

Frekans Uzayında Kirchhoff Kanunları

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

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

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

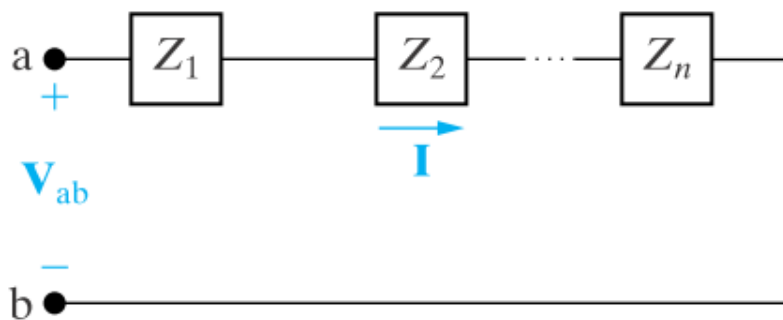
Kirchhoff Akım Kanunu: Bir düğümdeki akımların cebirsel toplamı 0'dır

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

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

1/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



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

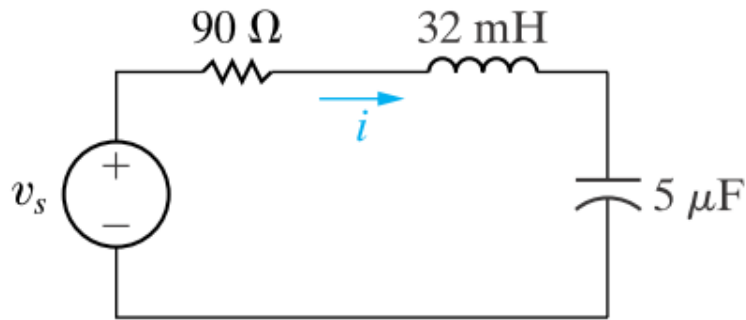
$$Z_{ab} = \frac{\mathbf{V}_{ab}}{\mathbf{I}} = Z_1 + Z_2 + \cdots + Z_n.$$

2/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

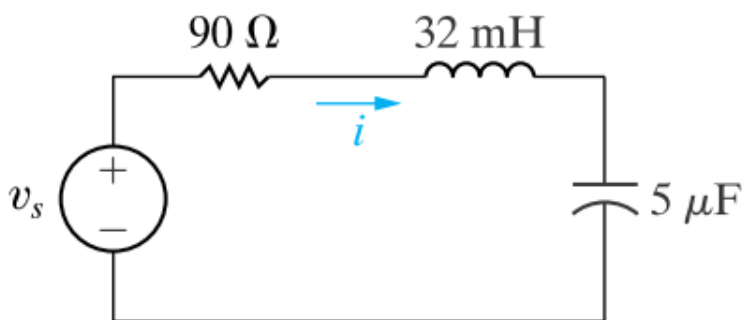
Soru: Verilen devrede $v_s = 750 \cos(5000t + 30)$ ise

- Frekans uzayı eşdeğer devreyi elde ediniz.
- Kararlı durum $i(t)$ akımını bulunuz.



3/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



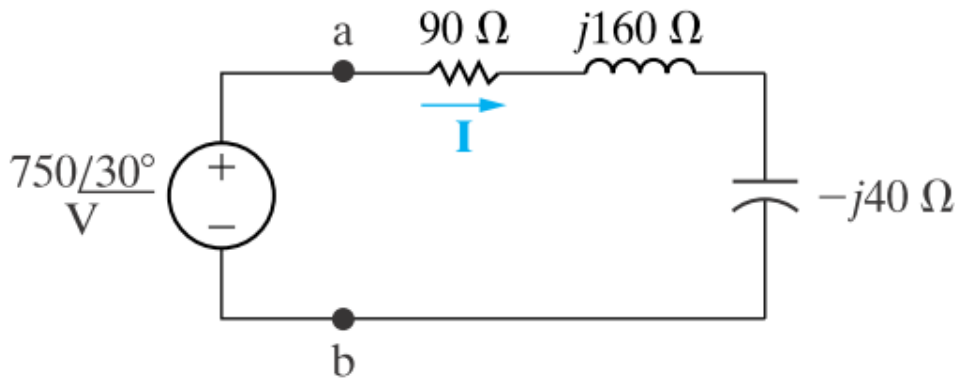
$$\omega = 5000 \text{ rad/s.}$$

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

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

4/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

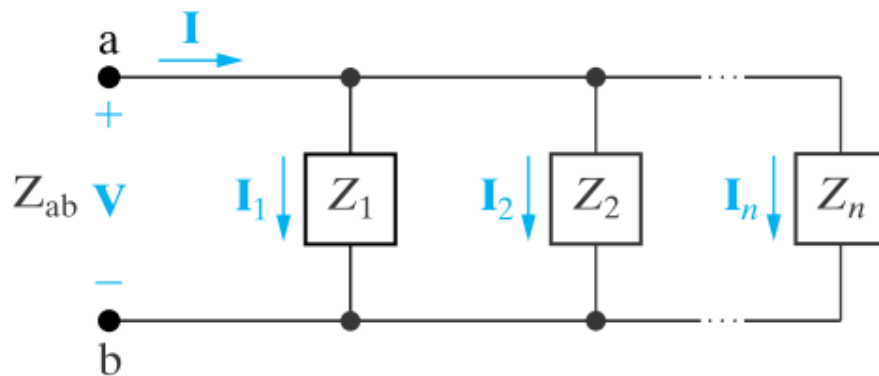


$$Z_{ab} = 90 + j160 - j40$$
$$= 90 + j120 = 150\angle 53.13^\circ\ \Omega.$$

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

5/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



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

Paralel iki empedans için:

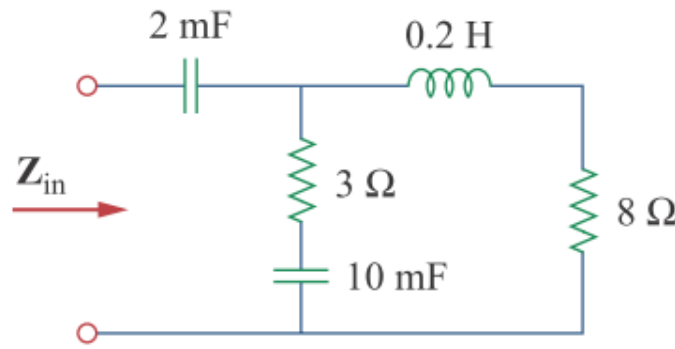
$$Z_{ab} = \frac{Z_1 Z_2}{Z_1 + Z_2}.$$

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

6/68

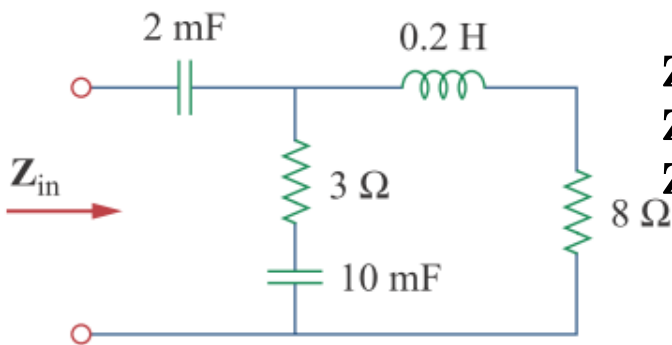
Seri, Paralel ve Δ - Y Sadeleştirmeleri

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



7/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



- Z_1 : 2mF kapasitör olsun,
 Z_2 : Seri 3 Ω ve 10 mF kapasitör olsun.
 Z_3 : Seri 8 Ω ve 0.2 H bobin olsun.

