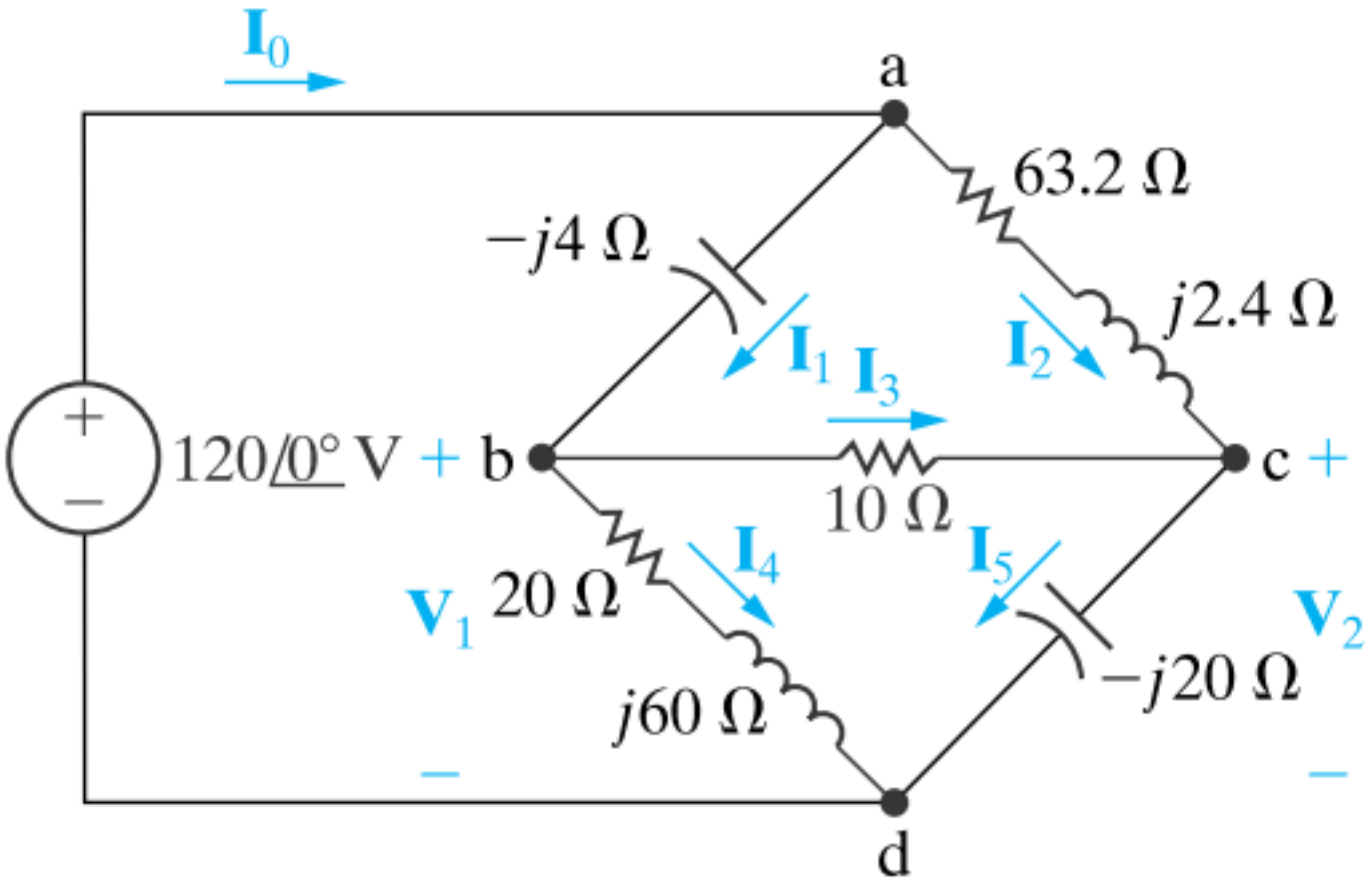
$$Z_a = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_1}$$

$$Z_b = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_2}$$

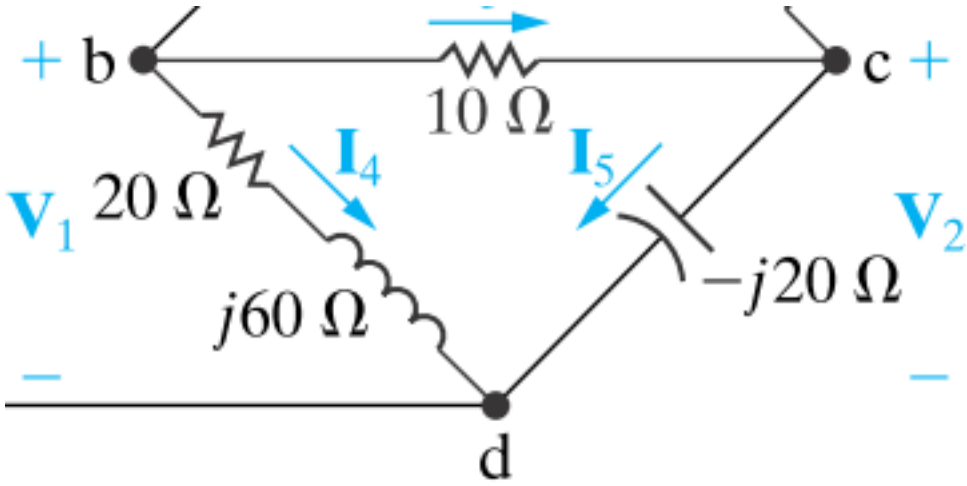
$$Z_c = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_3}$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

Soru: Δ-Y dönüşümünü kullanarak verilen devrede I_0, I_1, I_2, I_3, I_4, I_5, V_1, V_2, değerlerini bulunuz.



Seri, Paralel ve Δ - Y Sadeleştirmeleri

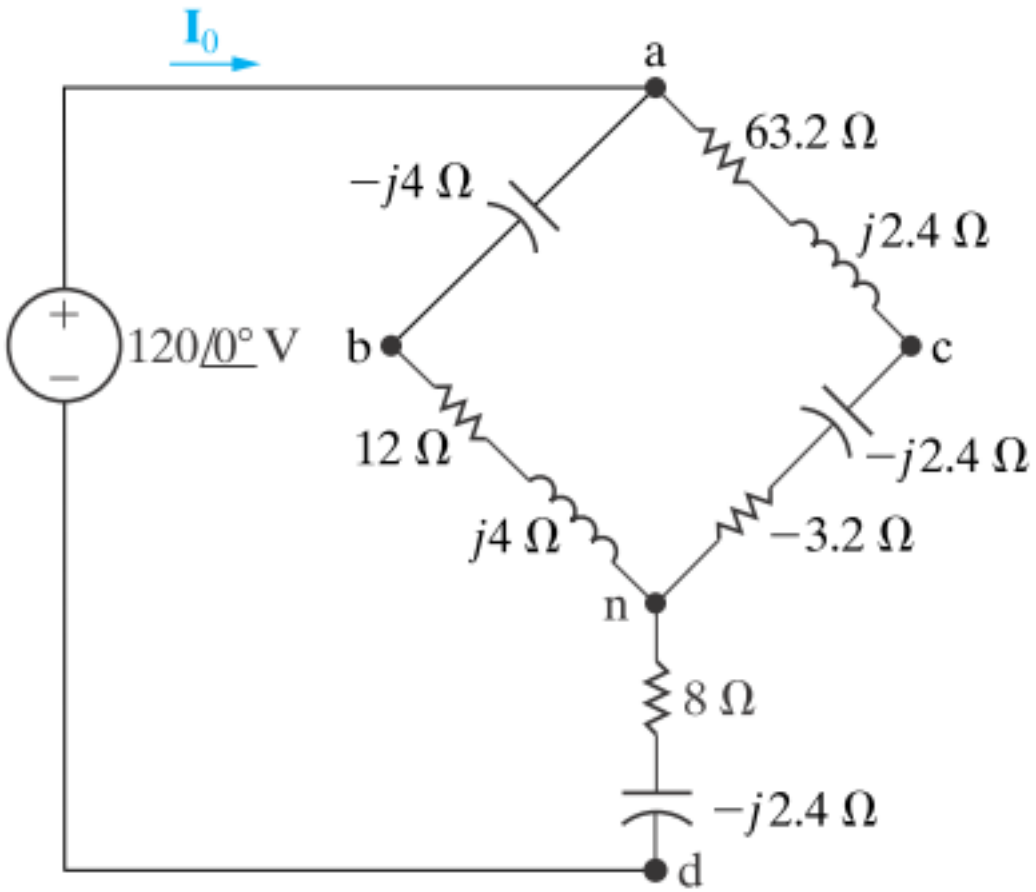


$$Z_1 = \frac{(20 + j60)(10)}{30 + j40} = 12 + j4\Omega$$

$$Z_2 = \frac{10(-j20)}{30 + j40} = -3.2 - j2.4\ \Omega$$

$$Z_3 = \frac{(20 + j60)(-j20)}{30 + j40} = 8 - j24\ \Omega.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



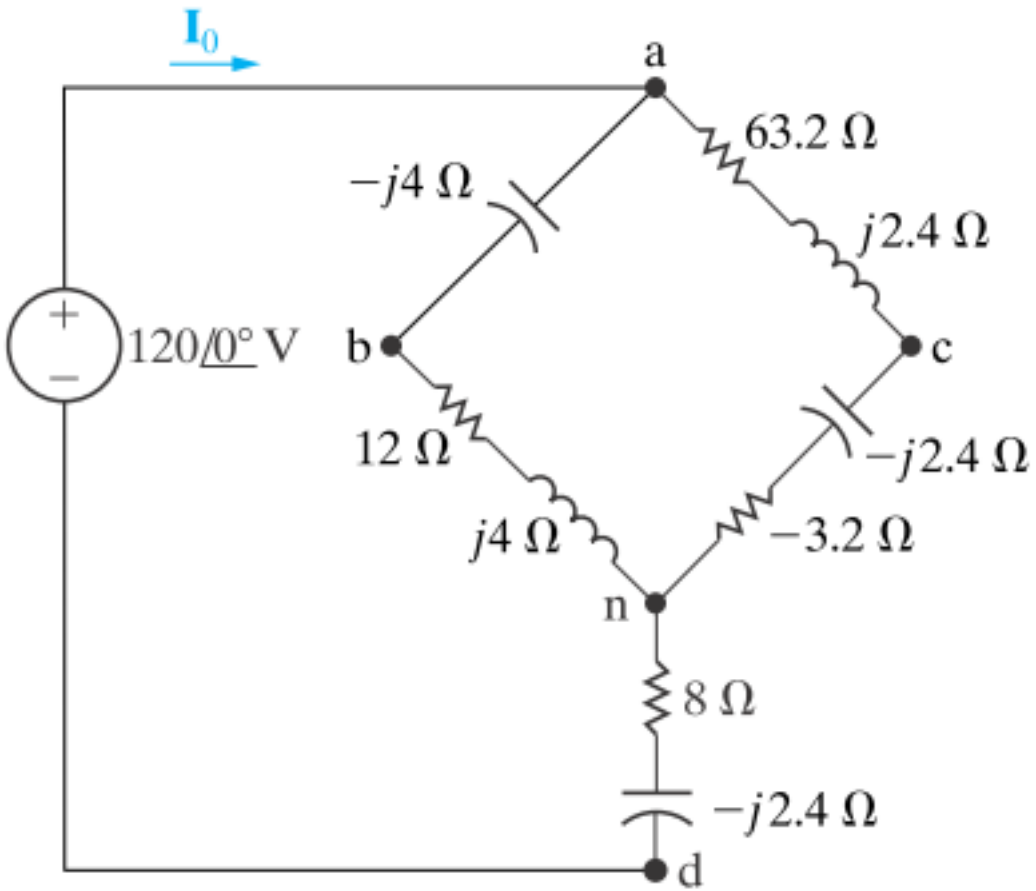
$$Z_{\text{abn}} = 12 + j4 - j4 = 12\ \Omega,$$

$$Z_{\text{acn}} = 63.2 + j2.4 - j2.4 - 3.2$$

$$= 60\ \Omega$$

$$Z_{\text{an}} = \frac{(60)(12)}{72} = 10\ \Omega.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$\mathbf{I}_0 = \frac{120\angle 0^\circ}{18 - j24} = 4\angle 53.13^\circ$$

$$= 2.4 + j3.2 \text{ A.}$$

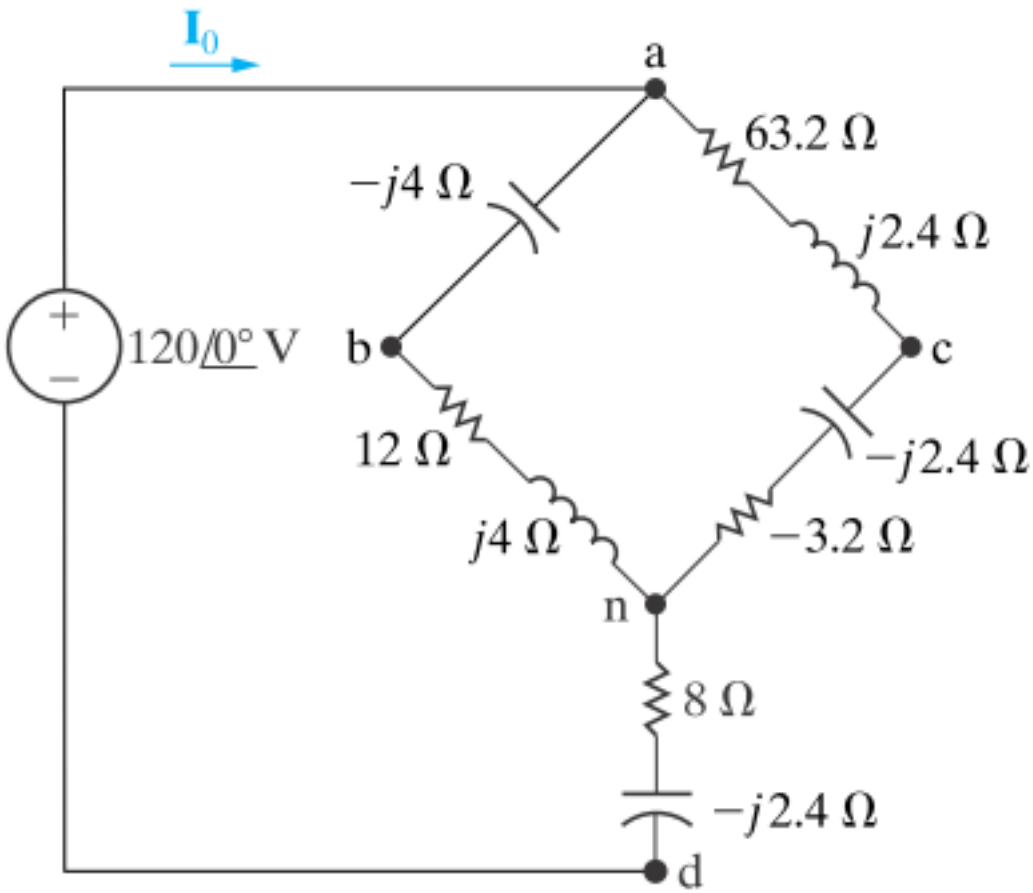
$$\mathbf{V}_{nd} = (8 - j24)\mathbf{I}_0 = 96 - j32 \text{ V}$$

$$\mathbf{V} = \mathbf{V}_{an} + \mathbf{V}_{nd}$$

$$\mathbf{V}_{an} = 120 - 96 + j32$$

$$= 24 + j32 \text{ V}$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$\mathbf{I}_{\text{abn}} = \frac{24 + j32}{12} = 2 + j\frac{8}{3} \text{ A},$$

$$\mathbf{I}_{\text{acn}} = \frac{24 + j32}{60} = \frac{4}{10} + j\frac{8}{15} \text{ A}.$$

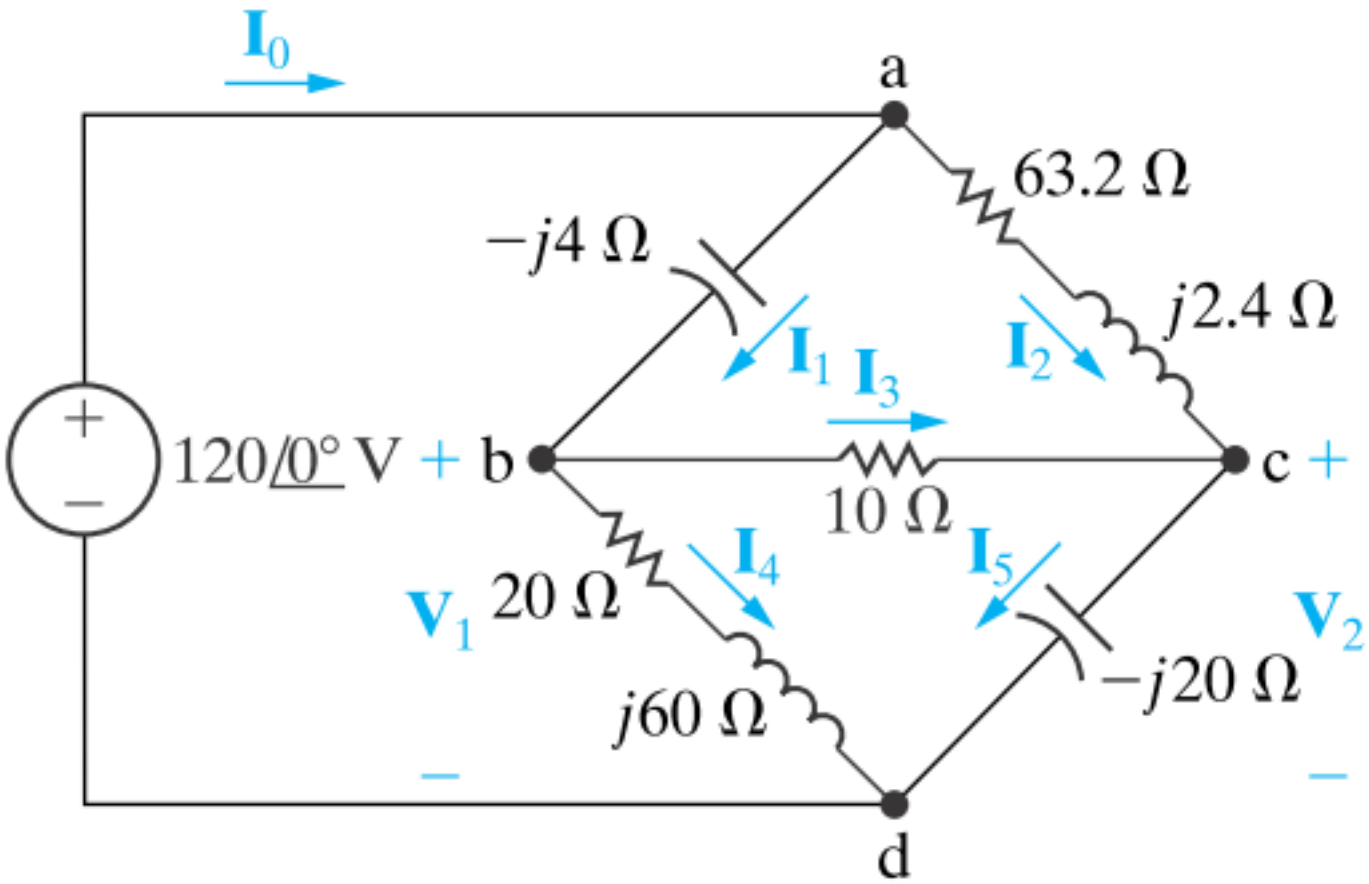
$$\mathbf{I}_1 = \mathbf{I}_{\text{abn}}$$

$$\mathbf{I}_2 = \mathbf{I}_{\text{acn}}$$

Sağlama:

$$\mathbf{I}_1 + \mathbf{I}_2 = 2.4 + j3.2 = \mathbf{I}_0.$$

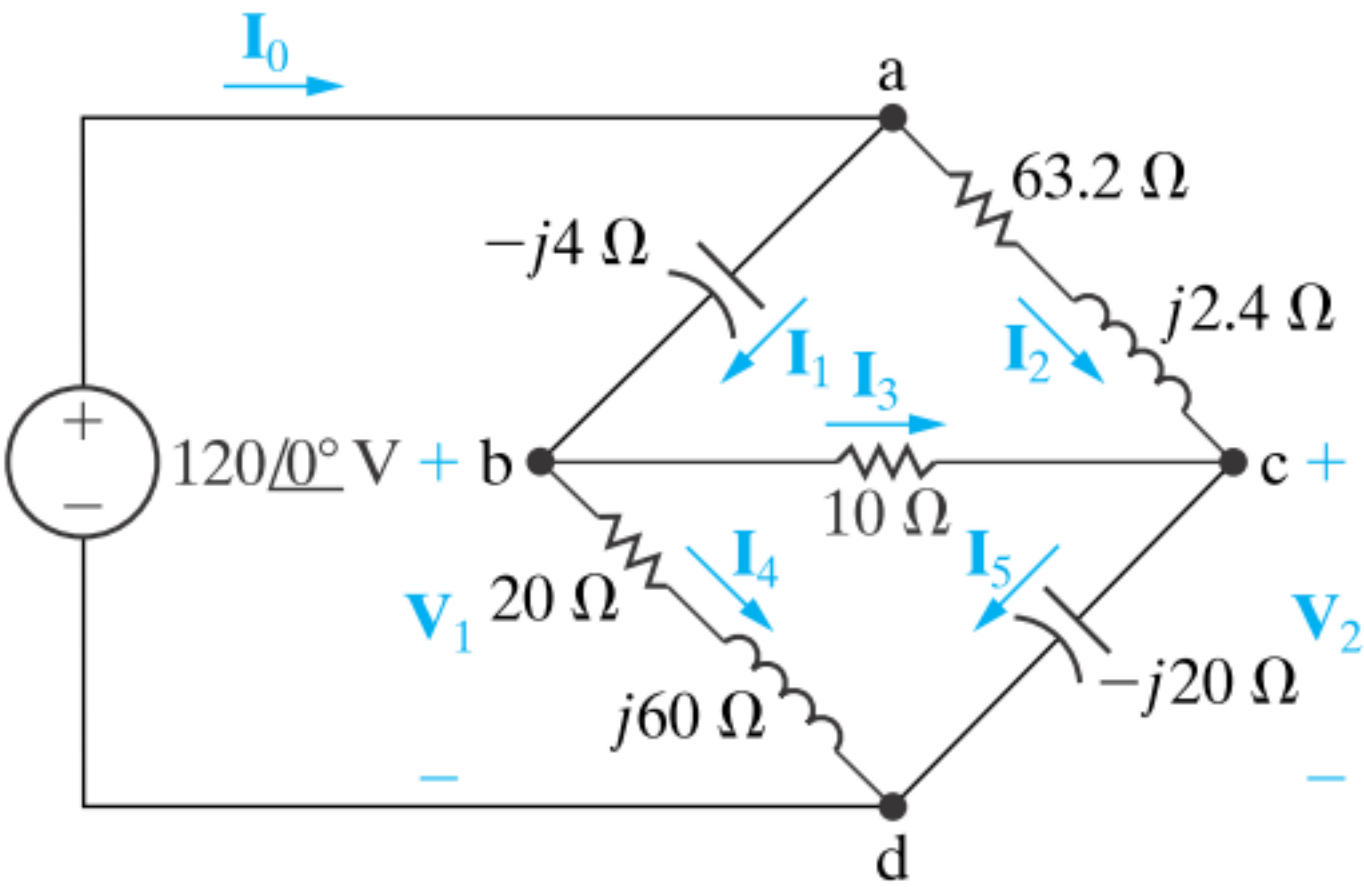
Seri, Paralel ve Δ - Y Sadeleştirmeleri



V_1: b noktasındaki voltaj

V_2: c noktasındaki voltaj

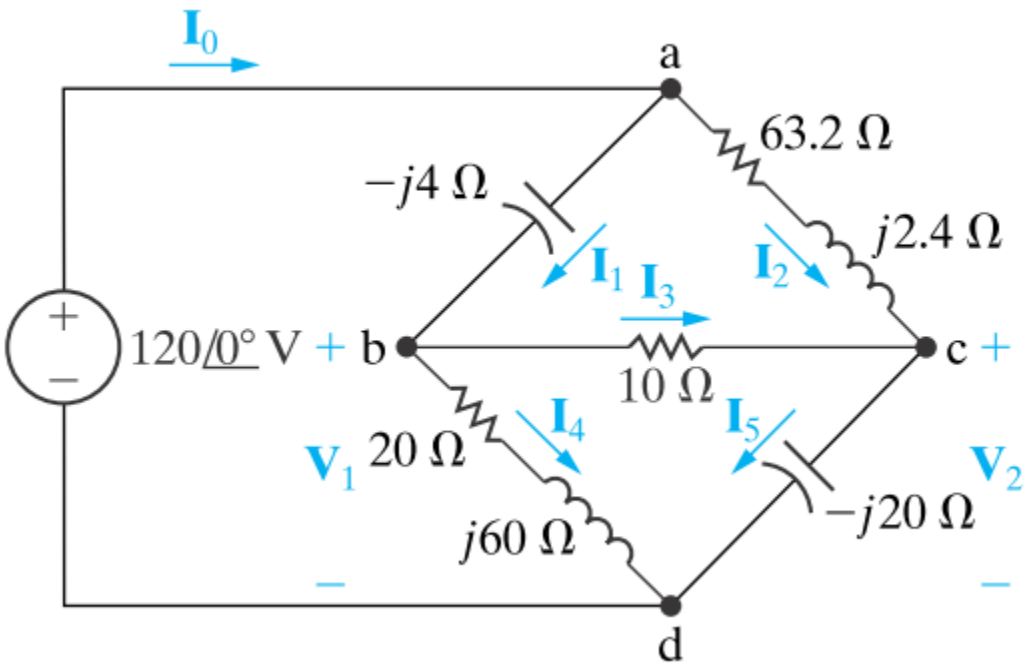
Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$\mathbf{V}_1 = 120\angle 0^\circ - (-j4)\mathbf{I}_1 = \frac{328}{3} + j8\ \text{V},$$

$$\mathbf{V}_2 = 120\angle 0^\circ - (63.2 + j2.4)\mathbf{I}_2 = 96 - j\frac{104}{3}\ \text{V}.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri



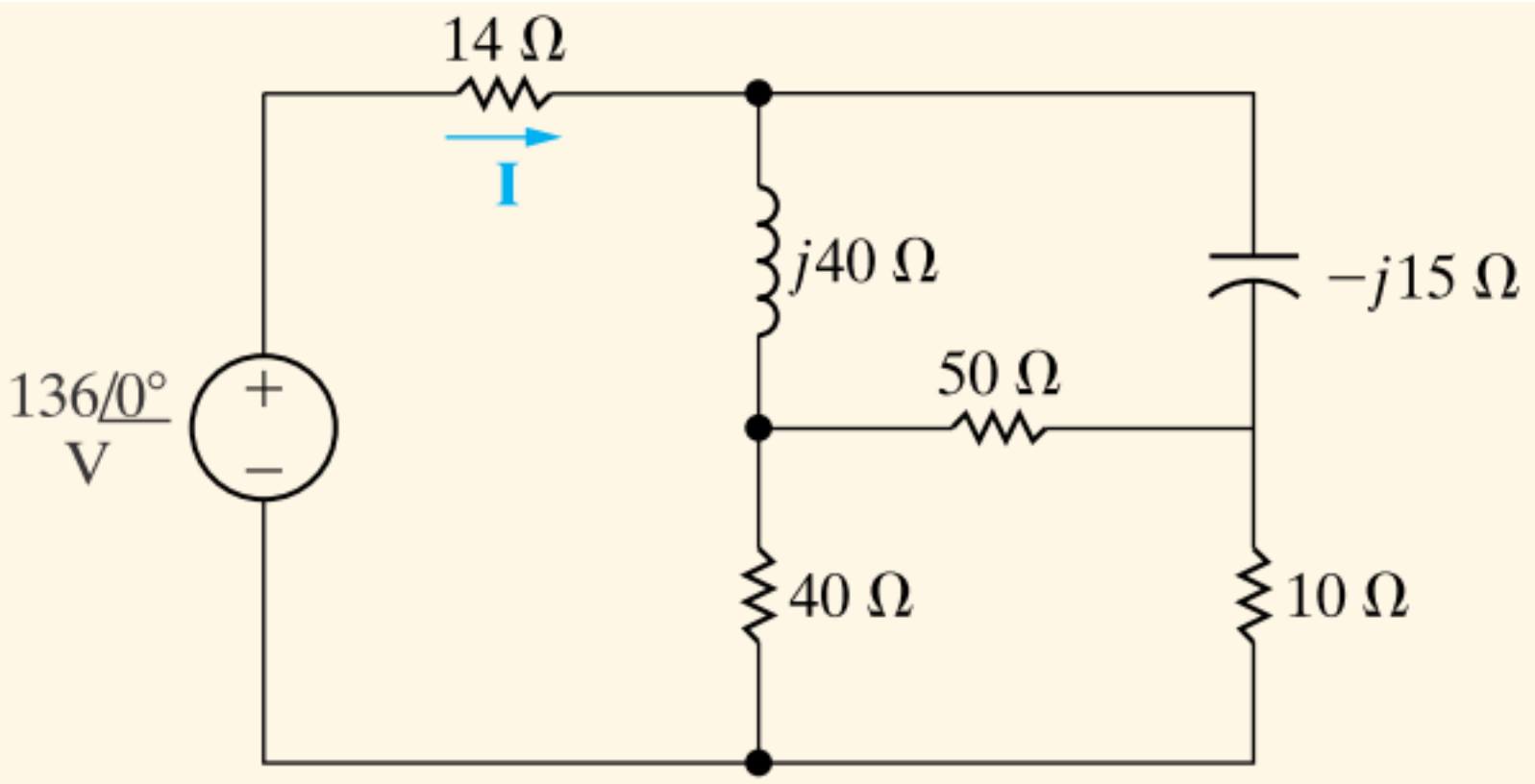
$$\mathbf{I}_3 = \frac{\mathbf{V}_1 - \mathbf{V}_2}{10} = \frac{4}{3} + j\frac{12.8}{3} \text{ A}$$

$$\mathbf{I}_4 = \frac{\mathbf{V}_1}{20 + j60} = \frac{2}{3} - j1.6 \text{ A},$$

$$\mathbf{I}_5 = \frac{\mathbf{V}_2}{-j20} = \frac{26}{15} + j4.8 \text{ A}.$$

Seri, Paralel ve Δ - Y Sadeleştirmeleri

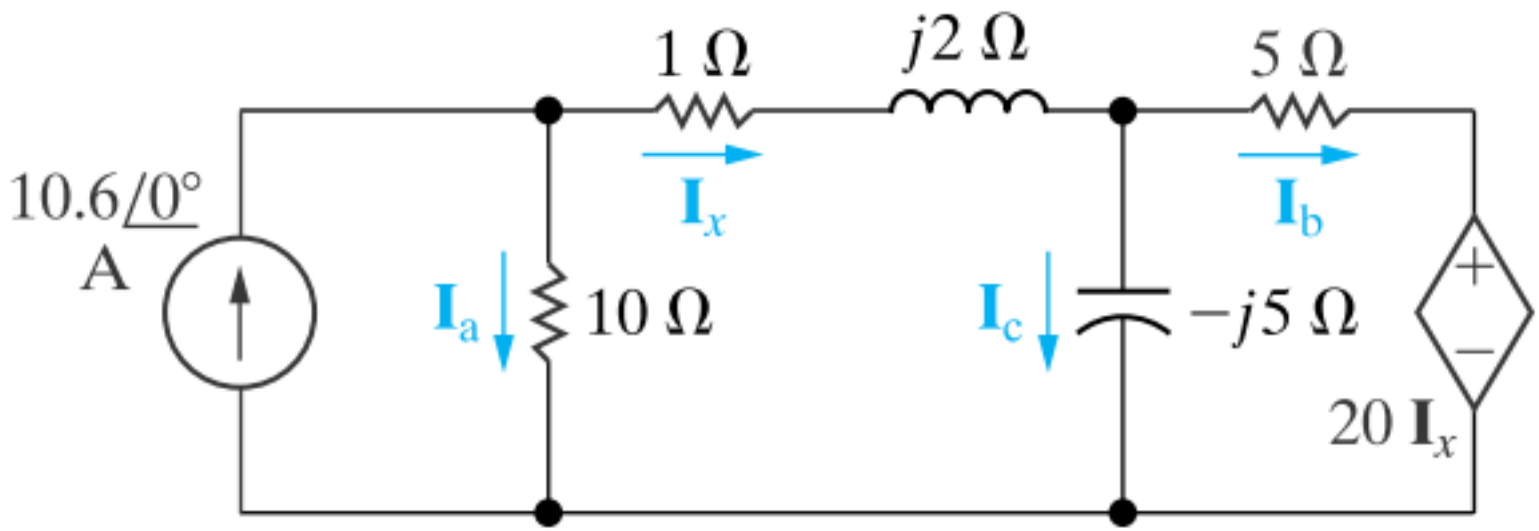
Ödev: Δ-Y dönüşümünü kullanarak verilen devrede $\mathbf{I}$ akımını bulunuz.



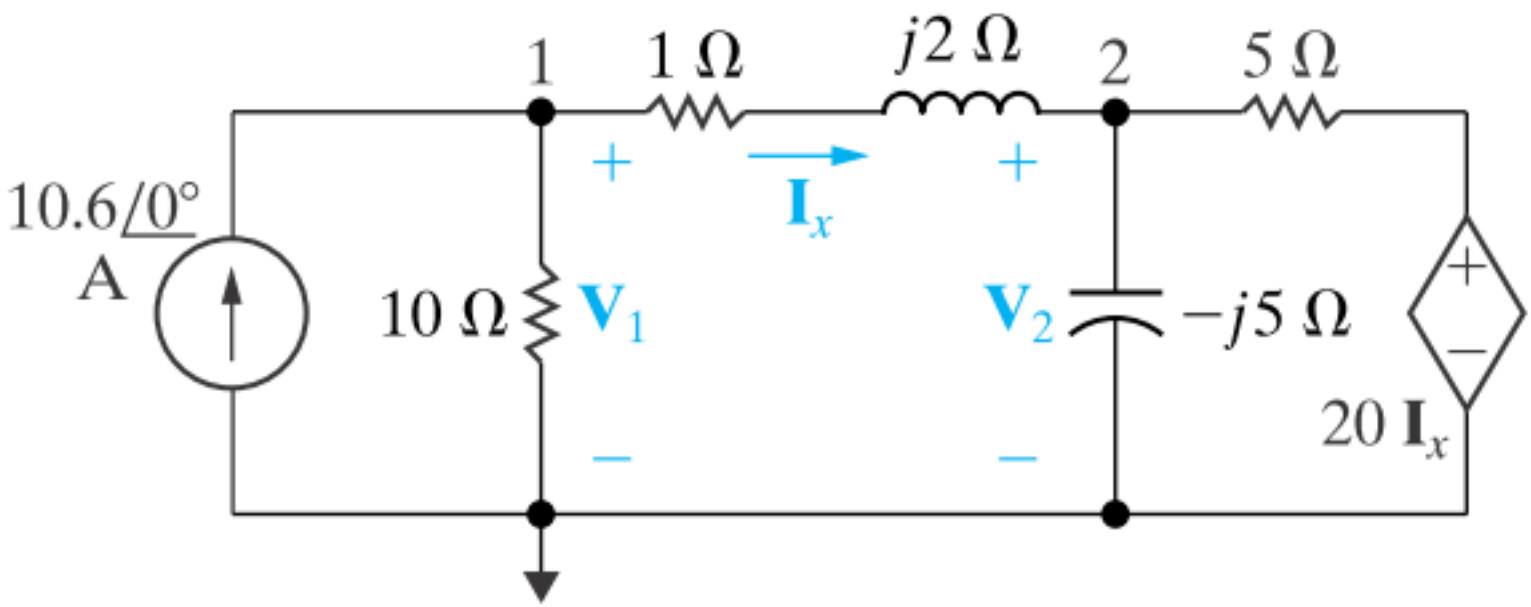
$$\mathbf{I} = 4 \angle 28.07^\circ \text{ A.}$$

Düğüm Gerilim Yöntemi

Soru: Verilen devrede düğüm gerilim yöntemini kullanarak $\mathbf{I}_a$, $\mathbf{I}_b$, $\mathbf{I}_c$ akımlarını bulunuz.



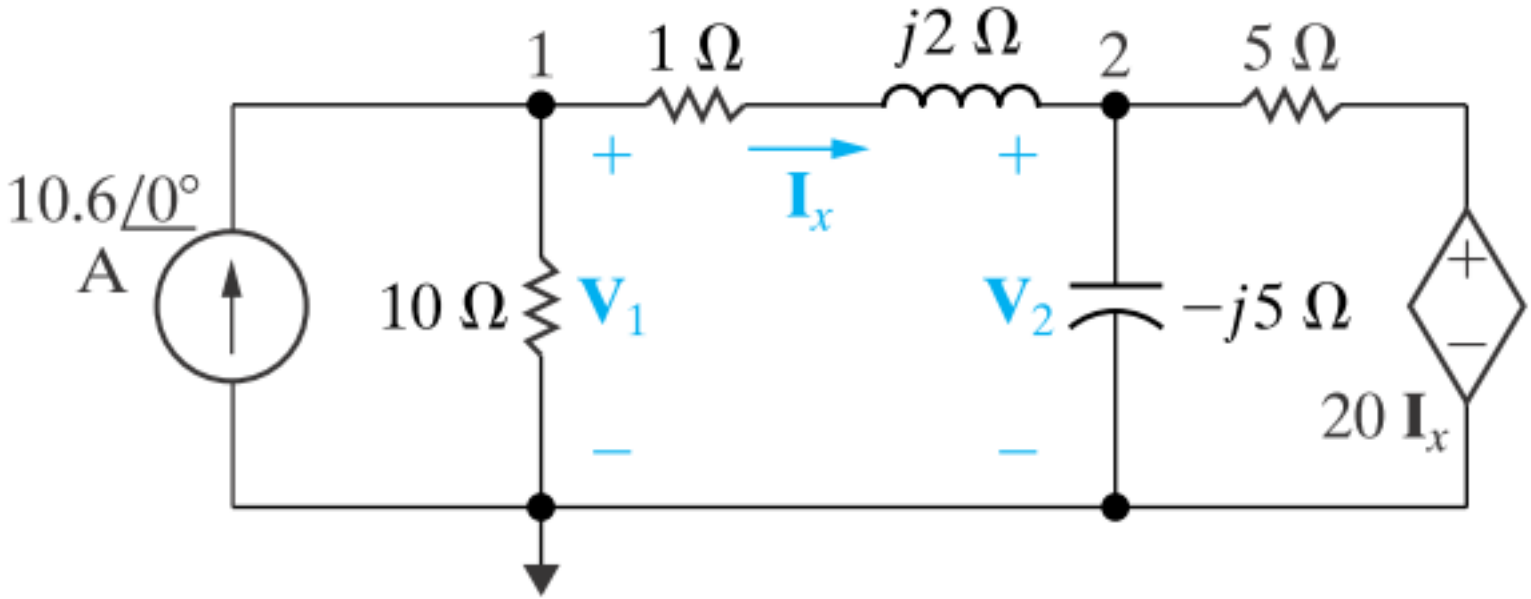
Düğüm Gerilim Yöntemi



$$-10.6 + \frac{\mathbf{V}_1}{10} + \frac{\mathbf{V}_1 - \mathbf{V}_2}{1 + j2} = 0.$$

$$\mathbf{V}_1(1.1 + j0.2) - \mathbf{V}_2 = 10.6 + j21.2.$$

Düğüm Gerilim Yöntemi



$$\frac{\mathbf{V}_2 - \mathbf{V}_1}{1 + j2} + \frac{\mathbf{V}_2}{-j5} + \frac{\mathbf{V}_2 - 20\mathbf{I}_x}{5} = 0. \qquad \mathbf{I}_x = \frac{\mathbf{V}_1 - \mathbf{V}_2}{1 + j2}.$$