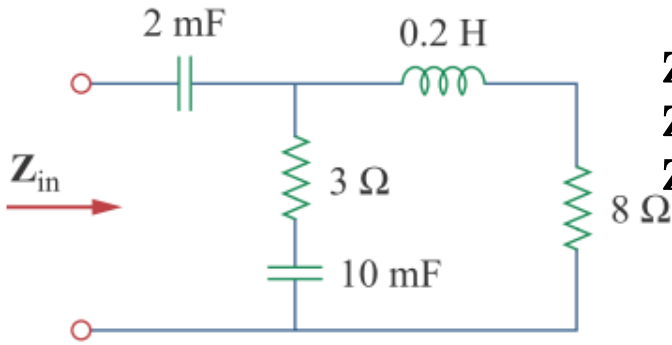
$$Z_1 = \frac{1}{j\omega C} = \frac{1}{j50 \times 2 \times 10^{-3}} = -j10 \Omega$$

$$Z_2 = 3 + \frac{1}{j\omega C} = 3 + \frac{1}{j50 \times 10 \times 10^{-3}} = (3 - j2) \Omega$$

$$Z_3 = 8 + j\omega L = 8 + j50 \times 0.2 = (8 + j10) \Omega$$

8/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



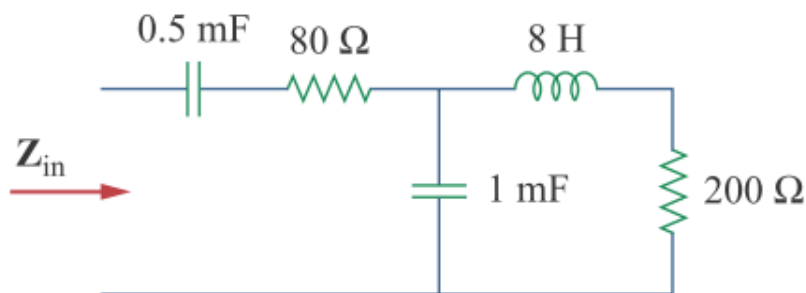
Z_1 : 2mF kapasitör olsun,
 Z_2 : Seri 3 Ω ve 10 mF kapasitör olsun.
 Z_3 : Seri 8 Ω ve 0.2 H bobin olsun.

$$\begin{aligned} Z_{in} &= Z_1 + Z_2 \parallel Z_3 = -j10 + \frac{(3 - j2)(8 + j10)}{11 + j8} \\ &= -j10 + \frac{(44 + j14)(11 - j8)}{11^2 + 8^2} = -j10 + 3.22 - j1.07 \Omega \\ Z_{in} &= 3.22 - j11.07 \Omega \end{aligned}$$

9/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

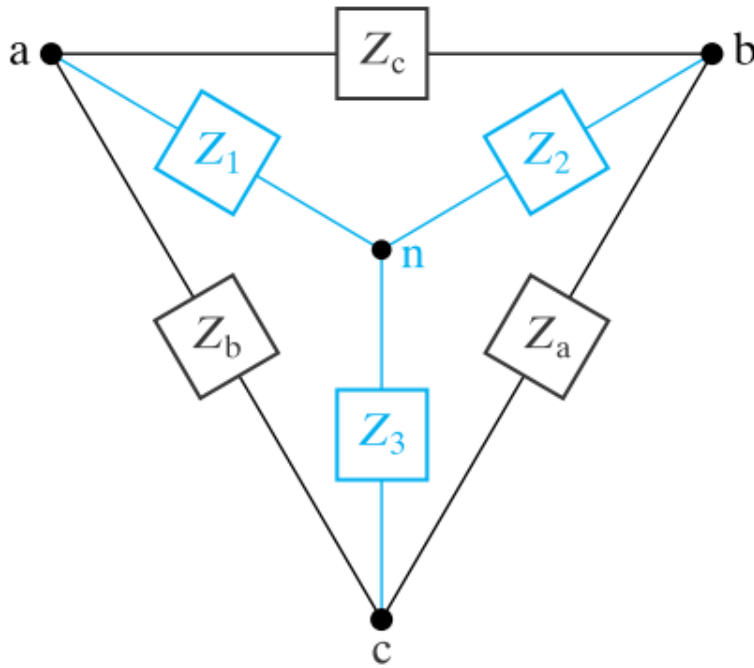
Ödev: $\omega = 10$ rad/s ise şekildeki devrenin input empedansını bulunuz.



$$(129.52 - j295)$$

10/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



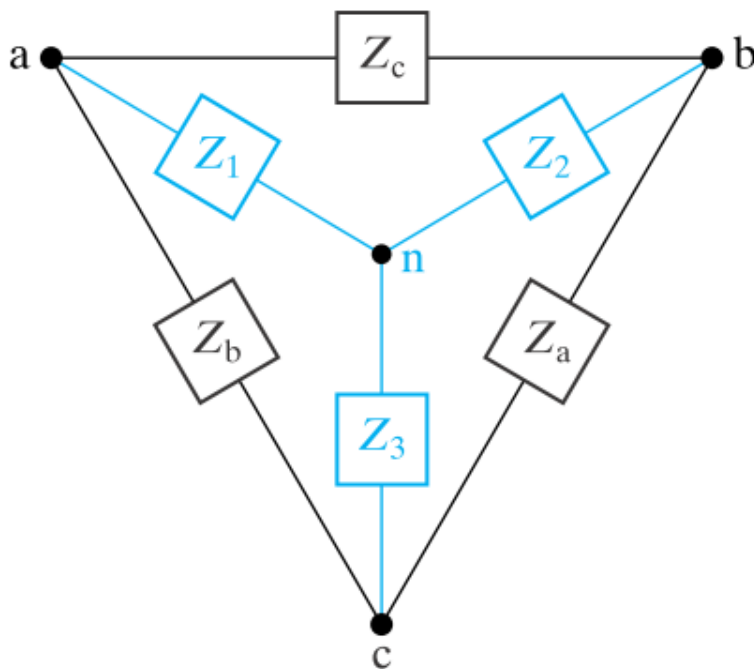
$$Z_1 = \frac{Z_b Z_c}{Z_a + Z_b + Z_c},$$

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

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

11/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$Z_a = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_1}$$

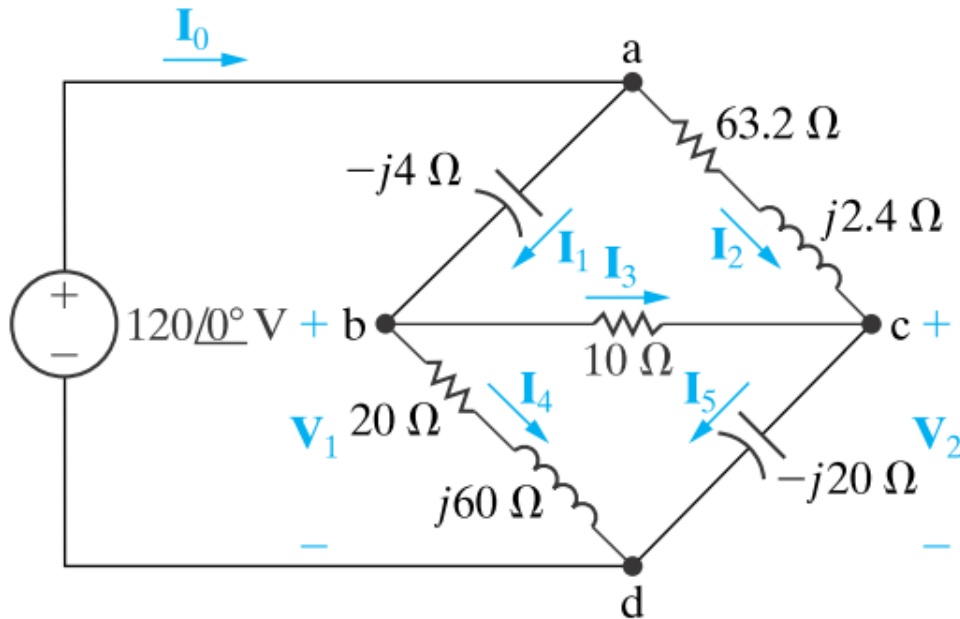
$$Z_b = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_2}$$

$$Z_c = \frac{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1}{Z_3}$$

12/68

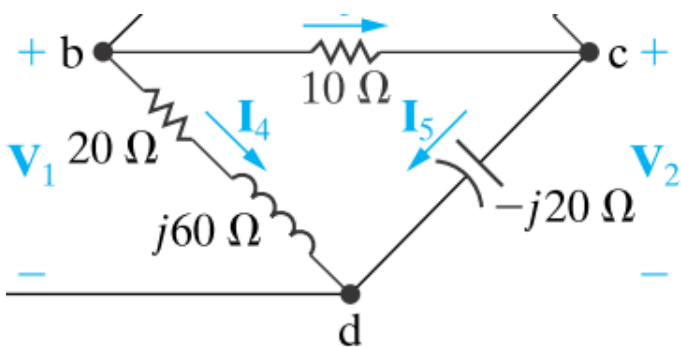
Seri, Paralel ve Δ - Y Sadeleştirmeleri

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.