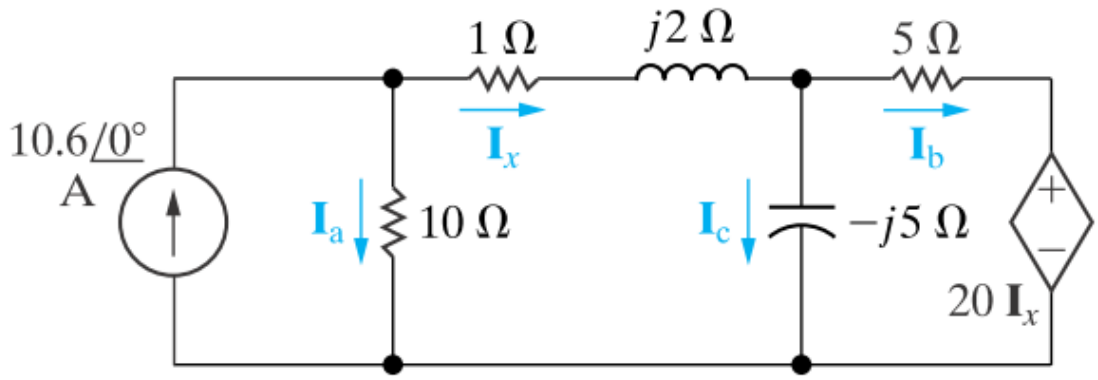
$$-5\mathbf{V}_1 + (4.8 + j0.6)\mathbf{V}_2 = 0.$$

Düğüm Gerilim Yöntemi

$$\mathbf{V}_1(1.1 + j0.2) - \mathbf{V}_2 = 10.6 + j21.2.$$

$$-5\mathbf{V}_1 + (4.8 + j0.6)\mathbf{V}_2 = 0.$$

$$\mathbf{V}_1 = 68.40 - j16.80 \text{ V},$$
$$\mathbf{V}_2 = 68 - j26 \text{ V}.$$



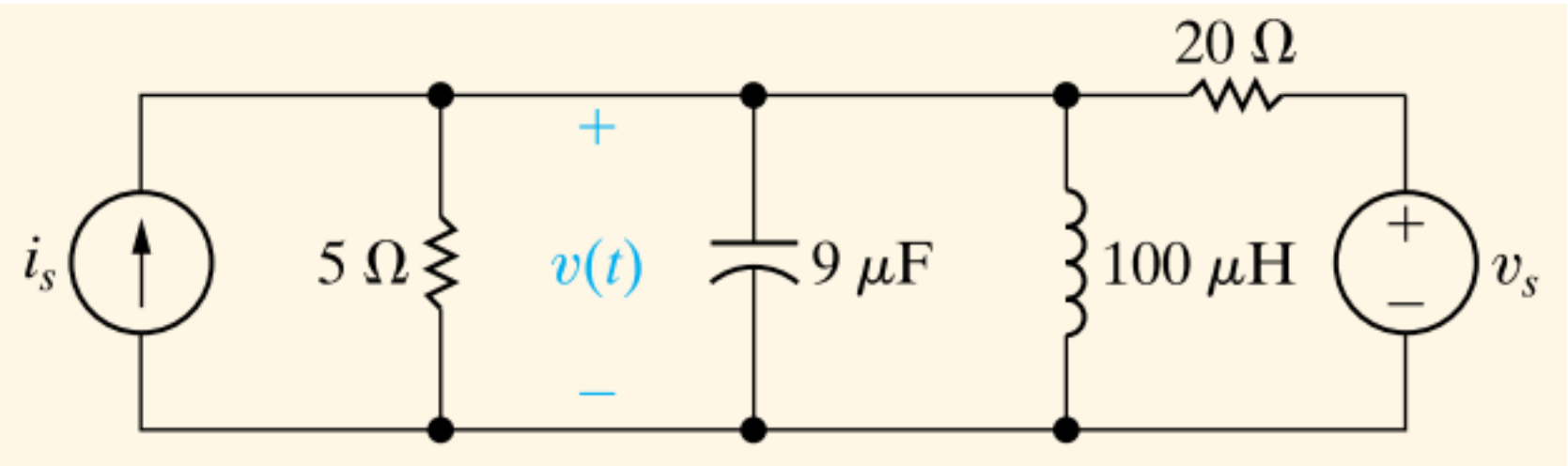
$$\mathbf{I}_a = \frac{\mathbf{V}_1}{10} = 6.84 - j1.68 \text{ A}, \quad \mathbf{I}_b = \frac{\mathbf{V}_2 - 20\mathbf{I}_x}{5} = -1.44 - j11.92 \text{ A}$$

$$\mathbf{I}_x = \frac{\mathbf{V}_1 - \mathbf{V}_2}{1 + j2} = 3.76 + j1.68 \text{ A}, \quad \mathbf{I}_c = \frac{\mathbf{V}_2}{-j5} = 5.2 + j13.6 \text{ A}.$$

Düğüm Gerilim Yöntemi

Ödev: Verilen devrede düğüm gerilim yöntemini kullanarak $v(t)$ gerilim ifadesini bulunuz.

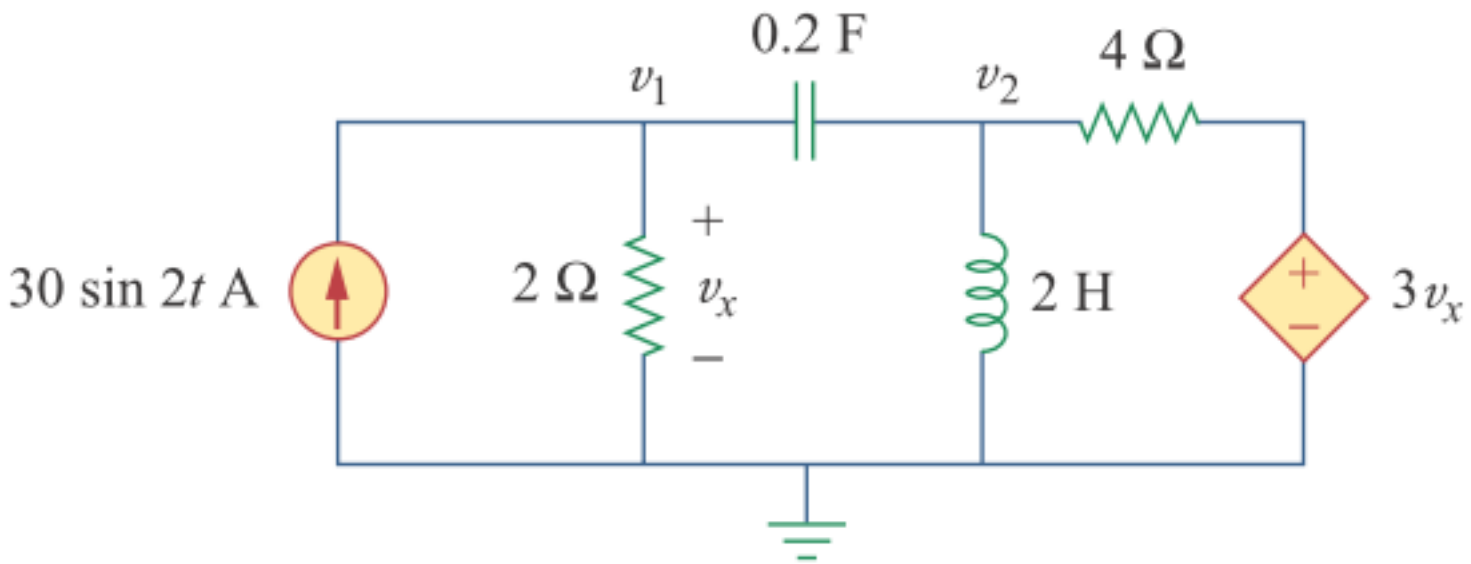
$i_s = 10\cos\omega t$ A $\quad v_s = 100\sin\omega t$ V $\quad \omega = 50$ krad/s



$$v(t) = 31.62\cos(50{,}000t - 71.57^\circ) \text{ V}.$$

Düğüm Gerilim Yöntemi

Ödev: Verilen devrede düğüm gerilim yöntemini kullanarak v_1 ve v_2 gerilim ifadelerini bulunuz.

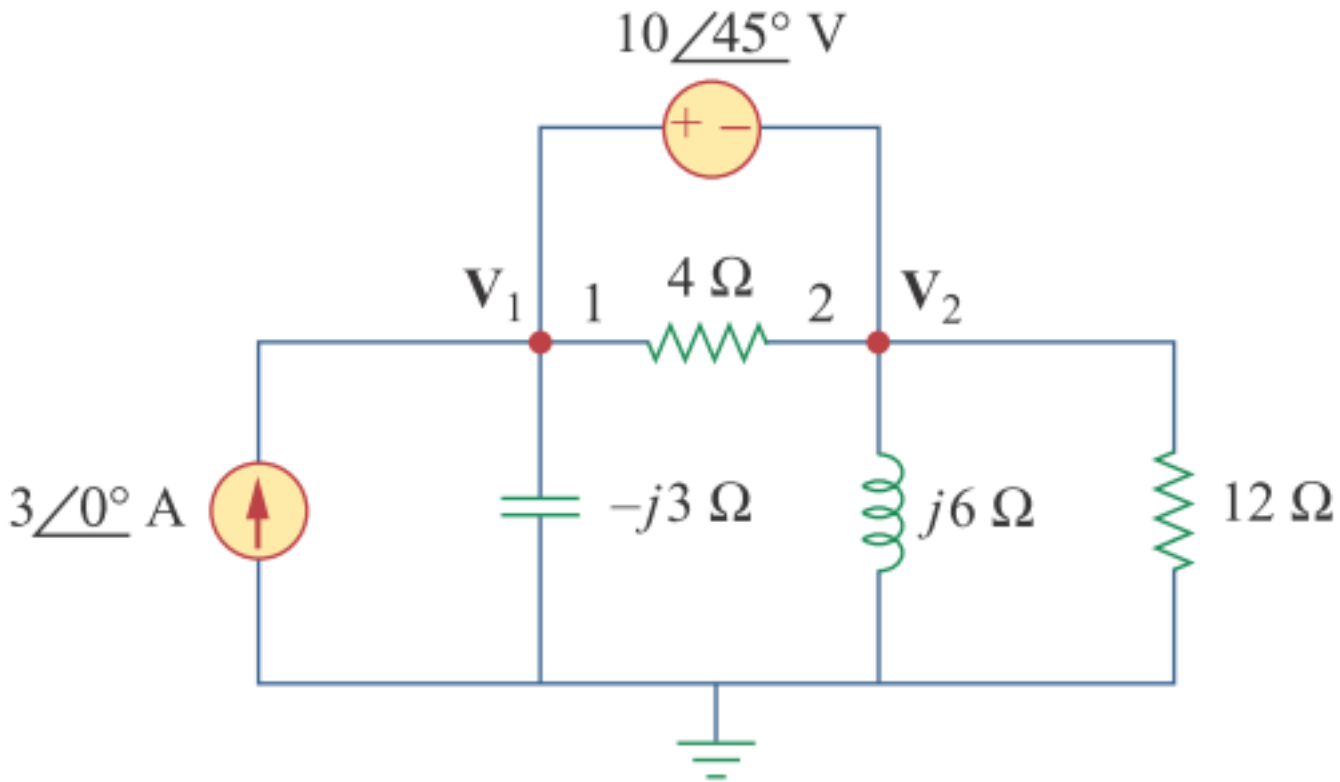


$$v_1(t) = 33.96 \sin(2t + 60.01°) \text{ V},$$

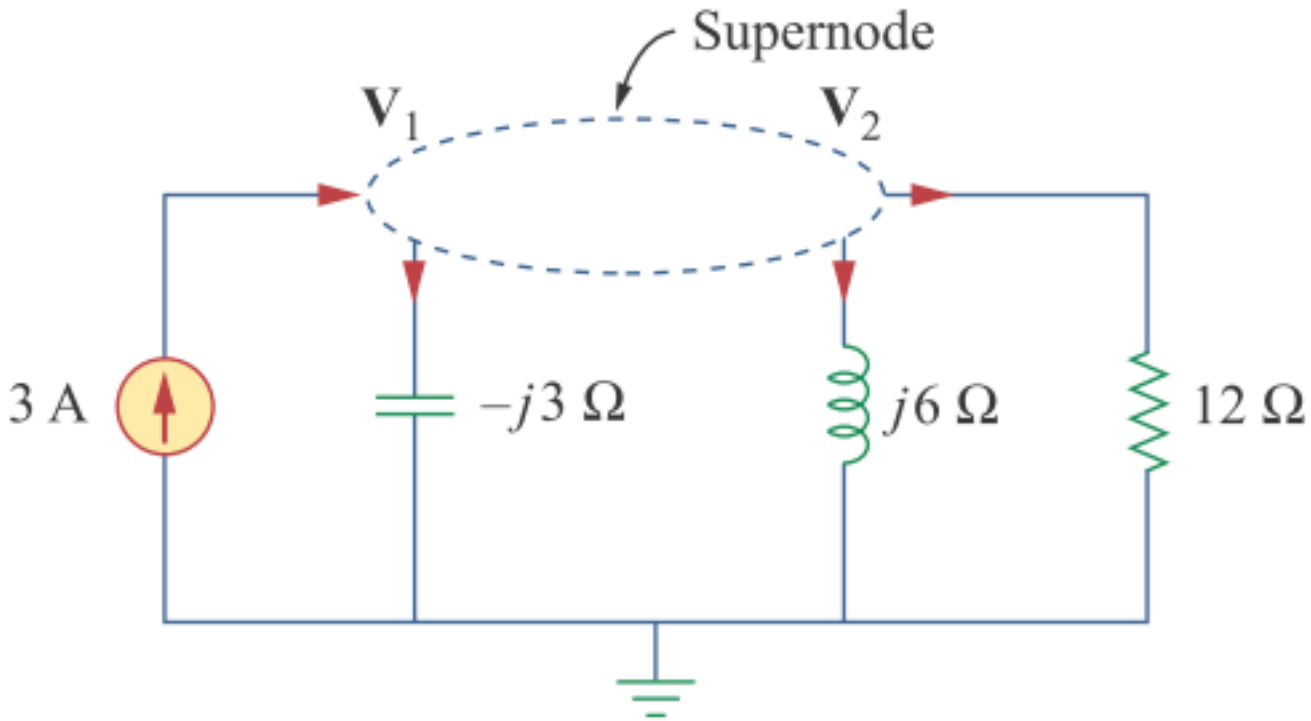
$$v_2(t) = 99.06 \sin(2t + 57.12°) \text{ V}.$$

Düğüm Gerilim Yöntemi

Soru: Verilen devrede düğüm voltaj gerilim kullanarak $\mathbf{V}_1$ ve $\mathbf{V}_2$ değerlerini hesağlayınız. (Süper düğüm)



Düğüm Gerilim Yöntemi



$$3 = \frac{\mathbf{V}_1}{-j3} + \frac{\mathbf{V}_2}{j6} + \frac{\mathbf{V}_2}{12}$$

$$\mathbf{V}_1 = \mathbf{V}_2 + 10\angle 45°$$

Düğüm Gerilim Yöntemi

$$3 = \frac{\mathbf{V}_1}{-j3} + \frac{\mathbf{V}_2}{j6} + \frac{\mathbf{V}_2}{12} \qquad \mathbf{V}_1 = \mathbf{V}_2 + 10\angle 45^\circ$$

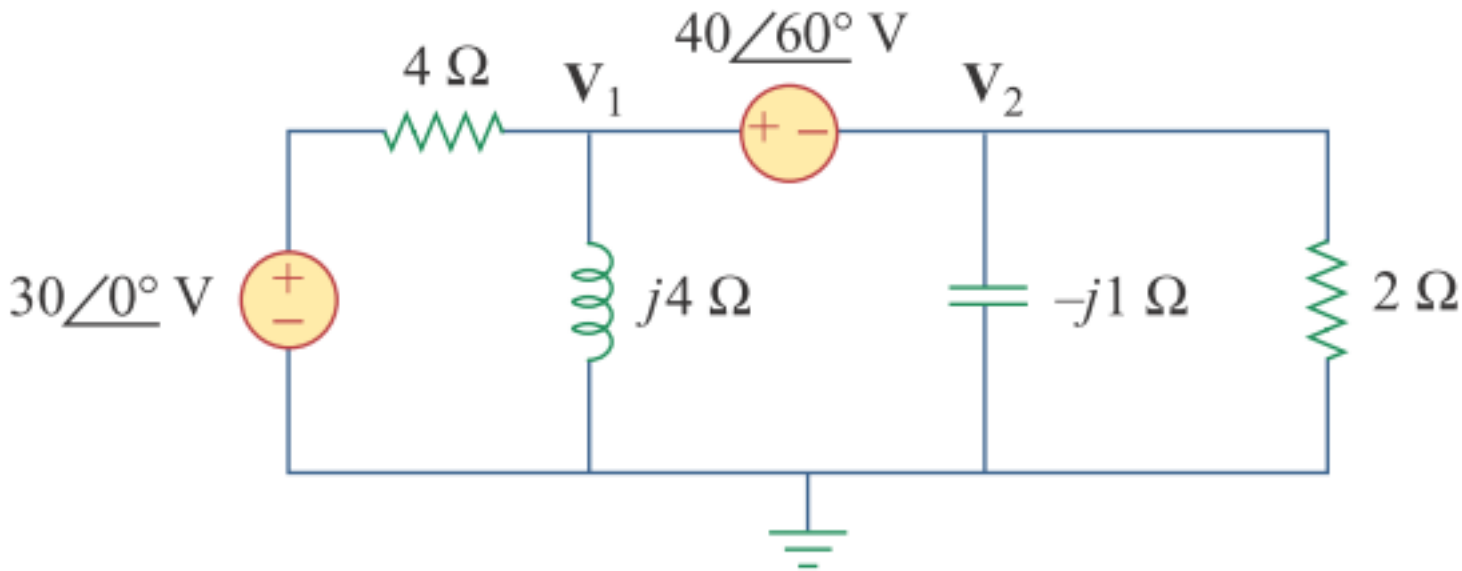
$$36 = j4\mathbf{V}_1 + (1 - j2)\mathbf{V}_2$$

$$36 - 40\angle 135^\circ = (1 + j2)\mathbf{V}_2 \quad \Rightarrow \quad \mathbf{V}_2 = 31.41\angle -87.18^\circ \text{ V}$$

$$\mathbf{V}_1 = \mathbf{V}_2 + 10\angle 45^\circ = 25.78\angle -70.48^\circ \text{ V}$$

Düğüm Gerilim Yöntemi

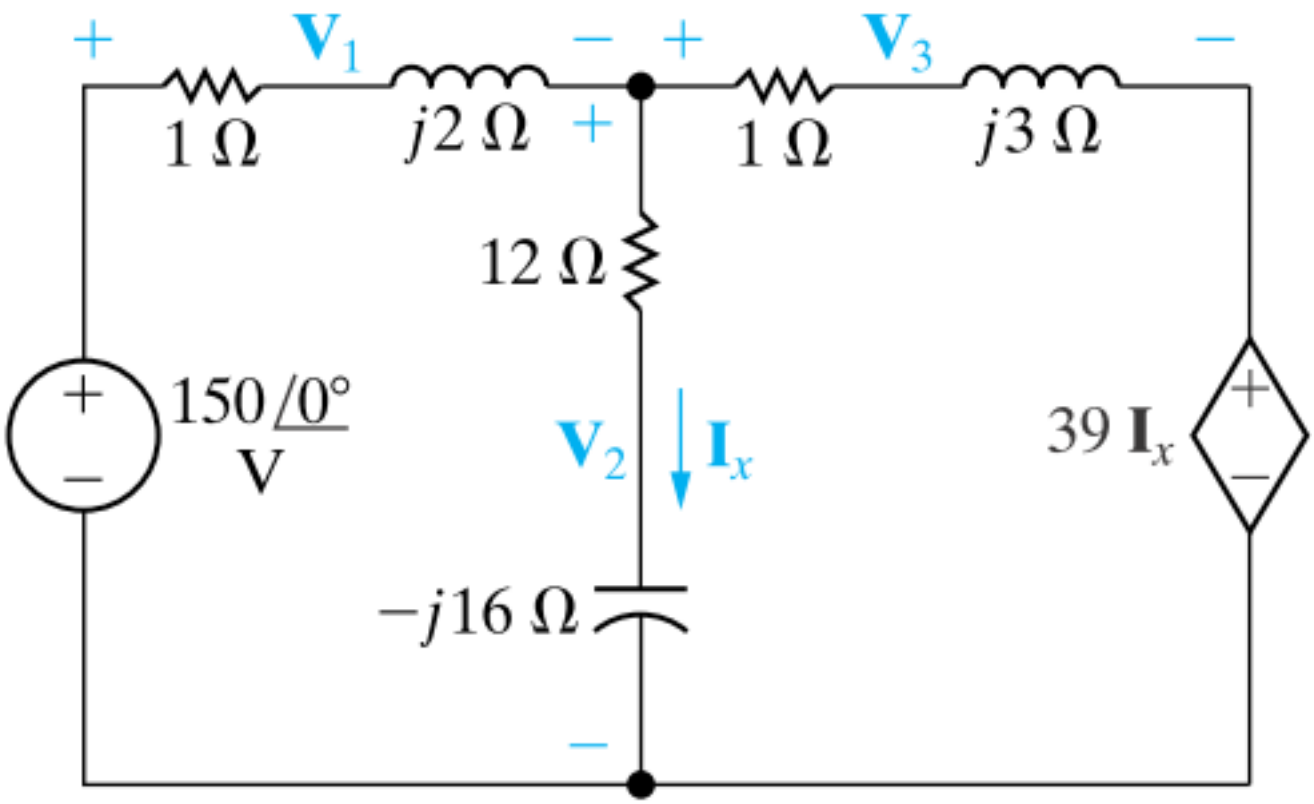
Ödev: Verilen devrede düğüm gerilim yöntemini kullanarak $\mathbf{V}_1$ ve $\mathbf{V}_2$ değerlerini hesağlayınız. (Süper düğüm)