13/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



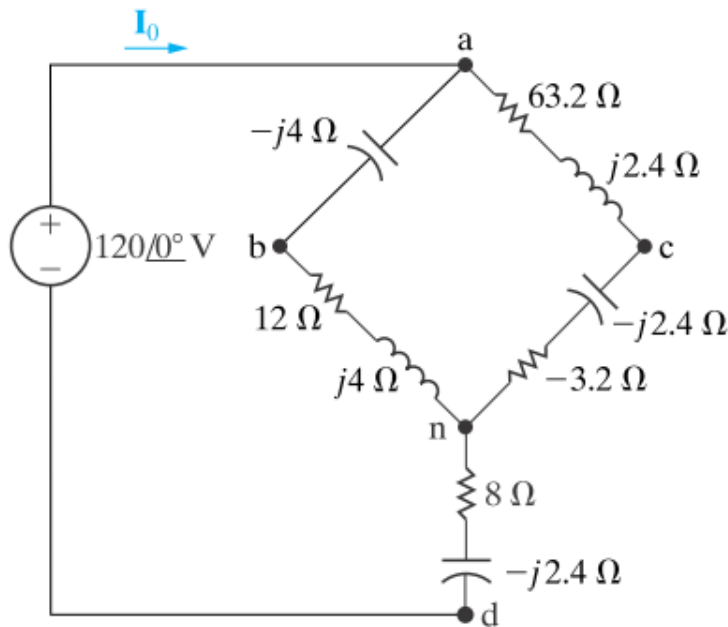
$$Z_1 = \frac{(20 + j60)(10)}{30 + j40} = 12 + j4\Omega$$

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

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

14/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



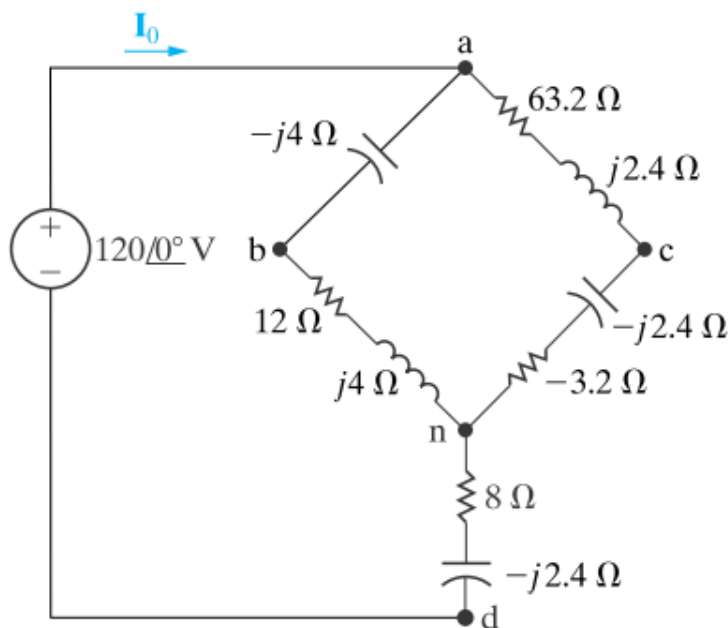
$$Z_{abn} = 12 + j4 - j4 = 12 \, \Omega,$$

$$Z_{acn} = 63.2 + j2.4 - j2.4 - 3.2 = 60 \, \Omega$$

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

15/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



$$\mathbf{I}_0 = \frac{120 \angle 0^\circ}{18 - j24} = 4 \angle 53.13^\circ = 2.4 + j3.2 \, \text{A}.$$

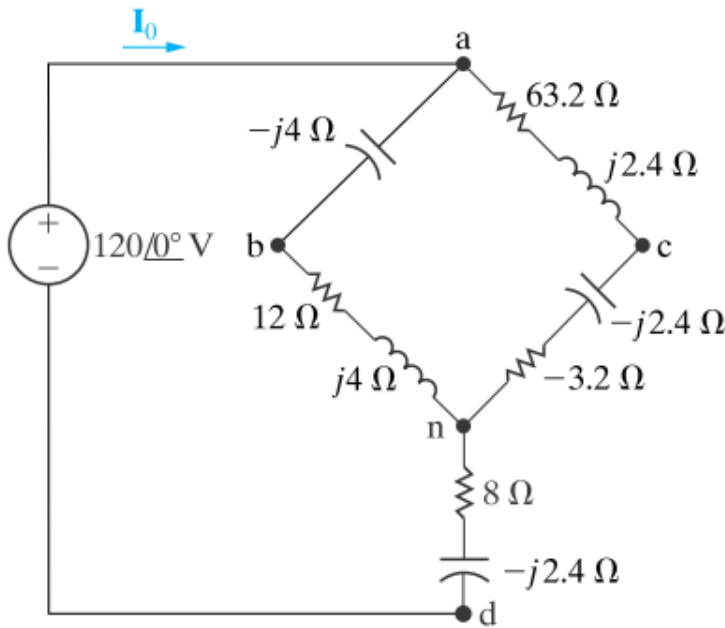
$$\mathbf{V}_{nd} = (8 - j24)\mathbf{I}_0 = 96 - j32 \, \text{V}$$

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

$$\mathbf{V}_{an} = 120 - 96 + j32 = 24 + j32 \, \text{V}$$

16/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



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

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

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

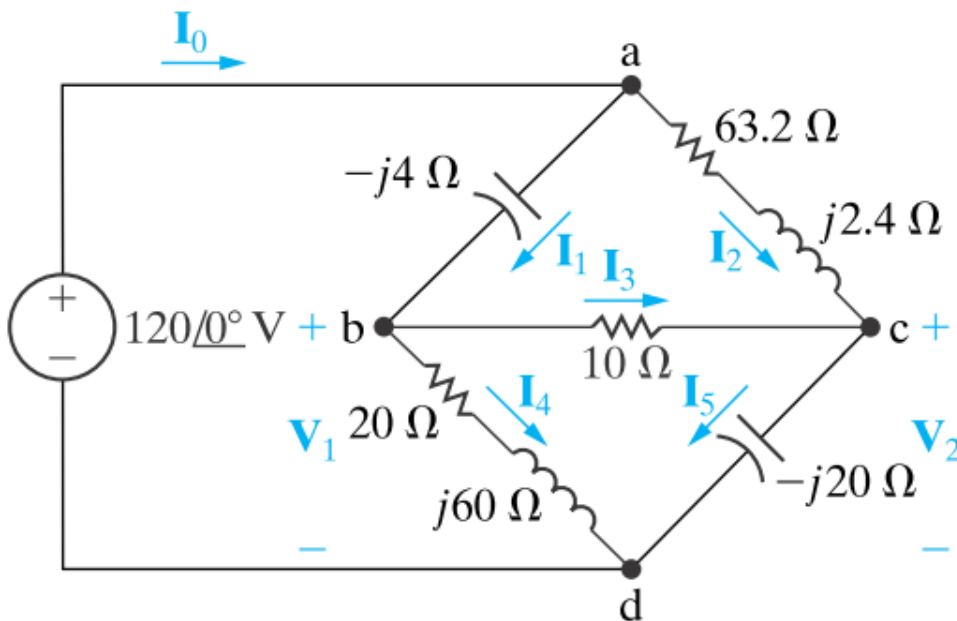
$$\mathbf{I}_2 = \mathbf{I}_{acn}$$

Sağlama:

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

17/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

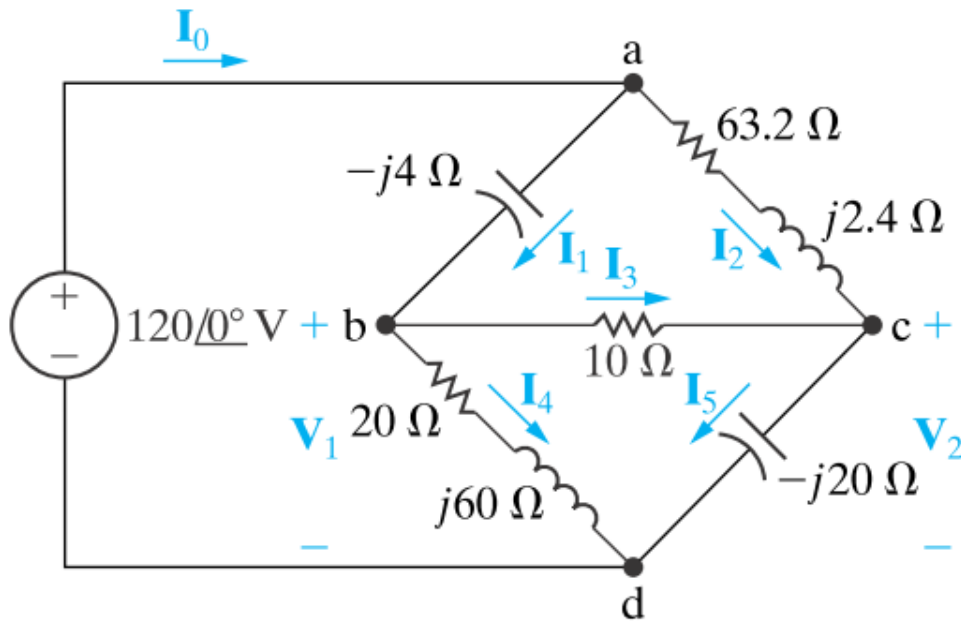


V_1 : b noktasındaki voltaj

V_2 : c noktasındaki voltaj

18/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

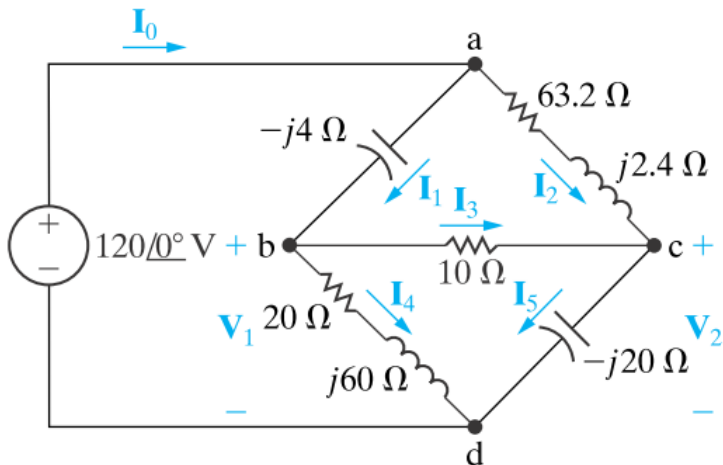


$$\begin{aligned}\mathbf{V}_1 &= 120 \angle 0^\circ - (-j4)\mathbf{I}_1 \\ &= \frac{328}{3} + j8 \text{ V},\end{aligned}$$

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

19/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri



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

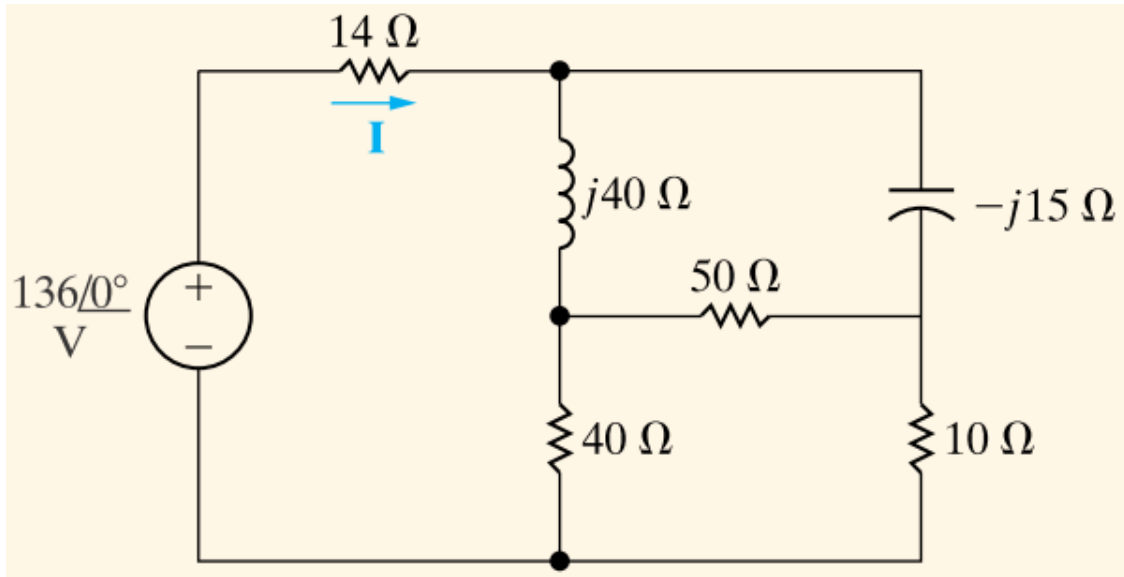
$$\mathbf{I}_4 = \frac{\mathbf{V}_1}{20 + j60} = \frac{2}{3} - j1.6 \text{ A},$$

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

20/68

Seri, Paralel ve Δ - Y Sadeleştirmeleri

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

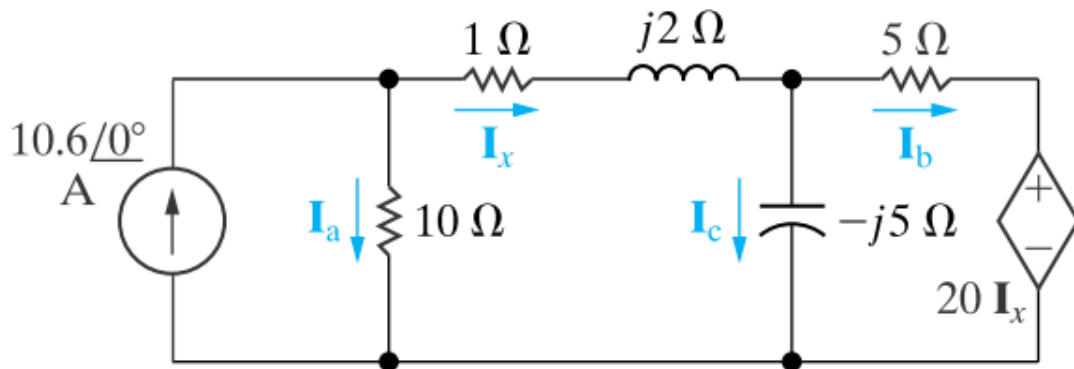


$$\mathbf{I} = 4 \angle 28.07^\circ \text{ A.}$$

21/68

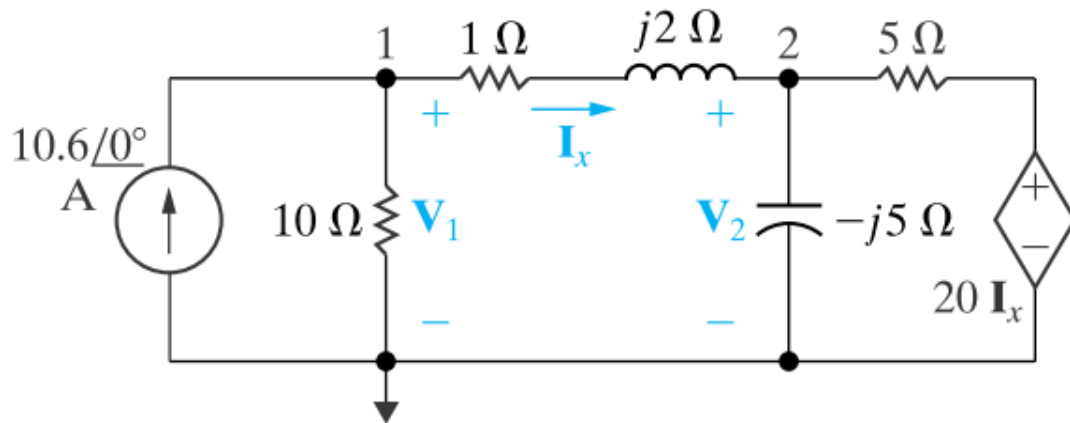
Düğüm Gerilim Yöntemi

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



22/68

Düğüm Gerilim Yöntemi

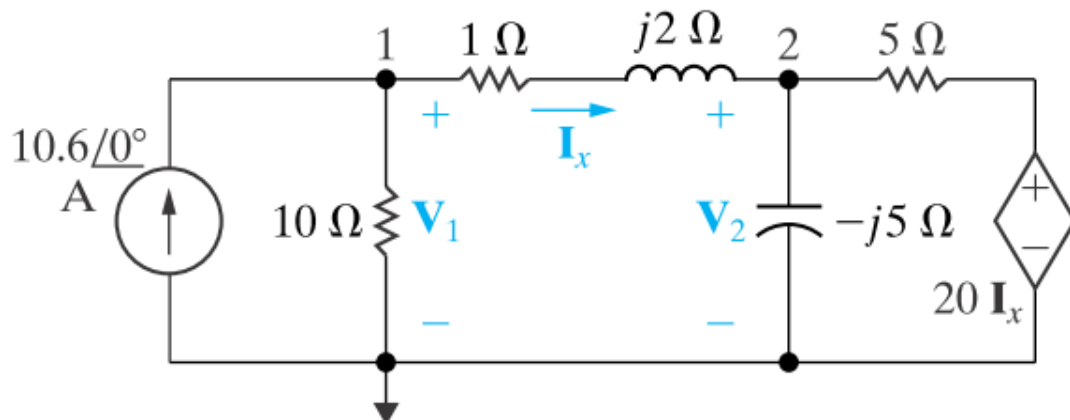


$$-10.6 + \frac{\mathbf{V}_1}{10} + \frac{\mathbf{V}_1 - \mathbf{V}_2}{1 + j2} = 0.$$