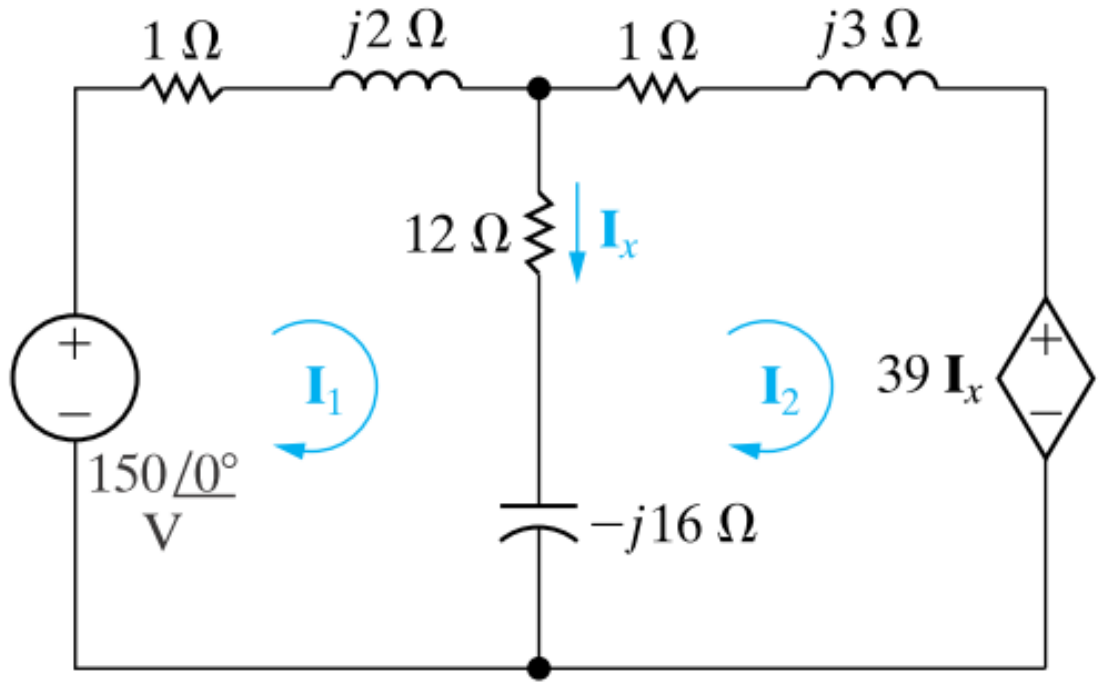
$$\mathbf{V}_1 = 38.72\angle 69.67^\circ \text{ V}, \mathbf{V}_2 = 6.752\angle 165.7^\circ \text{ V}.$$

Ağ Akım Yöntemi

Soru: Verilen devrede ağ akım yöntemini kullanarak $\mathbf{V}_1$, $\mathbf{V}_2$ ve $\mathbf{V}_3$ değerlerini hesağlayınız.



Ağ Akım Yöntemi



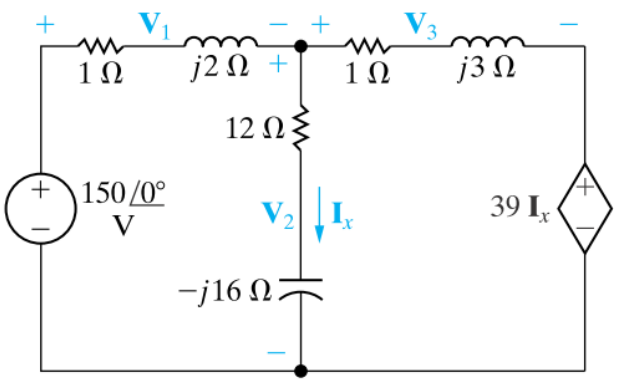
$$150 = (1 + j2)\mathbf{I}_1 + (12 - j16)(\mathbf{I}_1 - \mathbf{I}_2),$$

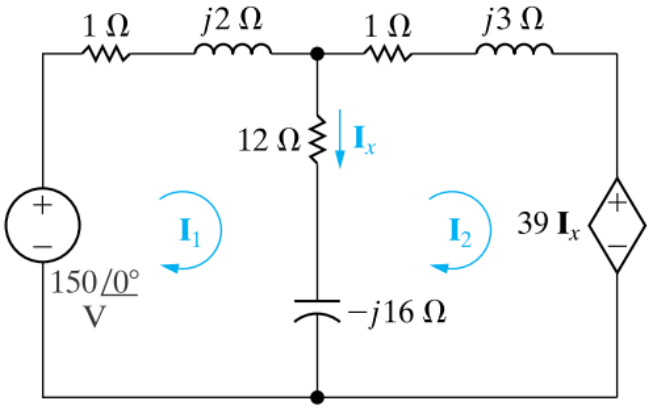
$$150 = (13 - j14)\mathbf{I}_1 - (12 - j16)\mathbf{I}_2.$$

$$0 = (12 - j16)(\mathbf{I}_2 - \mathbf{I}_1) + (1 + j3)\mathbf{I}_2 + 39\mathbf{I}_x. \qquad \mathbf{I}_x = \mathbf{I}_1 - \mathbf{I}_2.$$

$$0 = (27 + j16)\mathbf{I}_1 - (26 + j13)\mathbf{I}_2.$$

Ağ Akım Yöntemi





$$\mathbf{I}_1 = -26 - j52 \text{ A},$$

$$\mathbf{I}_2 = -24 - j58 \text{ A},$$

$$\mathbf{I}_x = -2 + j6 \text{ A}.$$

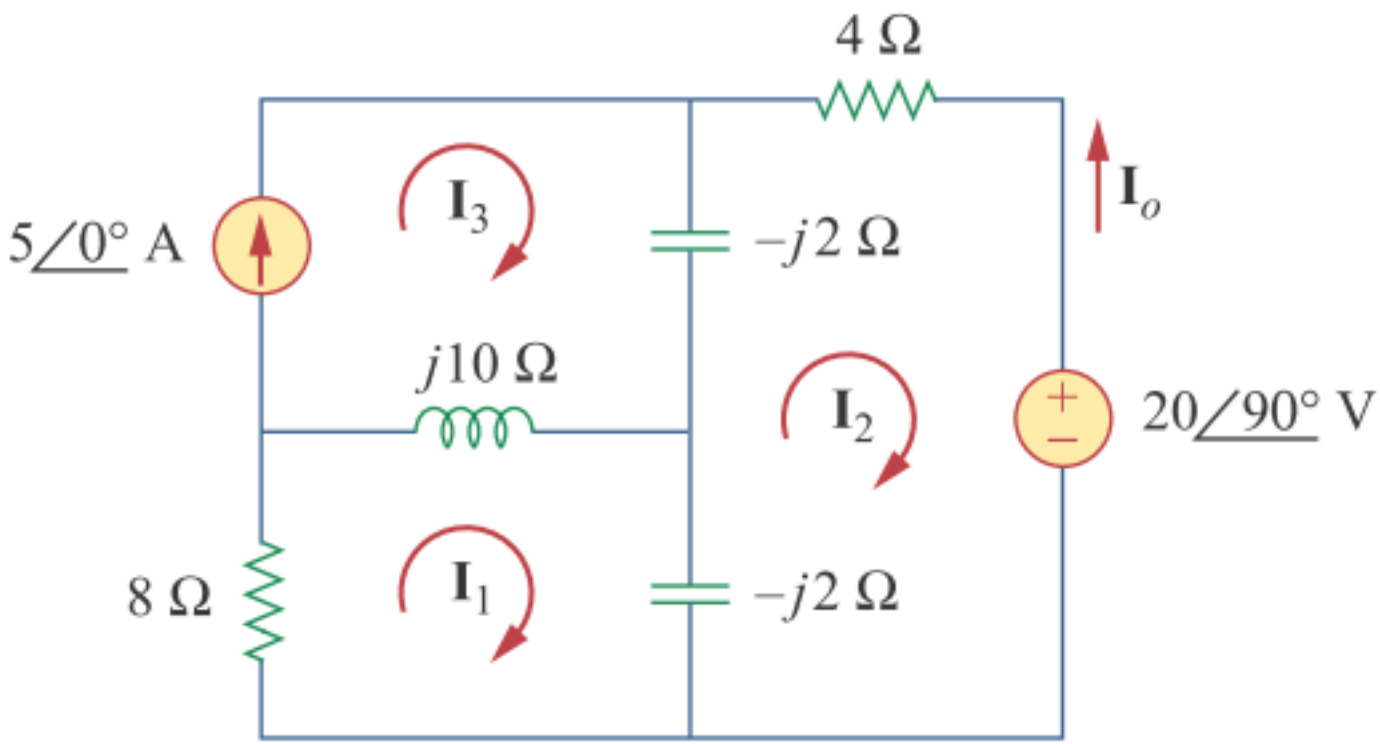
$$\mathbf{V}_1 = (1 + j2)\mathbf{I}_1 = 78 - j104 \text{ V},$$

$$\mathbf{V}_2 = (12 - j16)\mathbf{I}_x = 72 + j104 \text{ V},$$

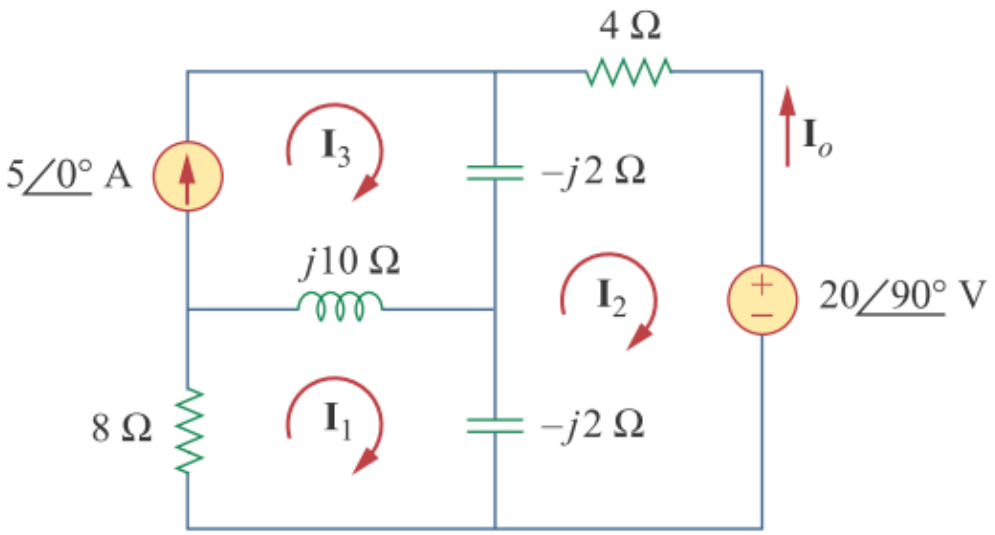
$$\mathbf{V}_3 = (1 + j3)\mathbf{I}_2 = 150 - j130 \text{ V}.$$

Ağ Akım Yöntemi

Soru: Verilen devrede $\mathbf{I}_0$ akımını bulunuz.



Ağ Akım Yöntemi



$$(8 + j10 - j2)\mathbf{I}_1 - (-j2)\mathbf{I}_2 - j10\mathbf{I}_3 = 0$$

$$(4 - j2 - j2)\mathbf{I}_2 - (-j2)\mathbf{I}_1 - (-j2)\mathbf{I}_3 + 20\angle 90° = 0$$

$$\mathbf{I}_3 = 5.$$

$$(8 + j8)\mathbf{I}_1 + j2\mathbf{I}_2 = j50$$

$$j2\mathbf{I}_1 + (4 - j4)\mathbf{I}_2 = -j20 - j10$$

$$\begin{bmatrix} 8 + j8 & j2 \\ j2 & 4 - j4 \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} j50 \\ -j30 \end{bmatrix}$$

Ağ Akım Yöntemi

$$\begin{bmatrix} 8+j8 & j2 \\ j2 & 4-j4 \end{bmatrix}\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} j50 \\ -j30 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 8+j8 & j2 \\ j2 & 4-j4 \end{vmatrix} = 32(1+j)(1-j) + 4 = 68$$

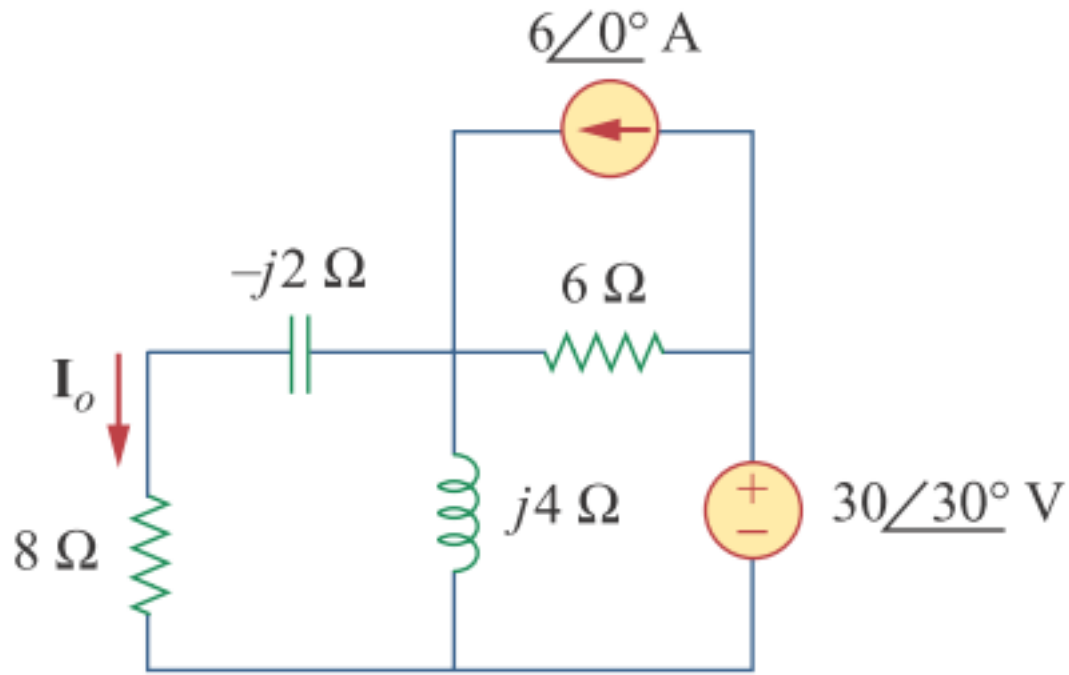
$$\Delta_2 = \begin{vmatrix} 8+j8 & j50 \\ j2 & -j30 \end{vmatrix} = 340 - j240 = 416.17\angle -35.22^\circ$$

$$\mathbf{I}_2 = \frac{\Delta_2}{\Delta} = \frac{416.17\angle -35.22^\circ}{68} = 6.12\angle -35.22^\circ \text{ A}$$

$$\mathbf{I}_o = -\mathbf{I}_2 = 6.12\angle 144.78^\circ \text{ A}$$

Ağ Akım Yöntemi

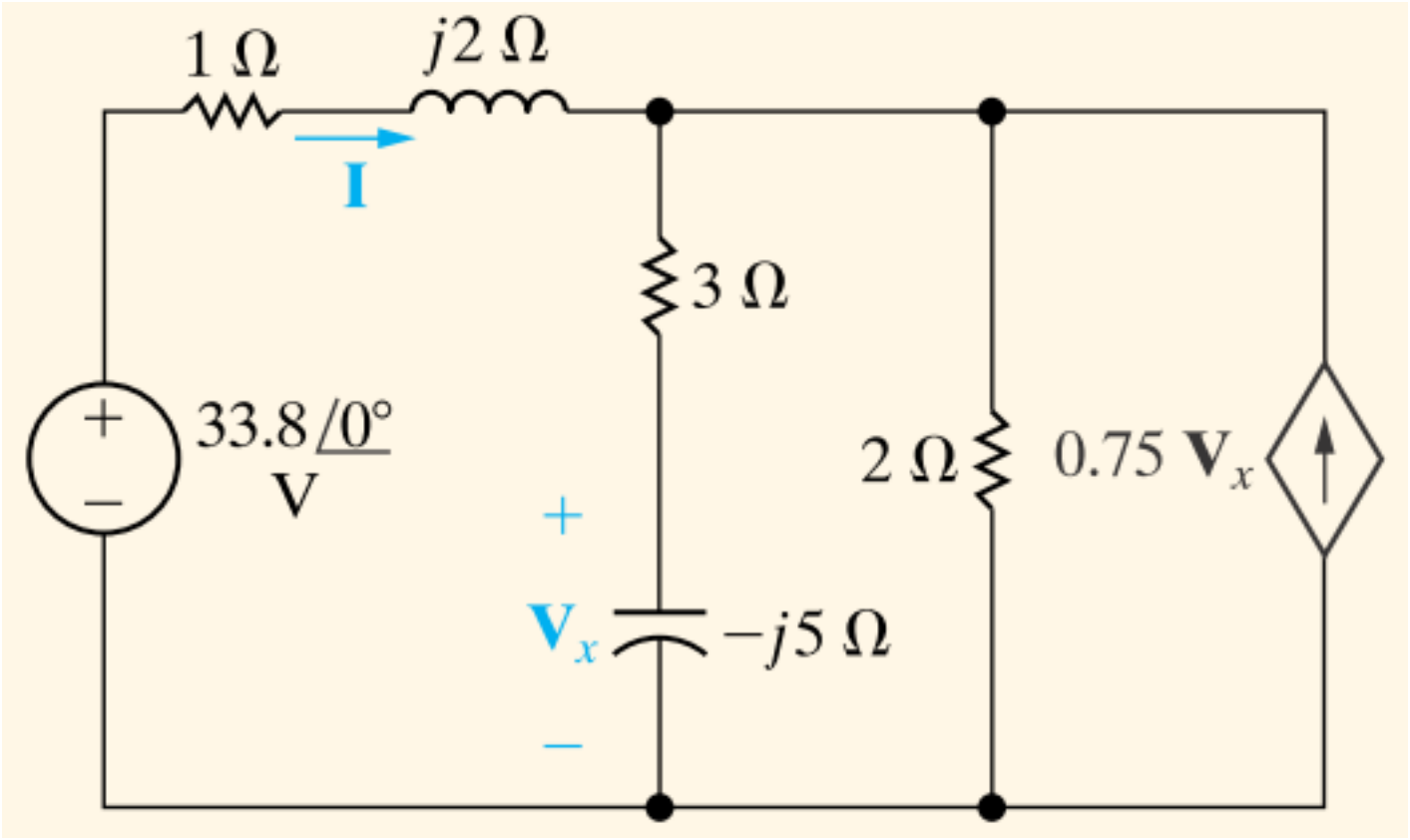
Ödev: Verilen devrede $\mathbf{I}_o$ fazör akımını bulunuz.



$3.582\angle 65.45°$ A.