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

23/68

Düğüm Gerilim Yöntemi



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

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

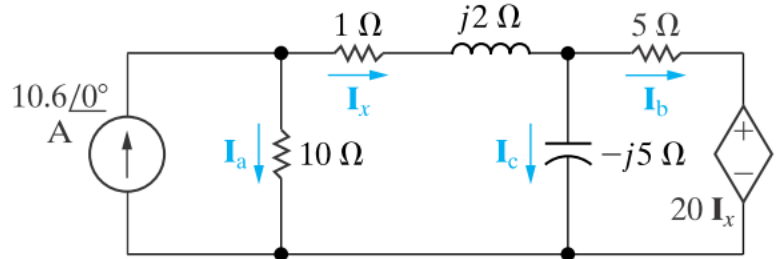
24/68

Düğüm Gerilim Yöntemi

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

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

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



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

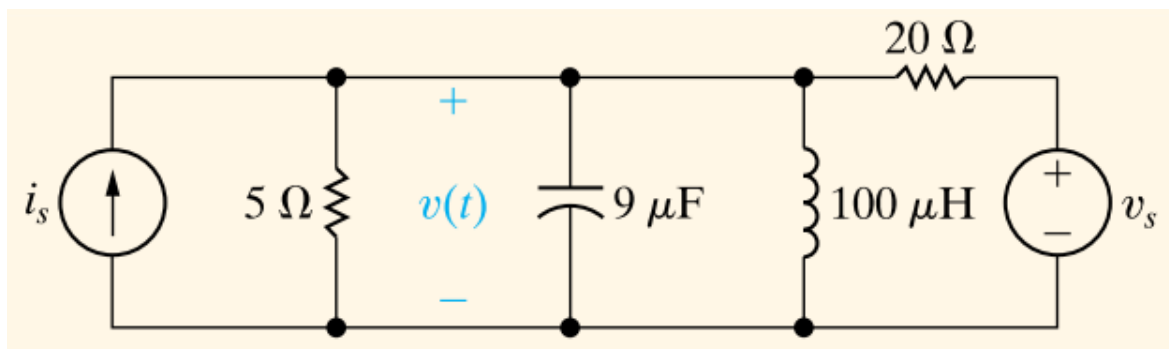
$$\mathbf{I}_x = \frac{\mathbf{V}_1 - \mathbf{V}_2}{1 + j2} = 3.76 + j1.68 \text{ A}, \quad \mathbf{I}_c = \frac{\mathbf{V}_2}{-j5} = 5.2 + j13.6 \text{ A}.$$

25/68

Düğüm Gerilim Yöntemi

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

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

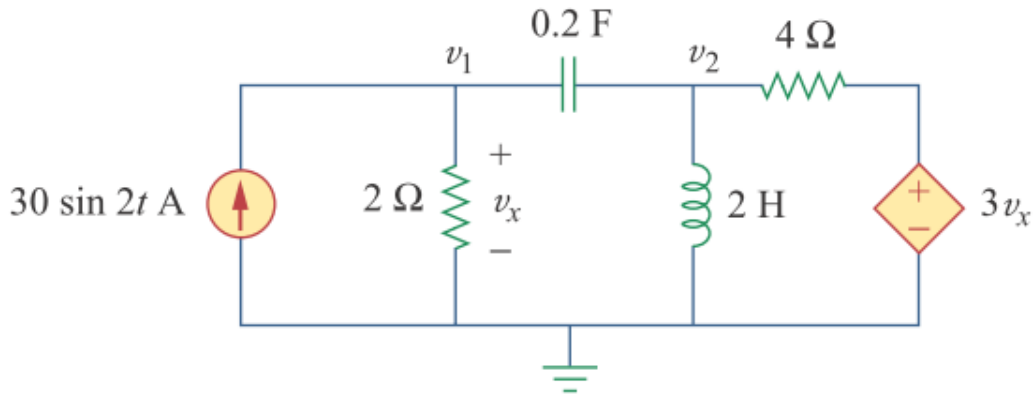


$$v(t) = 31.62 \cos(50,000t - 71.57^\circ) \text{ V}.$$

26/68

Düğüm Gerilim Yöntemi

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



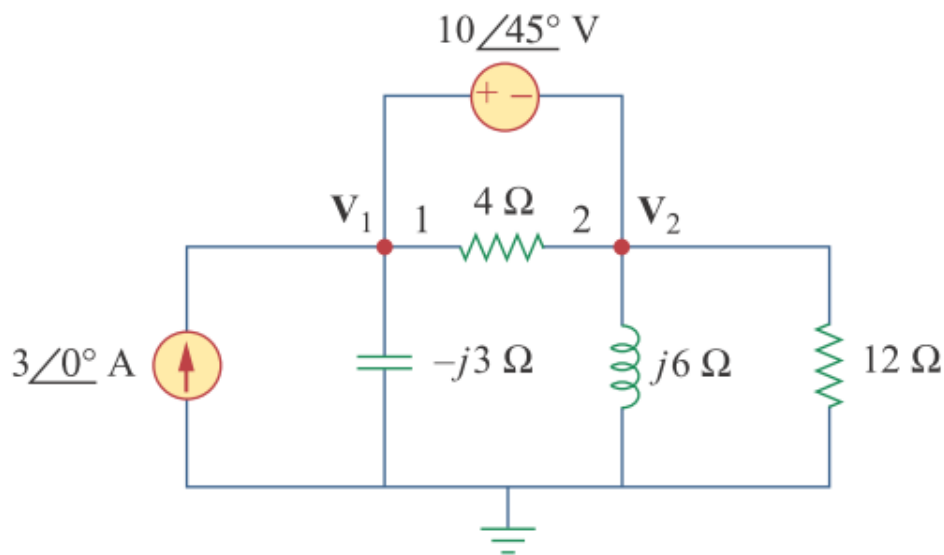
$$v_1(t) = 33.96 \sin(2t + 60.01^\circ) \text{ V},$$

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

27/68

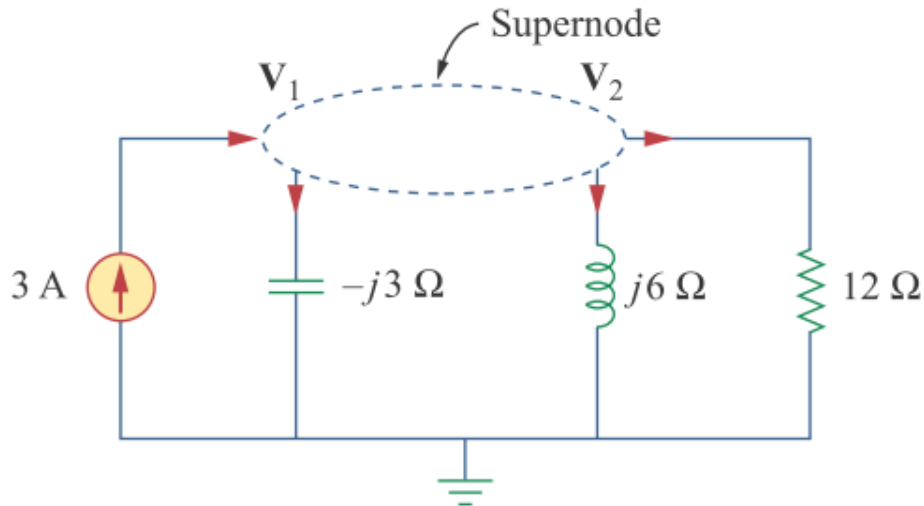
Düğüm Gerilim Yöntemi

Soru: Verilen devrede düğüm voltaj yöntemini kullanarak V_1 ve V_2 değerlerini hesaplayınız. (Süper düğüm)



28/68

Düğüm Gerilim Yöntemi



$$3 = \frac{V_1}{-j3} + \frac{V_2}{j6} + \frac{V_2}{12} \quad V_1 = V_2 + 10\angle 45^\circ$$

29/68

Düğüm Gerilim Yöntemi

$$3 = \frac{V_1}{-j3} + \frac{V_2}{j6} + \frac{V_2}{12} \quad V_1 = V_2 + 10\angle 45^\circ$$

$$36 = j4V_1 + (1 - j2)V_2$$

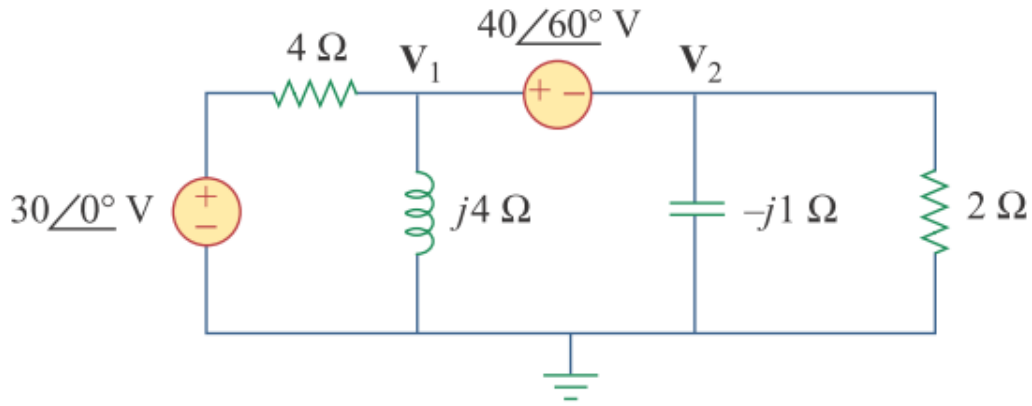
$$36 - 40\angle 135^\circ = (1 + j2)V_2 \quad \Rightarrow \quad V_2 = 31.41\angle -87.18^\circ \text{ V}$$

$$V_1 = V_2 + 10\angle 45^\circ = 25.78\angle -70.48^\circ \text{ V}$$

30/68

Düğüm Gerilim Yöntemi

Ödev: Verilen devrede düğüm voltaj yöntemini kullanarak V_1 ve V_2 değerlerini hesaplayınız. (Süper düğüm)

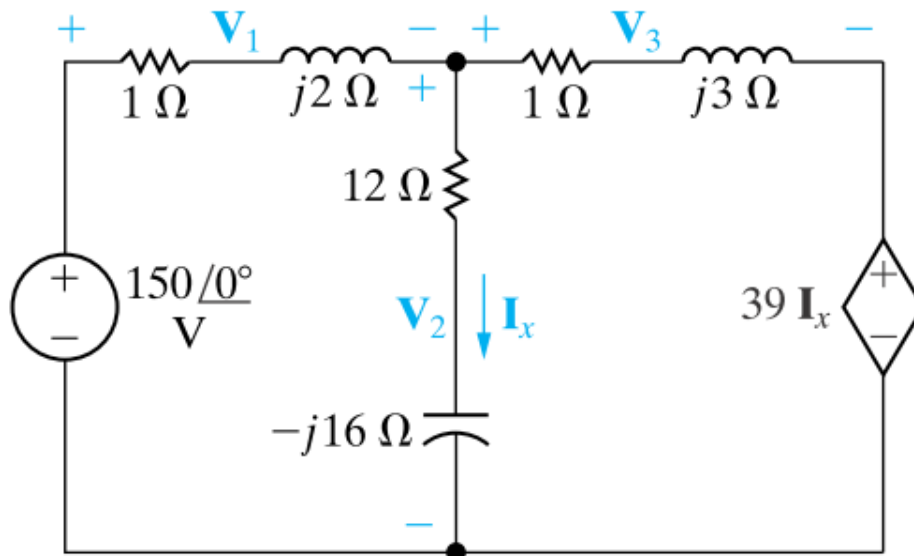


$$V_1 = 38.72 \angle 69.67^\circ \text{ V}, V_2 = 6.752 \angle 165.7^\circ \text{ V}.$$

31/68

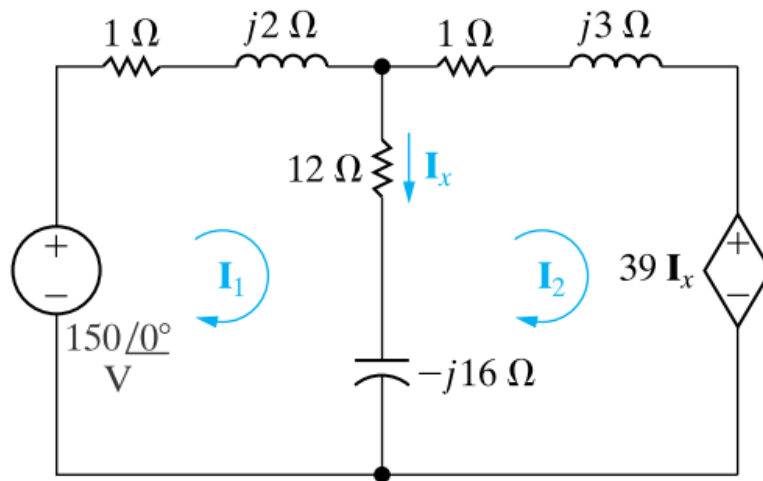
Ağ Akım Yöntemi

Soru: Verilen devrede ağ akım yöntemini kullanarak V_1 , V_2 ve V_3 değerlerini hesaplayınız.



32/68

Ağ Akım Yöntemi



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

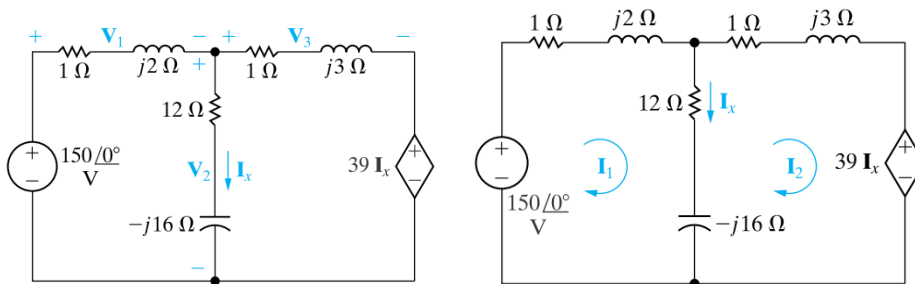
$$150 = (13 - j14)\mathbf{I}_1 - (12 - j16)\mathbf{I}_2.$$

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

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

33/68

Ağ Akım Yöntemi



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

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

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

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

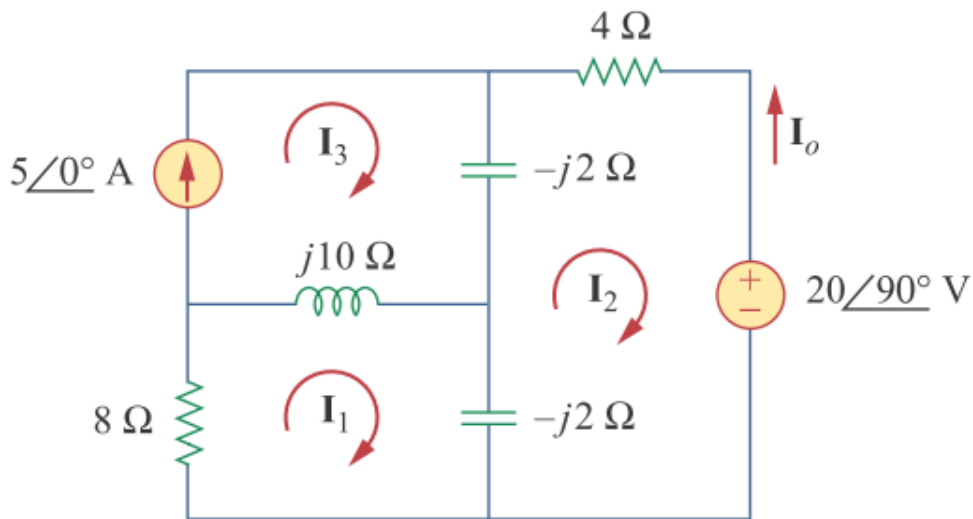
$$\mathbf{V}_2 = (12 - j16)\mathbf{I}_x = 72 + j104 \text{ V},$$

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

34/68

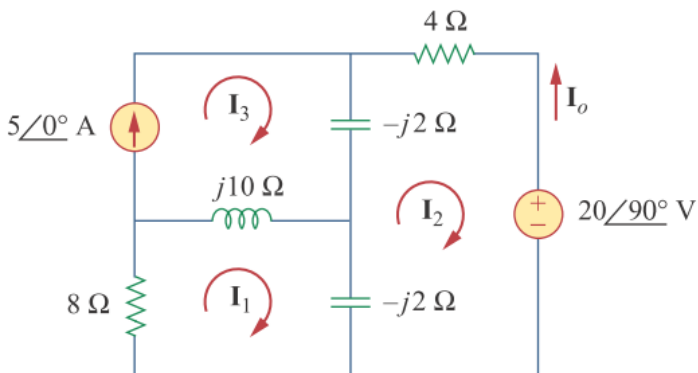
Ağ Akım Yöntemi

Soru: Verilen devrede I_0 akımını bulunuz.