Ağ Akım Yöntemi

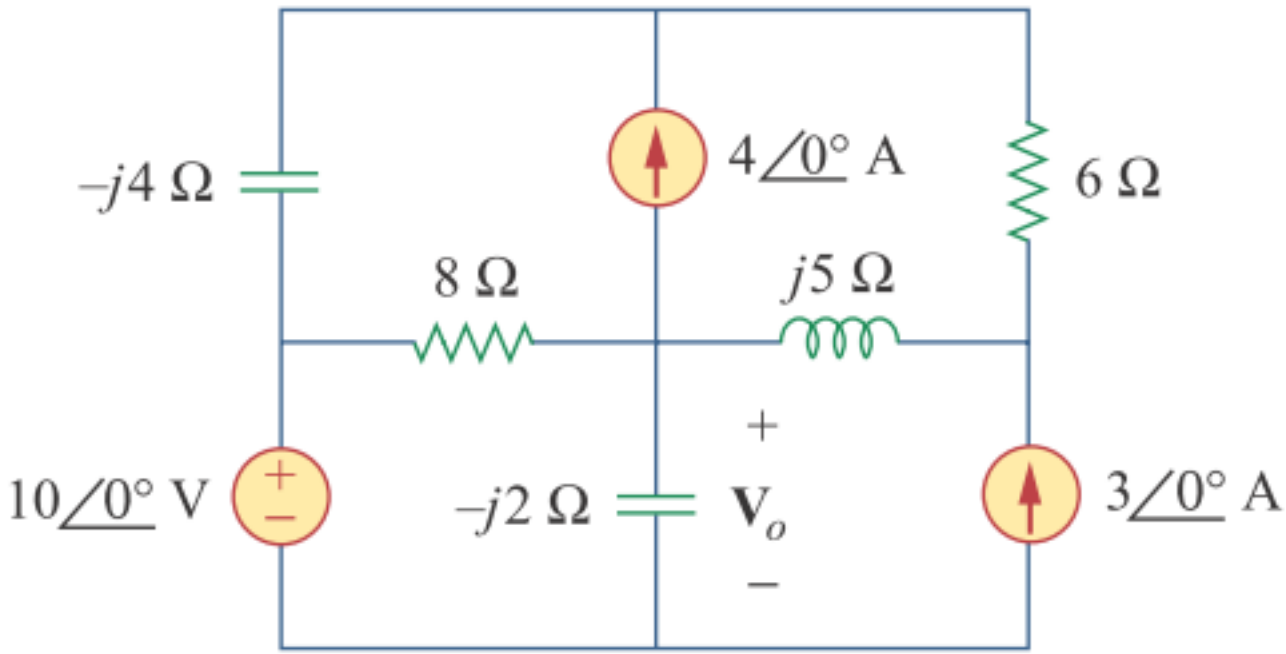
Ödev: Verilen devrede $\mathbf{I}$ fazör akımını bulunuz.



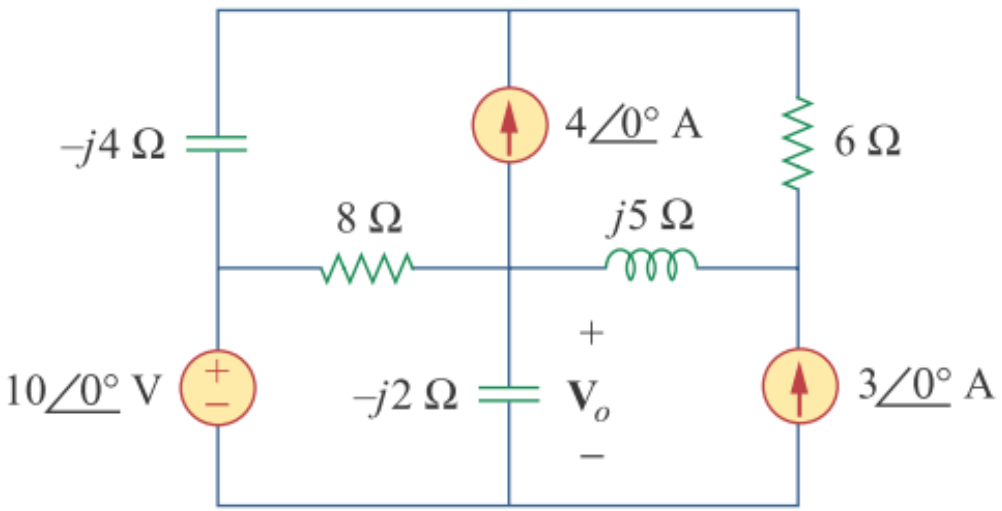
$$\mathbf{I} = 29 + j2 = 29.07 \angle 3.95^\circ \text{ A}.$$

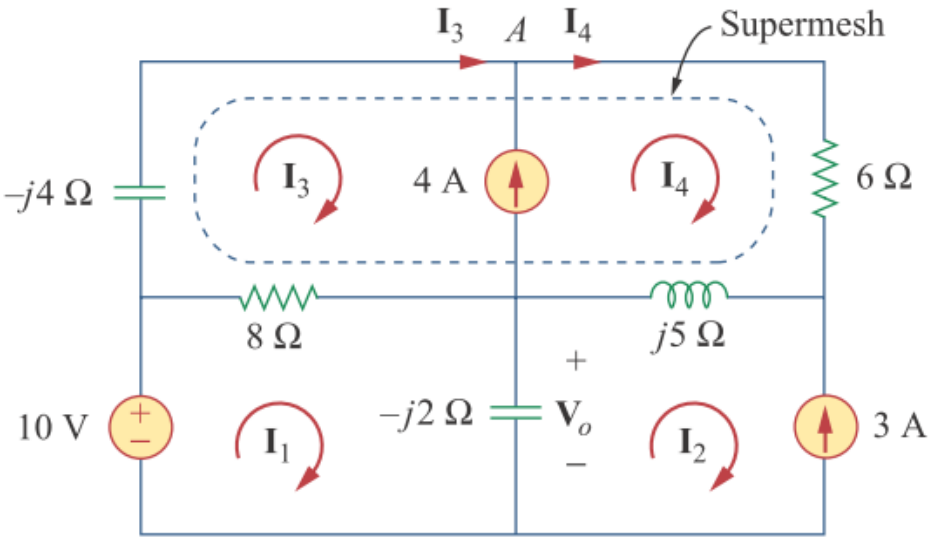
Ağ Akım Yöntemi

Soru: Verilen devrede $\mathbf{V}_o$ fazör gerilimini bulunuz.

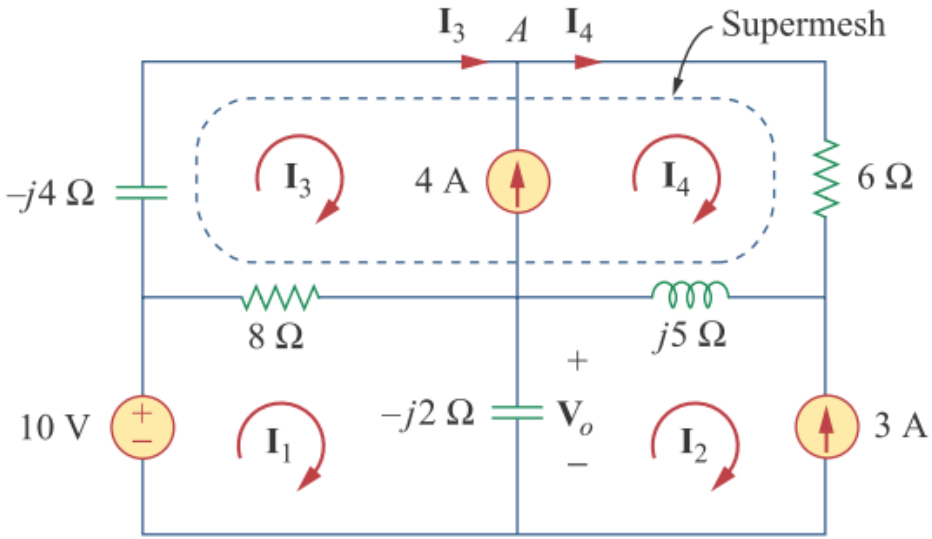


Ağ Akım Yöntemi





Ağ Akım Yöntemi



$$-10 + (8 - j2)\mathbf{I}_1 - (-j2)\mathbf{I}_2 - 8\mathbf{I}_3 = 0$$

$$(8 - j2)\mathbf{I}_1 + j2\mathbf{I}_2 - 8\mathbf{I}_3 = 10$$

$$\mathbf{I}_2 = -3$$

$$(8 - j4)\mathbf{I}_3 - 8\mathbf{I}_1 + (6 + j5)\mathbf{I}_4 - j5\mathbf{I}_2 = 0$$

$$\mathbf{I}_4 = \mathbf{I}_3 + 4$$

Ağ Akım Yöntemi

$$(8 - j4)\mathbf{I}_3 - 8\mathbf{I}_1 + (6 + j5)\mathbf{I}_4 - j5\mathbf{I}_2 = 0$$

$$\mathbf{I}_4 = \mathbf{I}_3 + 4$$

$$-8\mathbf{I}_1 + (14 + j)\mathbf{I}_3 = -24 - j35$$

Ağ Akım Yöntemi

$$-10 + (8 - j2)\mathbf{I}_1 - (-j2)\mathbf{I}_2 - 8\mathbf{I}_3 = 0$$

$$(8 - j2)\mathbf{I}_1 + j2\mathbf{I}_2 - 8\mathbf{I}_3 = 10$$

$$\mathbf{I}_2 = -3$$

$$(8 - j2)\mathbf{I}_1 - 8\mathbf{I}_3 = 10 + j6$$

$$-8\mathbf{I}_1 + (14 + j)\mathbf{I}_3 = -24 - j35$$

$$\begin{bmatrix} 8 - j2 & -8 \\ -8 & 14 + j \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_3 \end{bmatrix} = \begin{bmatrix} 10 + j6 \\ -24 - j35 \end{bmatrix}$$

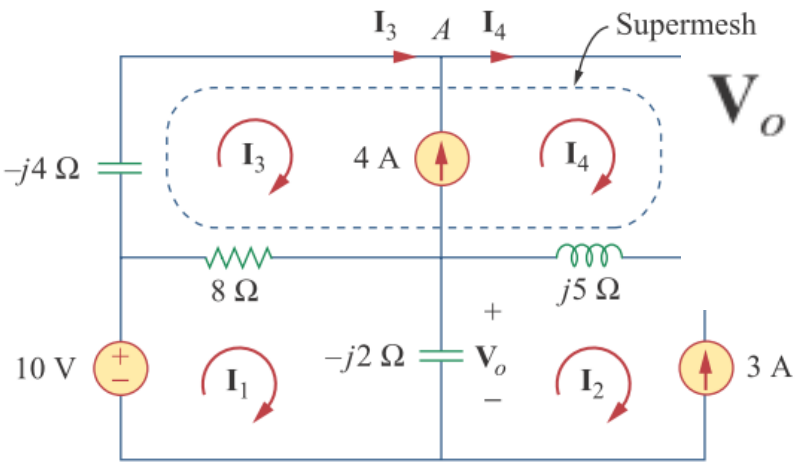
Ağ Akım Yöntemi

$$\Delta = \begin{vmatrix} 8 - j2 & -8 \\ -8 & 14 + j \end{vmatrix} = 112 + j8 - j28 + 2 - 64 = 50 - j20$$

$$\Delta_1 = \begin{vmatrix} 10 + j6 & -8 \\ -24 - j35 & 14 + j \end{vmatrix} = 140 + j10 + j84 - 6 - 192 - j280$$

$$= -58 - j186$$

$$\mathbf{I}_1 = \frac{\Delta_1}{\Delta} = \frac{-58 - j186}{50 - j20} = 3.618\angle 274.5^\circ \text{ A}$$

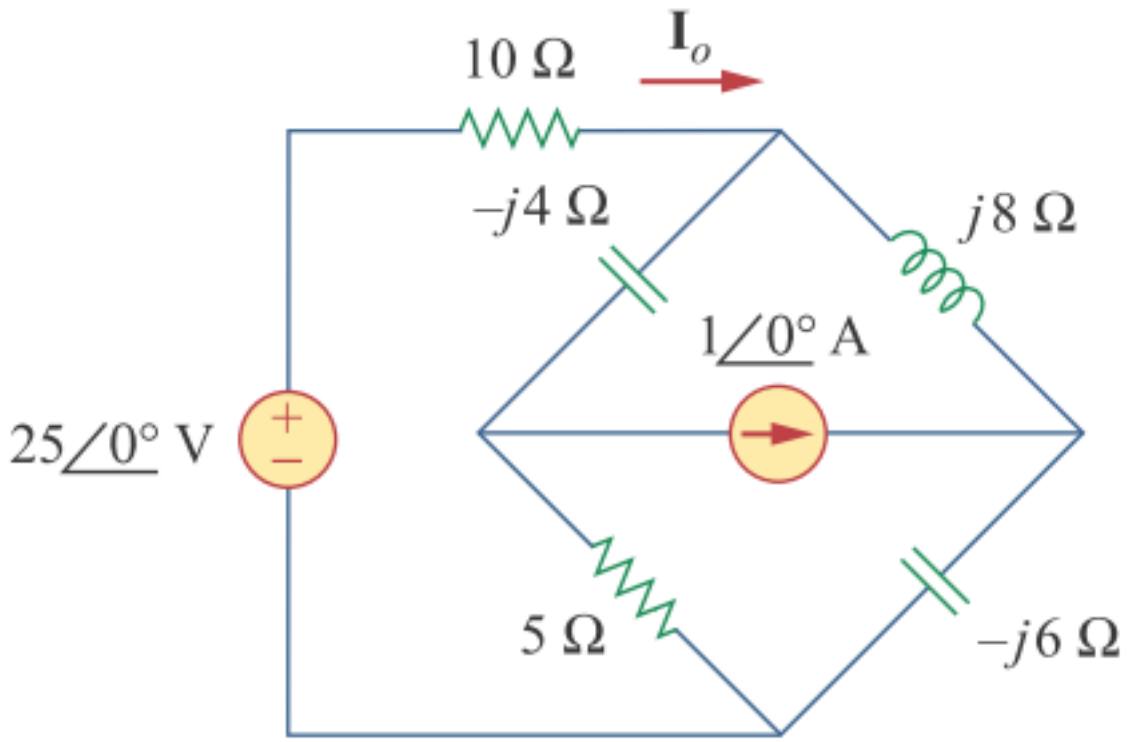


$$\mathbf{V}_o = -j2(\mathbf{I}_1 - \mathbf{I}_2) = -j2(3.618\angle 274.5^\circ + 3)$$

$$= -7.2134 - j6.568 = 9.756\angle 222.32^\circ \text{ V}$$

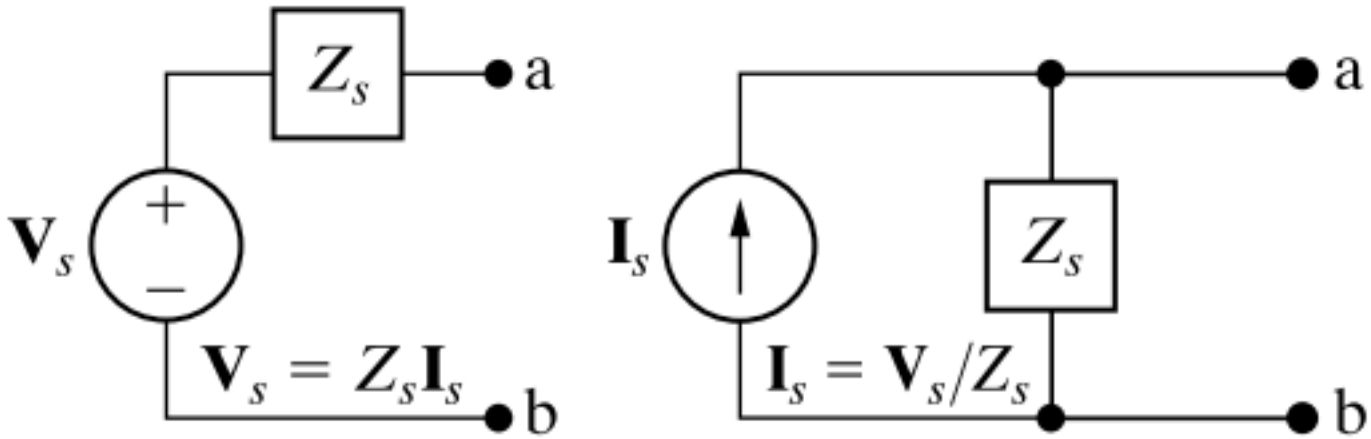
Ağ Akım Yöntemi

Ödev: Verilen devrede $\mathbf{I}_o$ akımını hesaplayınız.



$2.538\angle 5.943°$ A.

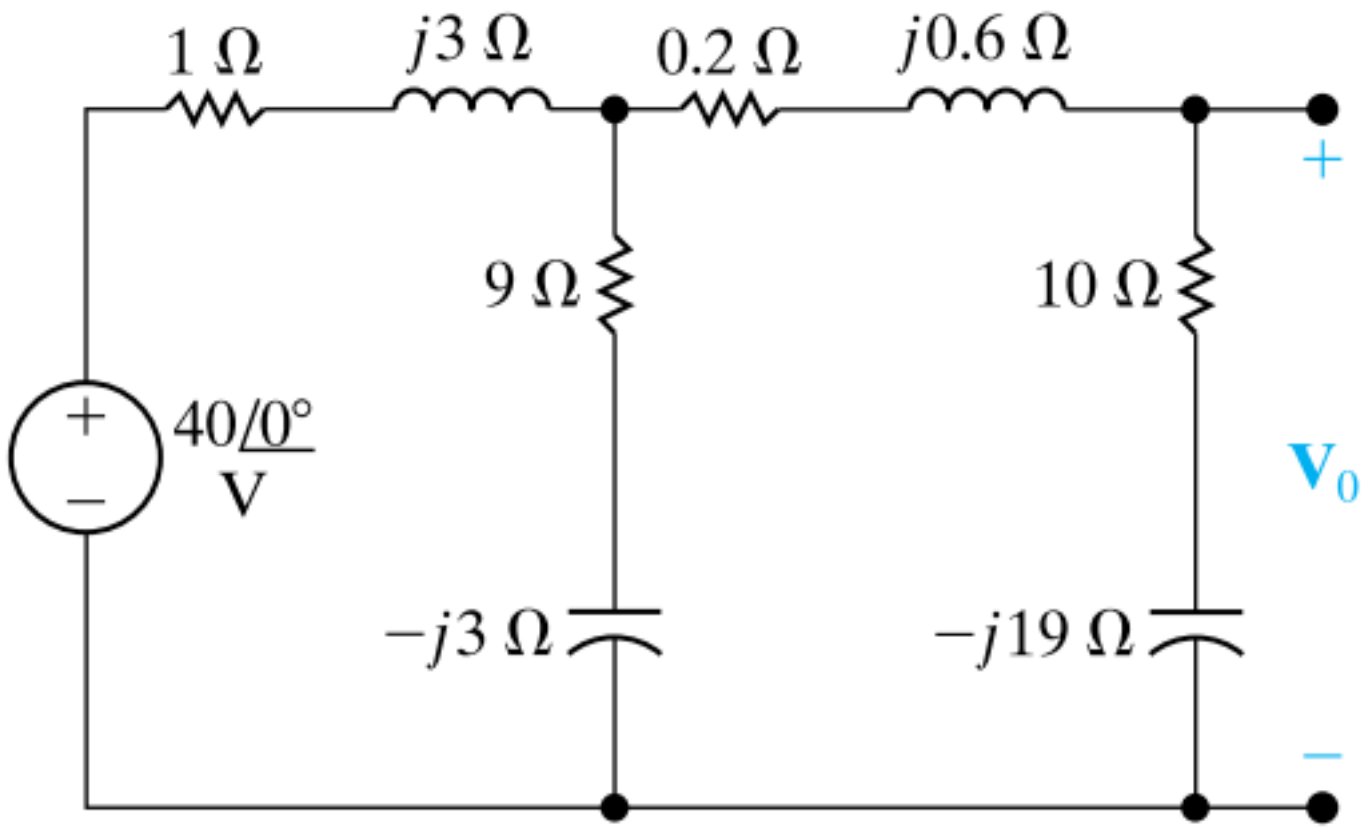
Kaynak Dönüşümü



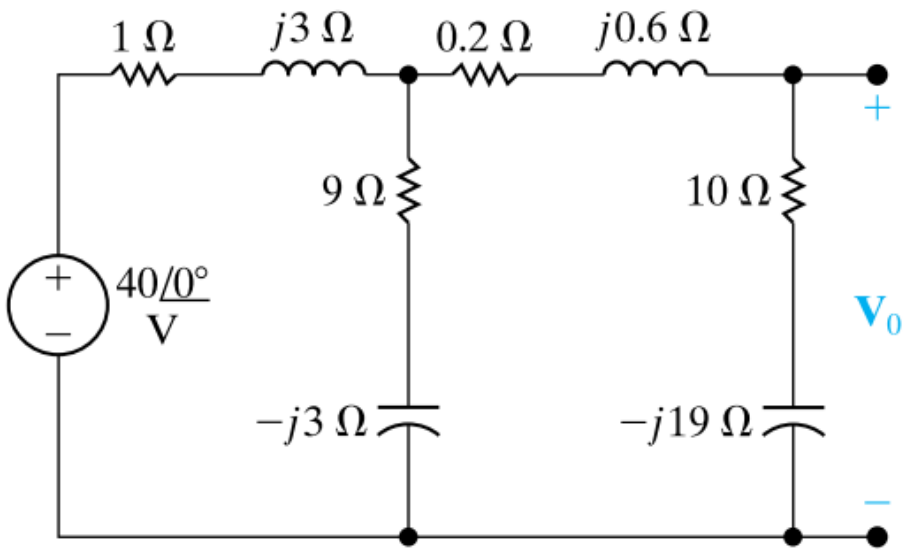
Frekans uzayında kaynak dönüşümü

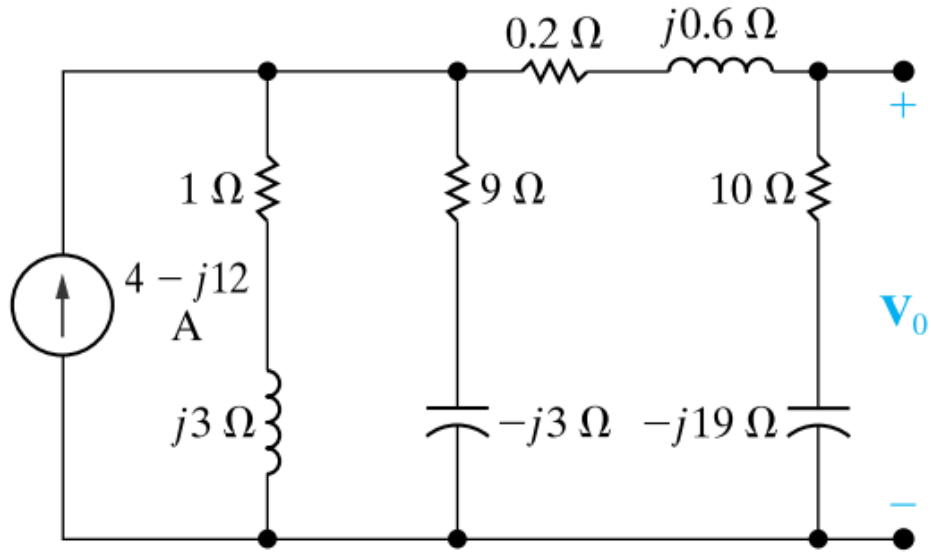
Kaynak Dönüşümü

Soru: Verilen devrede kaynak dönüşümü yöntentemini kullanarak V_0 fazör voltajını bulunuz.