35/68

Ağ Akım Yöntemi



$$(8 + j10 - j2)I_1 - (-j2)I_2 - j10I_3 = 0$$

$$(4 - j2 - j2)I_2 - (-j2)I_1 - (-j2)I_3 + 20\angle 90^\circ = 0$$

$$I_3 = 5.$$

$$\begin{aligned} (8 + j8)I_1 + j2I_2 &= j50 \\ j2I_1 + (4 - j4)I_2 &= -j20 - j10 \end{aligned} \quad \begin{bmatrix} 8 + j8 & j2 \\ j2 & 4 - j4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} j50 \\ -j30 \end{bmatrix}$$

36/68

Ağ Akım Yöntemi

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

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

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

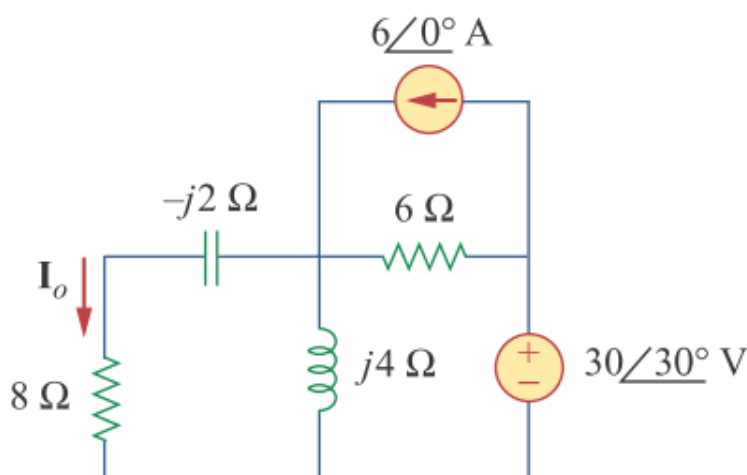
$$\mathbf{I}_2 = \frac{\Delta_2}{\Delta} = \frac{416.17 \angle -35.22^\circ}{68} = 6.12 \angle -35.22^\circ \text{ A}$$

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

37/68

Ağ Akım Yöntemi

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

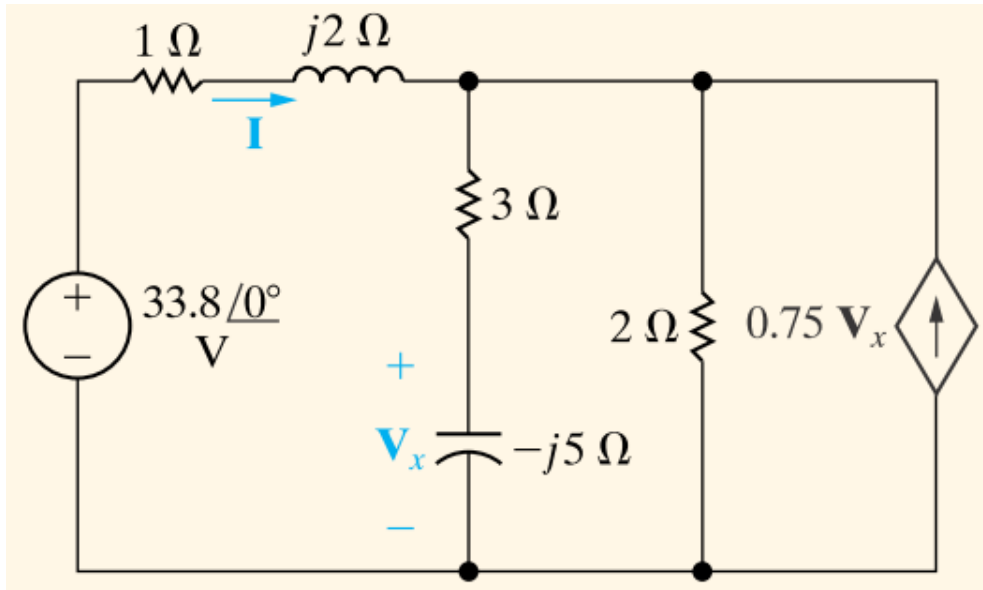


$$3.582 \angle 65.45^\circ \text{ A.}$$

38/68

Ağ Akım Yöntemi

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

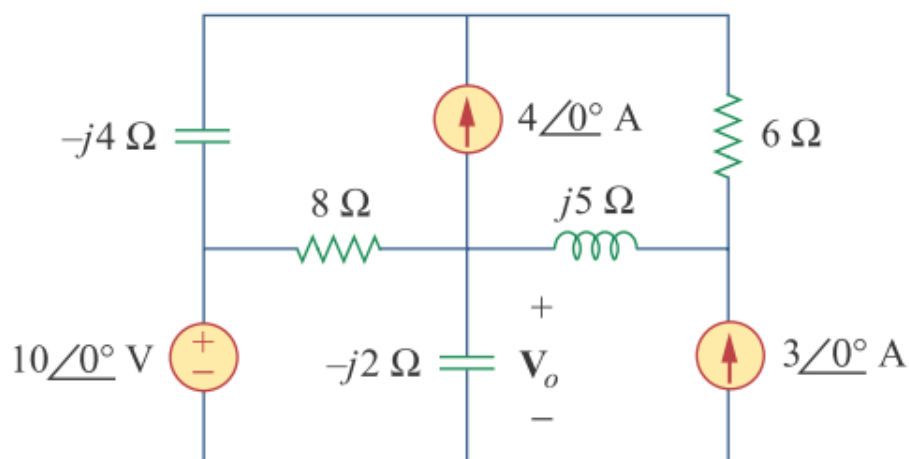


$$\mathbf{I} = 29 + j2 = 29.07 \angle 3.95^\circ \text{ A.}$$

39/68

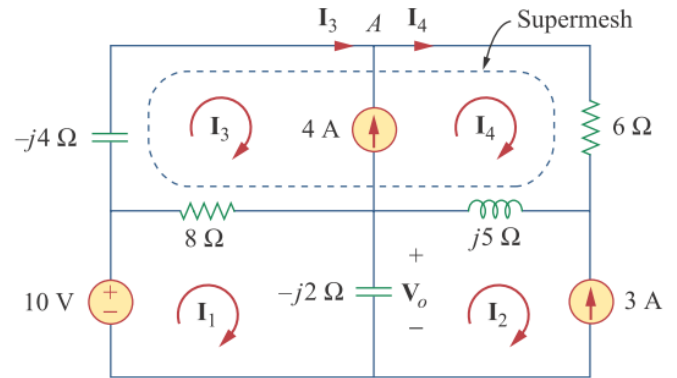
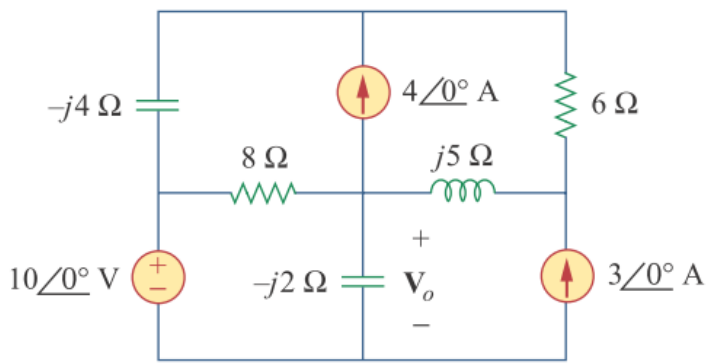
Ağ Akım Yöntemi