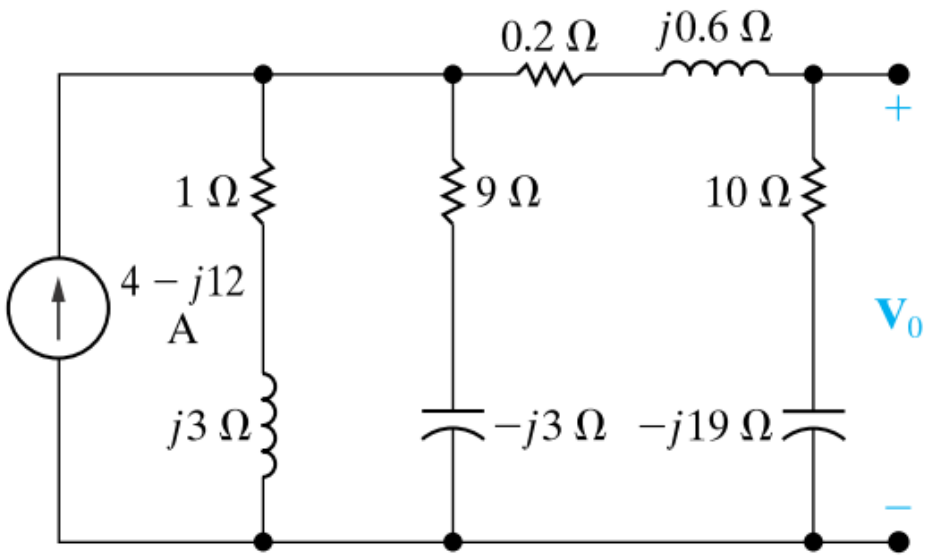
Kaynak Dönüşümü

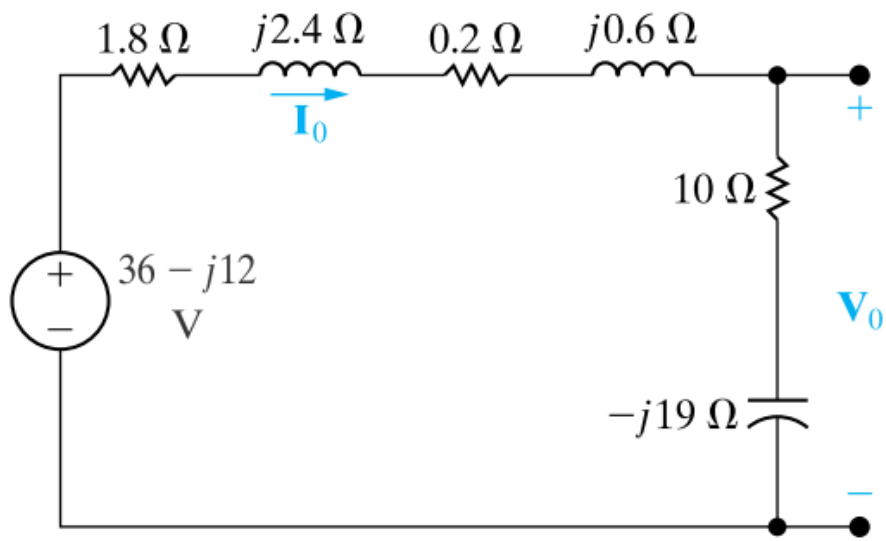




$$\mathbf{I} = \frac{40}{1 + j3} = \frac{40}{10}(1 - j3) = 4 - j12 \text{ A}.$$

Kaynak Dönüşümü

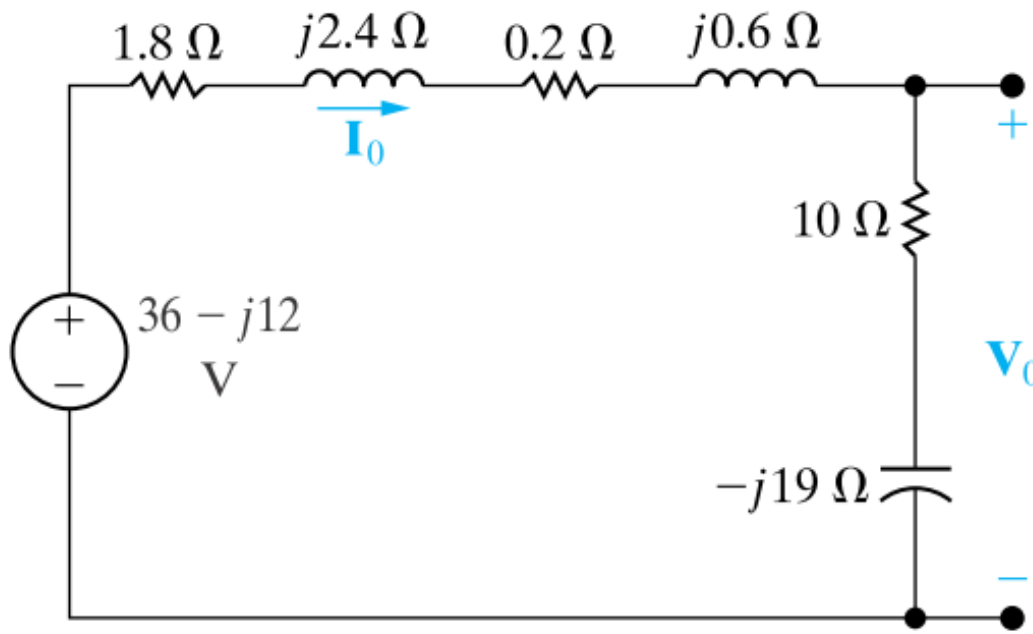




$$Z = \frac{(1 + j3)(9 - j3)}{10} = 1.8 + j2.4\ \Omega,$$

$$\mathbf{V} = (4 - j12)(1.8 + j2.4) = 36 - j12\ \mathrm{V}.$$

Kaynak Dönüşümü



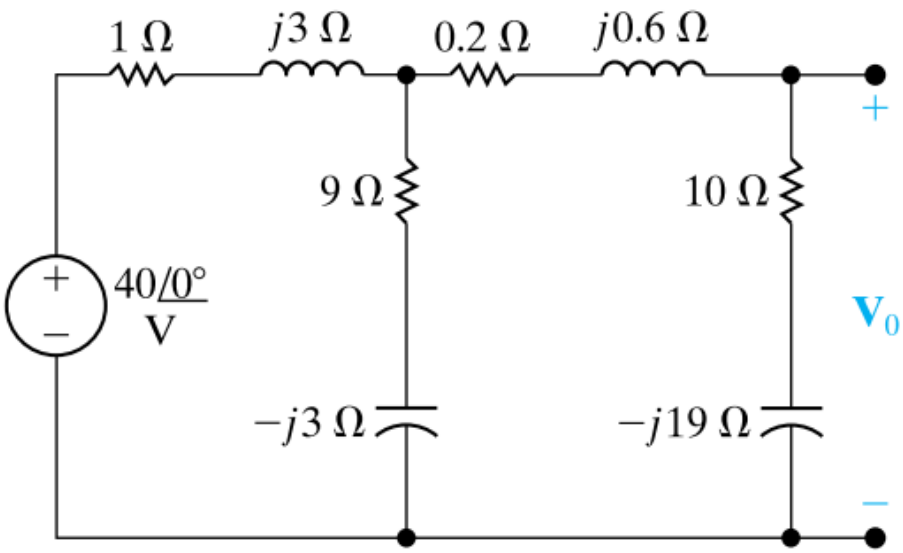
$$\mathbf{I}_0 = \frac{36 - j12}{12 - j16} = \frac{12(3 - j1)}{4(3 - j4)}$$

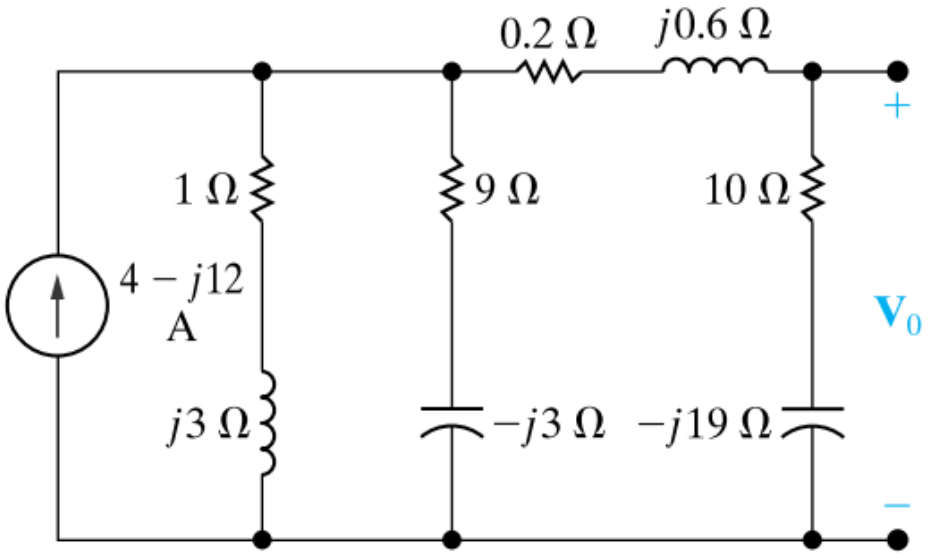
$$= \frac{39 + j27}{25} = 1.56 + j1.08 \text{ A}.$$

$$\mathbf{V}_0 = (1.56 + j1.08)(10 - j19)$$

$$= 36.12 - j18.84 \text{ V}.$$

Kaynak Dönüşümü

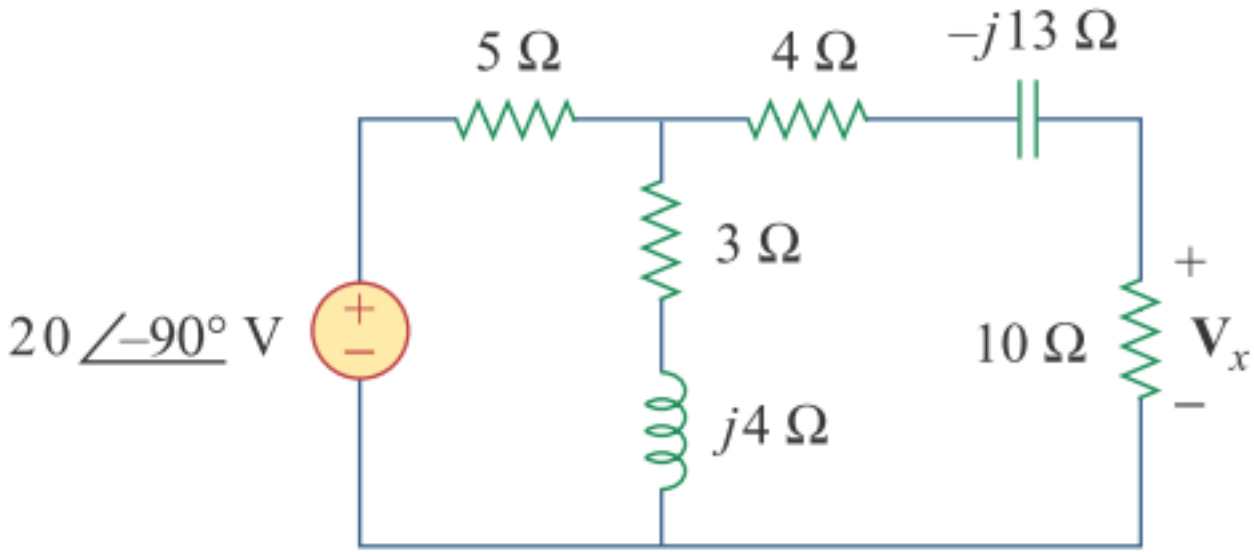




$$\mathbf{I} = \frac{40}{1 + j3} = \frac{40}{10}(1 - j3) = 4 - j12 \text{ A}.$$

Kaynak Dönüşümü

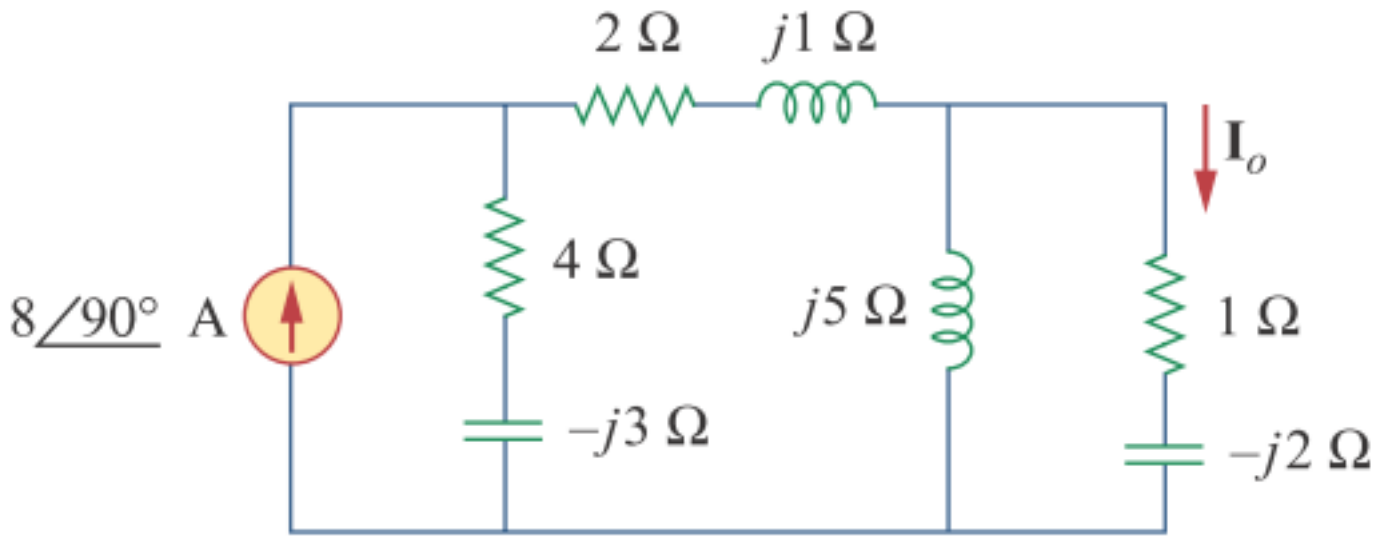
Ödev: Verilen devrede kaynak dönüşümü yöntentemini kullanarak V_x fazör voltajını bulunuz.



$$5.519\angle -28^\circ \text{ V}$$

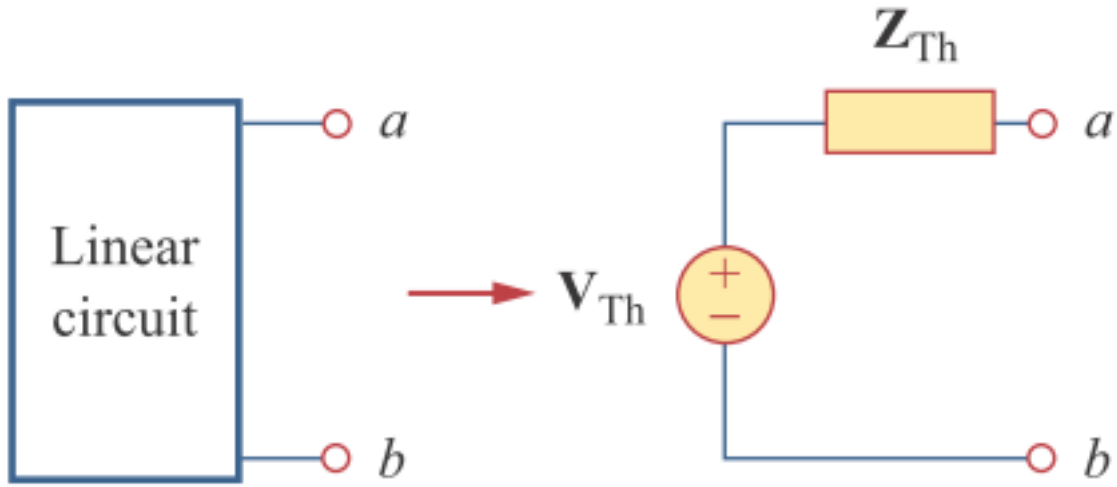
Kaynak Dönüşümü

Ödev: Verilen devrede kaynak dönüşümü yöntentemini kullanarak I_o fazör akımını bulunuz.



$6.576\angle 99.46°$ A.

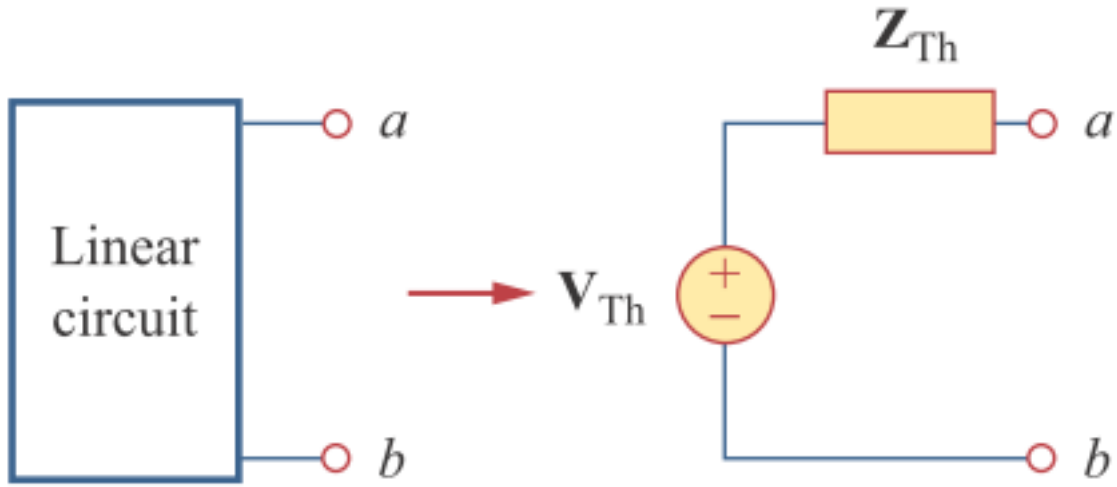
Thevenin Eşlenik Devreleri



Genel Çözüm

- Thevenin eşlenik devre bulunmak istenilen terminal açık devre yapılır.
  - $V_{oc} = V_{Th}$ olur.
- Thevenin eşlenik devre bulunmak istenilen terminal kısa devre yapılır ve I_{sc} bulunur.
  - $V_{oc}/I_{sc} = Z_{Th}$ olur

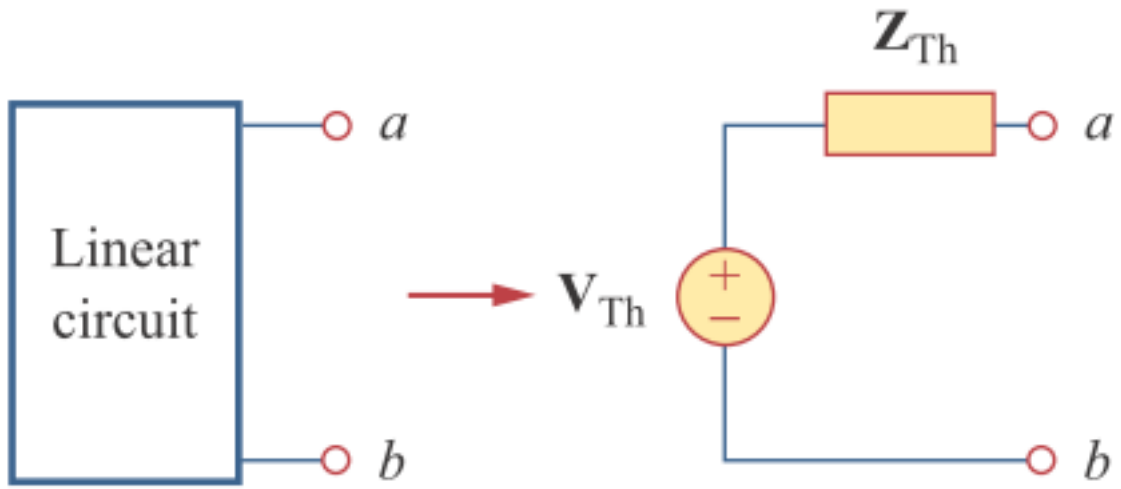
Thevenin Eşlenik Devreleri



Bağımlı kaynak yok ise

- Thevenin eşlenik devre bulunmak istenilen terminal açık devre yapılır.
  - $V_{oc} = V_{Th}$ olur.
- Devredeki akım kaynakları açık devre, voltaj kaynakları kısa devre yapılır ve terminalden görünen empedans Z_{Th} olur

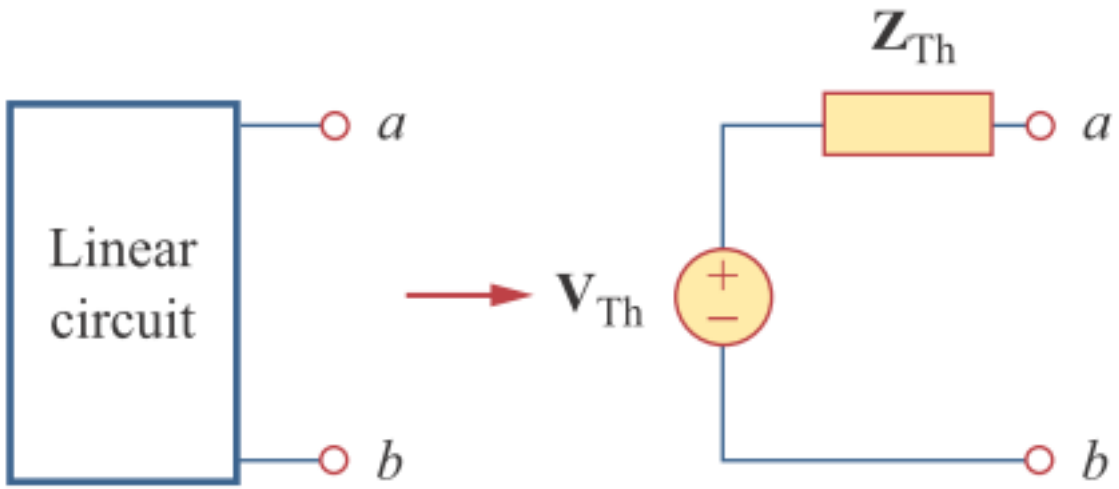
Thevenin Eşlenik Devreleri



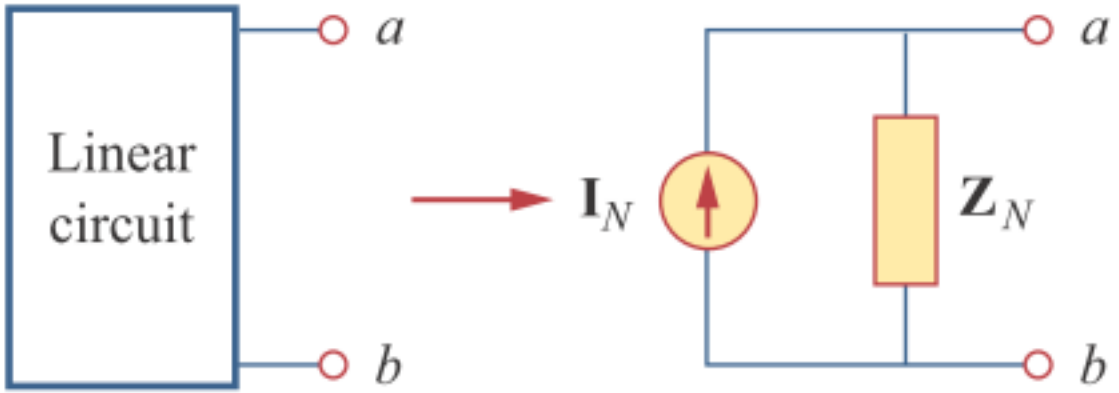
Bağımlı kaynak var ise

- Thevenin eşlenik devre bulunmak istenilen terminal açık devre yapılır.
  - $V_{oc} = V_{Th}$ olur.
- Bağımsız akım kaynakları açık devre, gerilim kaynakları kısa devre yapıldıktan sonra, Thevenin eşlenik devre bulunmak istenilen terminale test kaynağı bağlanılır. Bu kaynağın terminalindeki voltaj ve akım değerleri kullanılıarak Z_{Th} bulunur. $V_t/I_t = Z_{Th}$

Norton Eşlenik Devreleri

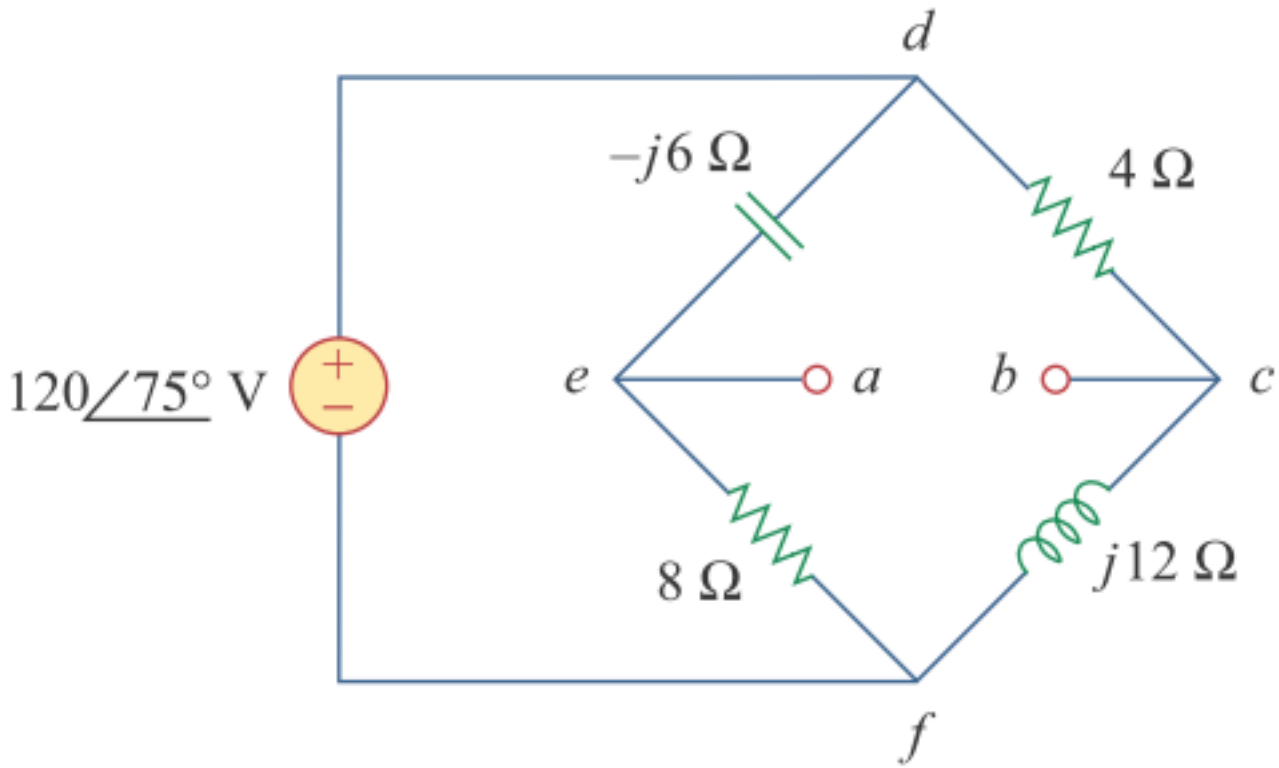


Thevenin Eşlenik bulunduktan sonra Norton Eşlenik devre kaynak çevrimi ile bulunabilir.
Veya $Z_N = Z_{Th}$ ve I_N terminal kısa devre yapılarak bulunur.

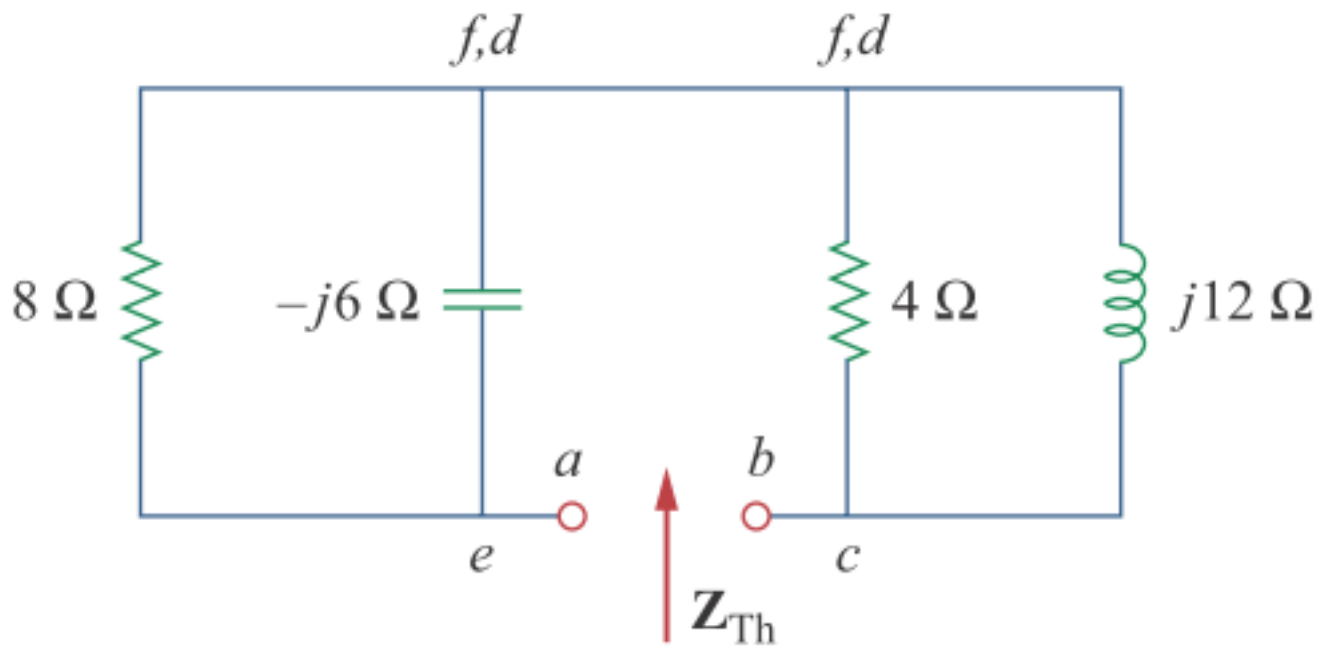


Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



Thevenin Eşlenik Devreleri



$$\mathbf{Z}_1 = -j6 \parallel 8 = \frac{-j6 \times 8}{8 - j6} = 2.88 - j3.84\ \Omega$$

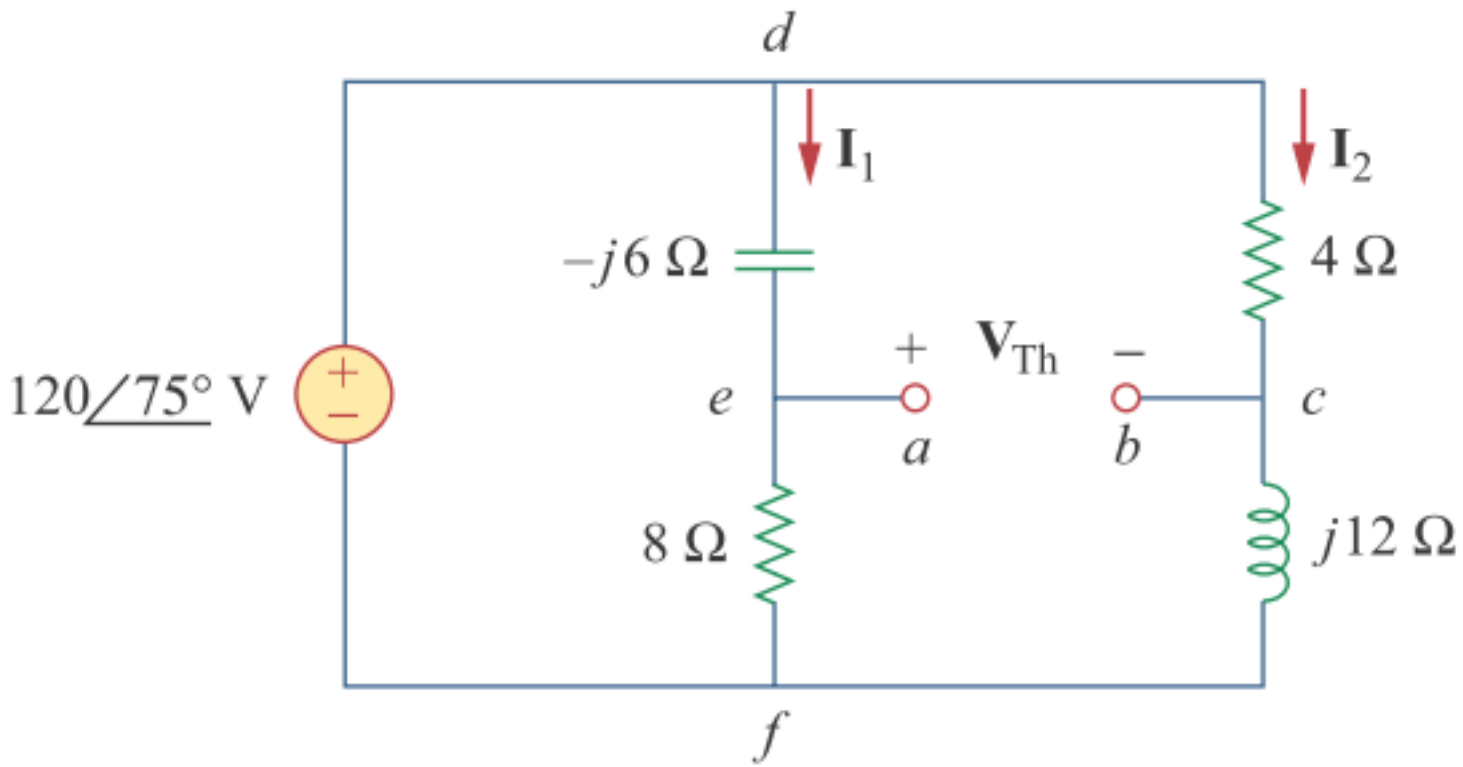
$$\mathbf{Z}_2 = 4 \parallel j12 = \frac{j12 \times 4}{4 + j12} = 3.6 + j1.2\ \Omega$$

$$\mathbf{Z}_{\text{Th}} = \mathbf{Z}_1 + \mathbf{Z}_2 =$$

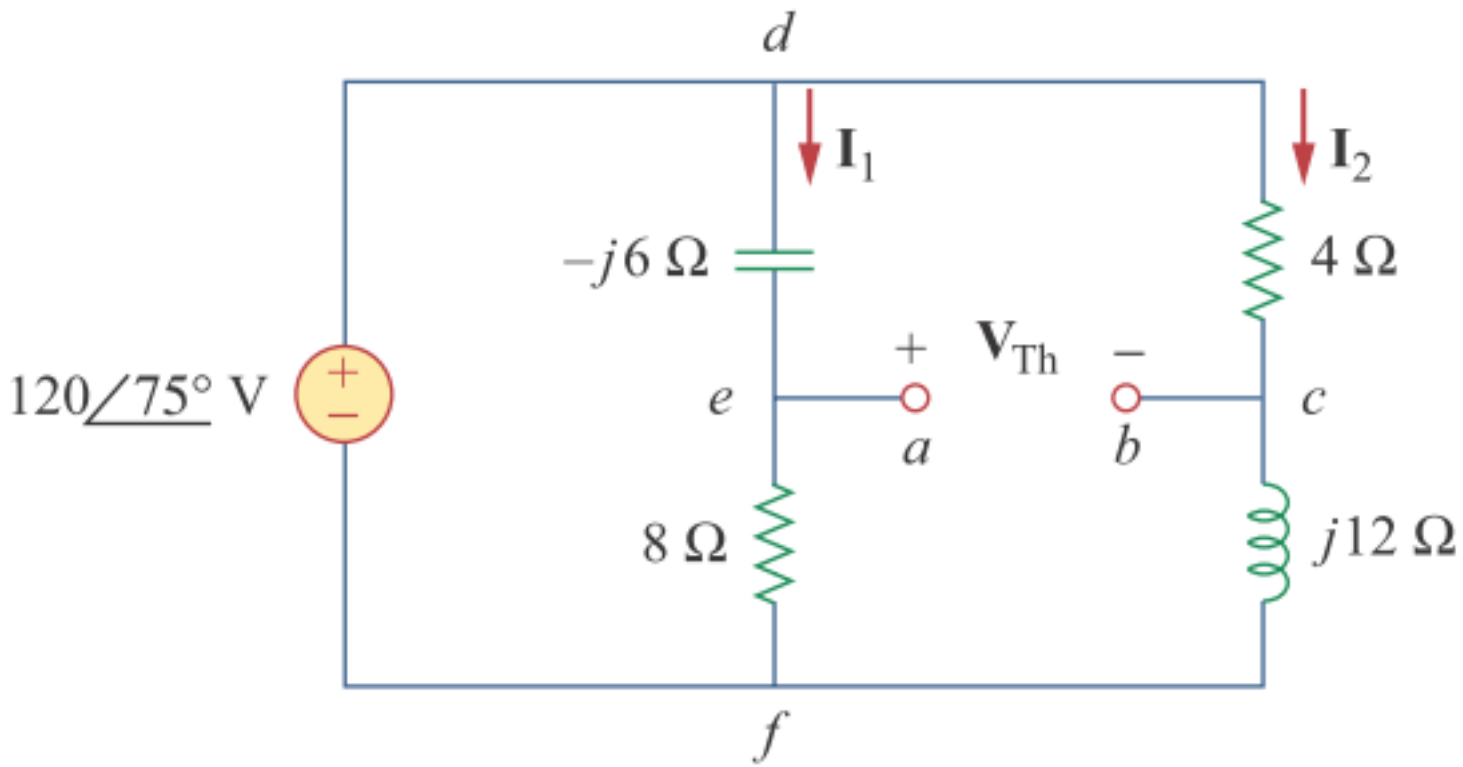
$$6.48 - j2.64\ \Omega$$

Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



Thevenin Eşlenik Devreleri



$$\mathbf{I}_1 = \frac{120\angle 75^\circ}{8 - j6}\ \text{A}, \qquad \mathbf{I}_2 = \frac{120\angle 75^\circ}{4 + j12}\ \text{A}$$

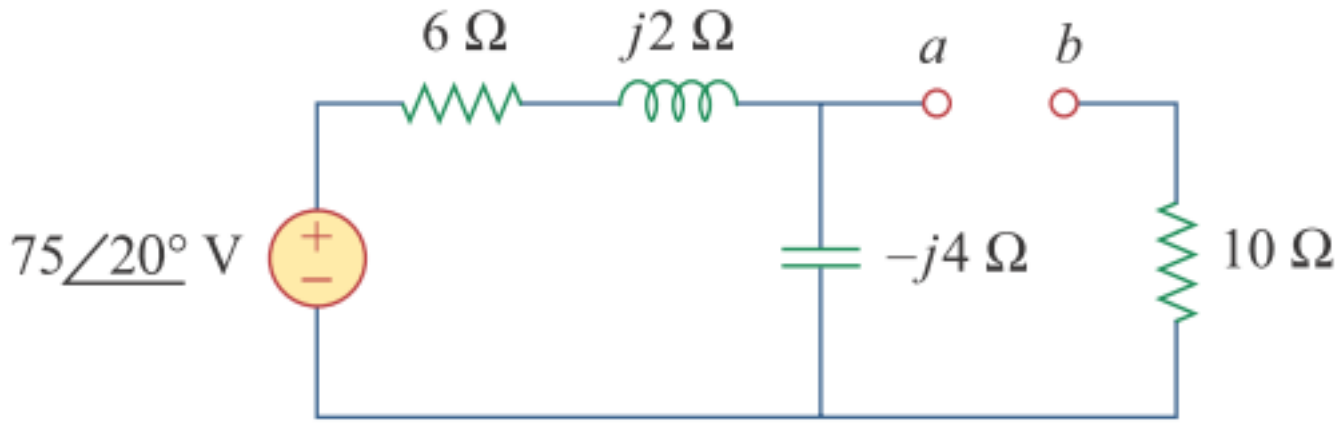
$$bcdeab$$

$$\mathbf{V}_{\text{Th}} - 4\mathbf{I}_2 + (-j6)\mathbf{I}_1 = 0$$

$$= 37.95\angle 220.31^\circ\ \text{V}$$

Thevenin Eşlenik Devreleri

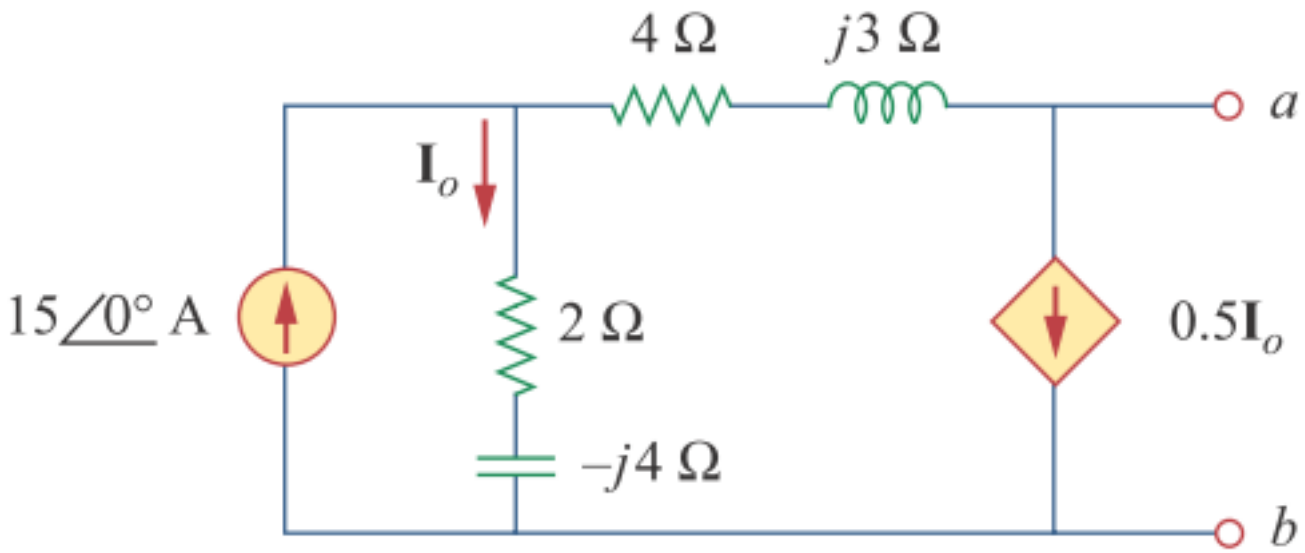
Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.



$$\mathbf{Z}_{\text{Th}} = 12.4 - j3.2\ \Omega, \mathbf{V}_{\text{Th}} = 47.42\angle -51.57^\circ\ \text{V}.$$

Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



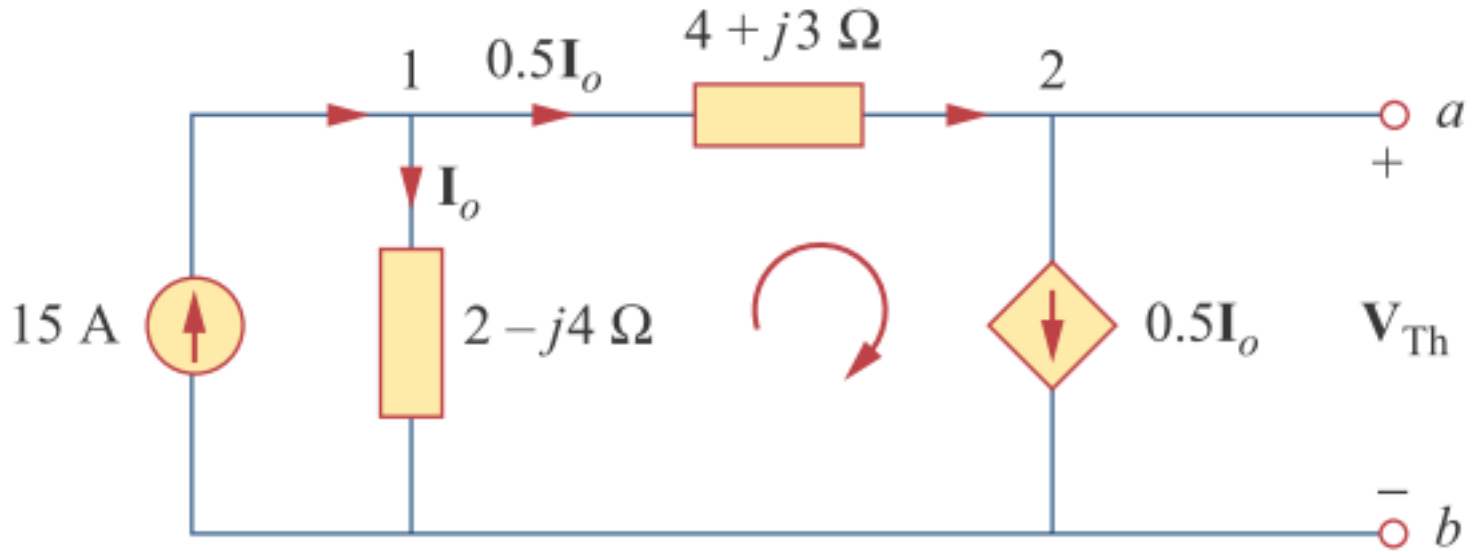
$$15 = \mathbf{I}_o + 0.5\mathbf{I}_o \quad \Rightarrow \quad \mathbf{I}_o = 10 \text{ A}$$

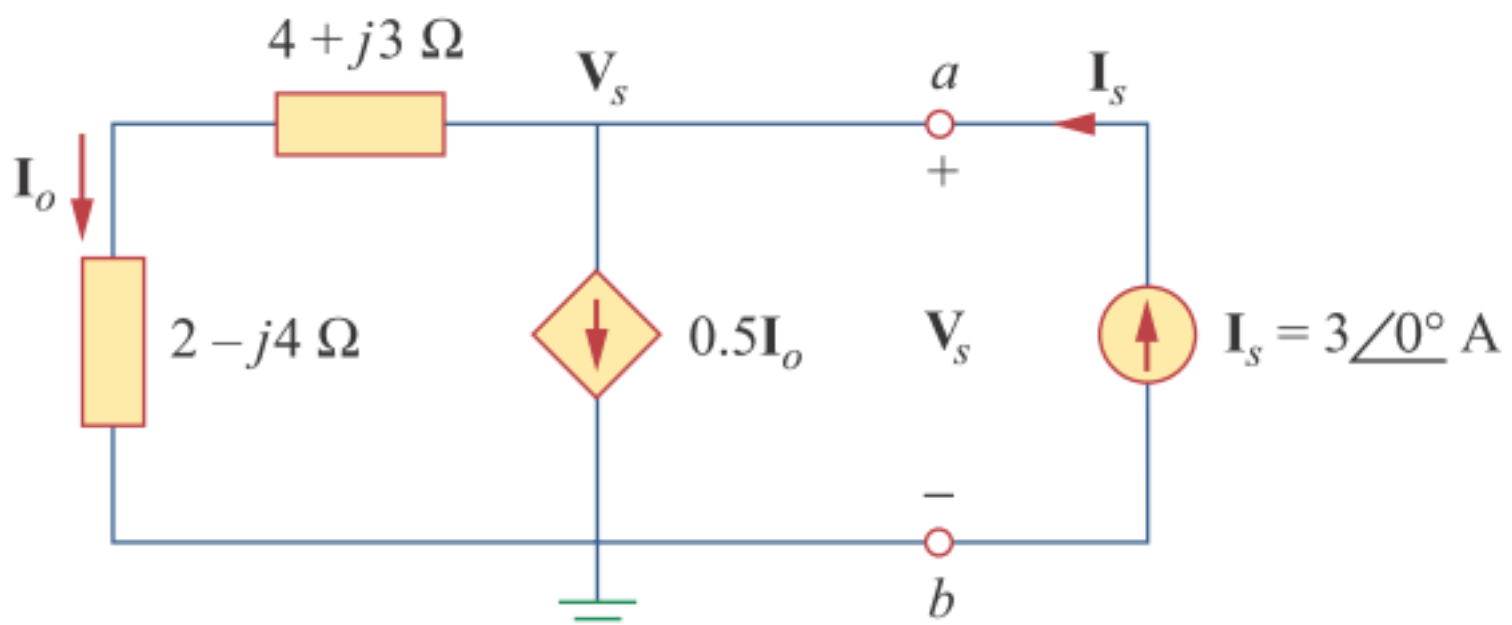
$$\mathbf{V}_{\text{Th}} = 10(2 - j4) - 5(4 + j3) = -j55$$

$$\mathbf{V}_{\text{Th}} = 55\angle -90^\circ \text{ V}$$

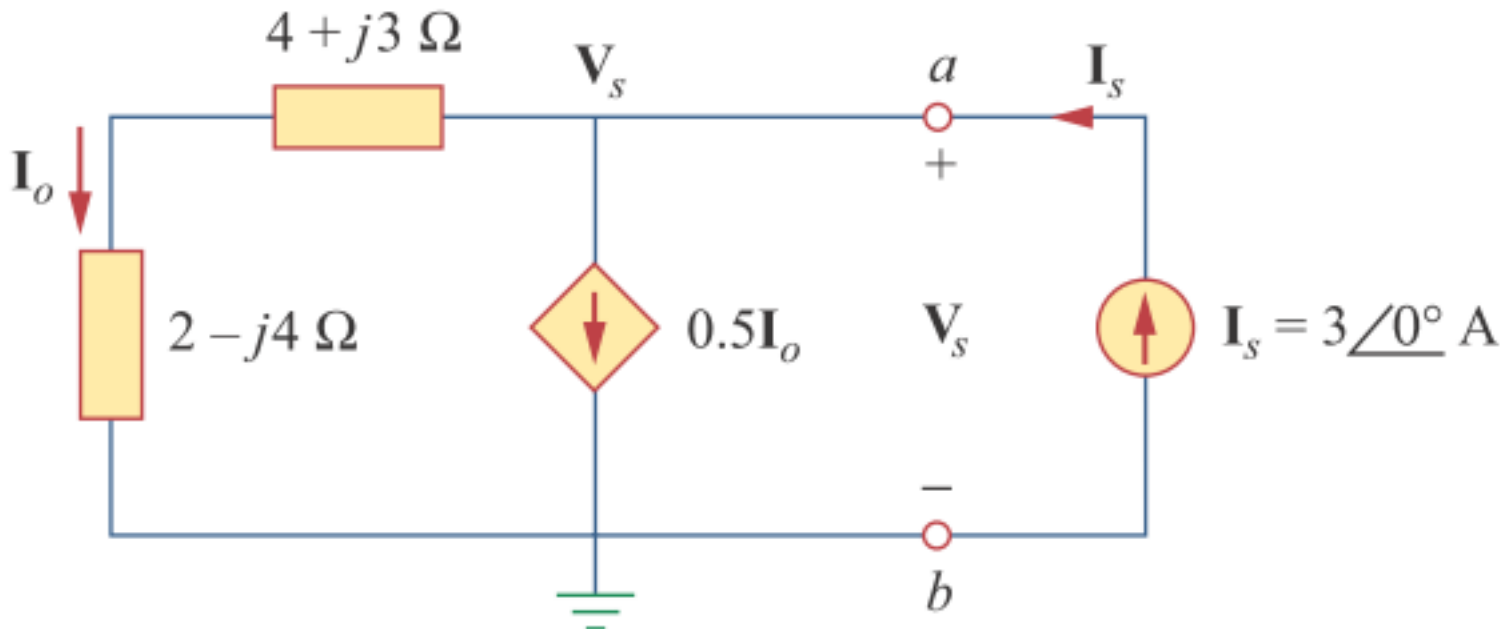
Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.





Thevenin Eşlenik Devreleri



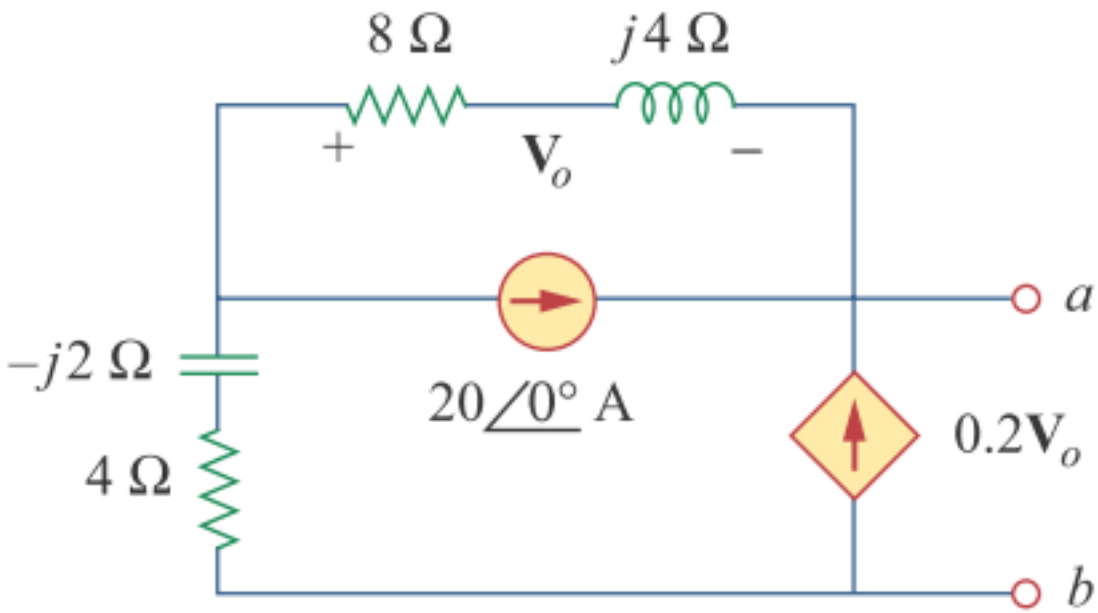
$$3 = \mathbf{I}_o + 0.5\mathbf{I}_o \quad \Rightarrow \quad \mathbf{I}_o = 2 \text{ A}$$

$$\mathbf{V}_s = \mathbf{I}_o(4 + j3 + 2 - j4) = 2(6 - j)$$

$$\mathbf{Z}_{\text{Th}} = \frac{\mathbf{V}_s}{\mathbf{I}_s} = \frac{2(6 - j)}{3} = 4 - j0.6667\ \Omega$$

Thevenin Eşlenik Devreleri

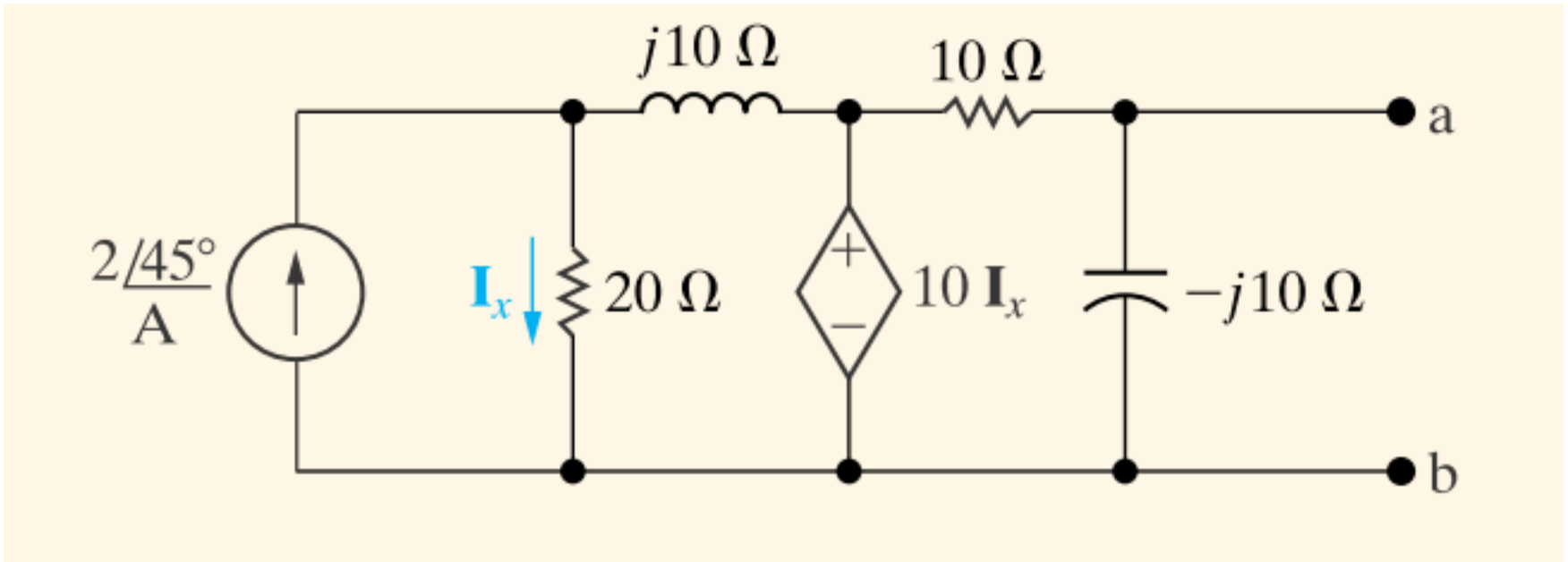
Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.



$$\mathbf{Z}_{\text{Th}} = 4.473\angle -7.64^\circ\ \Omega,\ \mathbf{V}_{\text{Th}} = 29.4\angle 72.9^\circ\ \text{V}.$$

Thevenin Eşlenik Devreleri

Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.



$$\mathbf{V}_{\text{Th}} = \mathbf{V}_{\text{ab}} = 10\angle 45^\circ \text{ V};$$
$$Z_{\text{Th}} = 5 - j5\ \Omega.$$