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



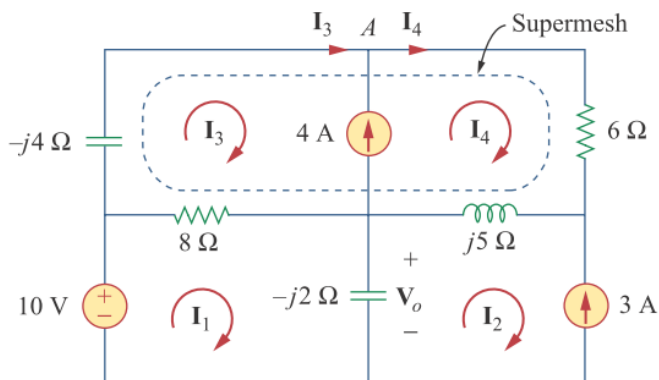
40/68

Ağ Akım Yöntemi



41/68

Ağ Akım Yöntemi



$$-10 + (8 - j2)I_1 - (-j2)I_2 - 8I_3 = 0$$

$$(8 - j2)I_1 + j2I_2 - 8I_3 = 10$$

$$I_2 = -3$$

$$(8 - j4)I_3 - 8I_1 + (6 + j5)I_4 - j5I_2 = 0$$

$$I_4 = I_3 + 4$$

42/68

Ağ Akım Yöntemi

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

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

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

43/68

Ağ Akım Yöntemi

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

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

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

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

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

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

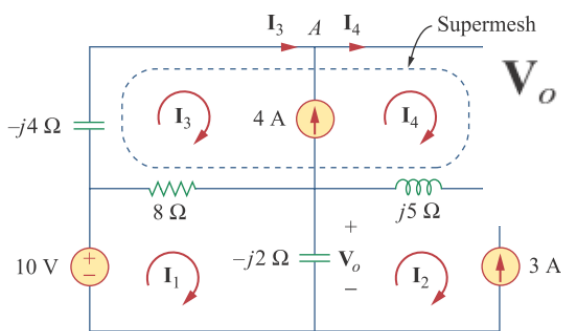
44/68

Ağ Akım Yöntemi

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

$$\Delta_1 = \begin{vmatrix} 10 + j6 & -8 \\ -24 - j35 & 14 + j \end{vmatrix} = 140 + j10 + j84 - 6 - 192 - j280 \\ = -58 - j186$$

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

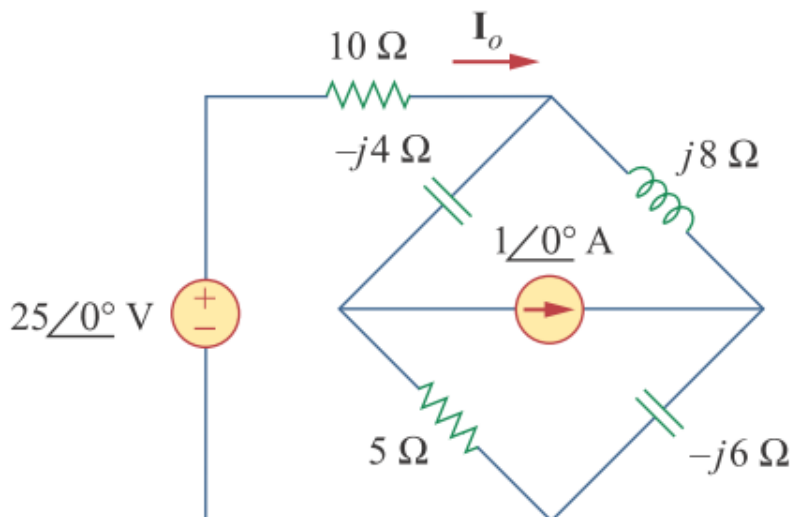


$$\mathbf{V}_o = -j2(\mathbf{I}_1 - \mathbf{I}_2) = -j2(3.618 \angle 274.5^\circ + 3) \\ = -7.2134 - j6.568 = 9.756 \angle 222.32^\circ \text{ V}$$

45/68

Ağ Akım Yöntemi

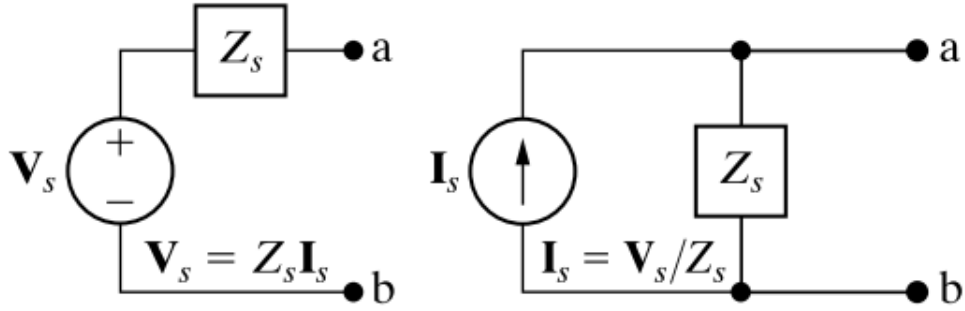
Ödev: Verilen devrede \mathbf{I}_o akımını hesaplayınız.



$$2.538 \angle 5.943^\circ \text{ A.}$$

46/68

Kaynak Dönüşümü

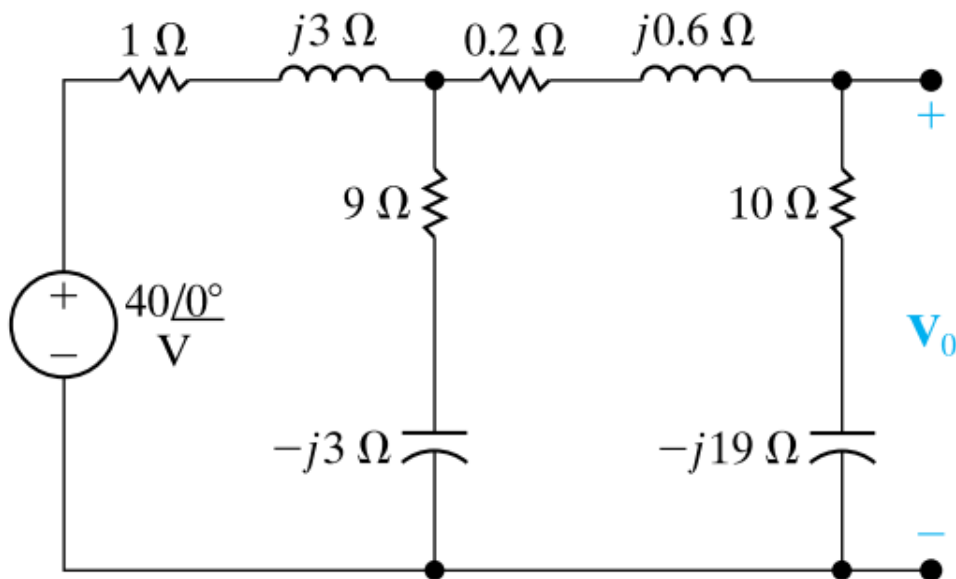


Frekans uzayında kaynak dönüşümü

47/68

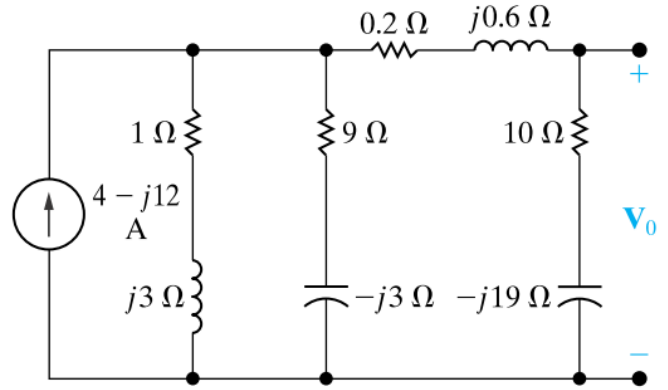
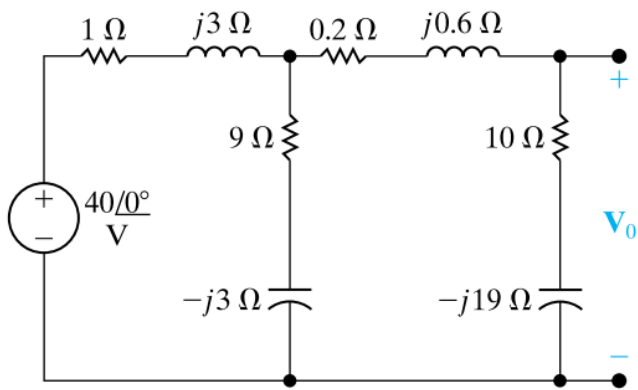
Kaynak Dönüşümü

Soru: Verilen devrede kaynak dönüşümü yöntemi kullanılarak V_0 fazör voltajını bulunuz.



48/68

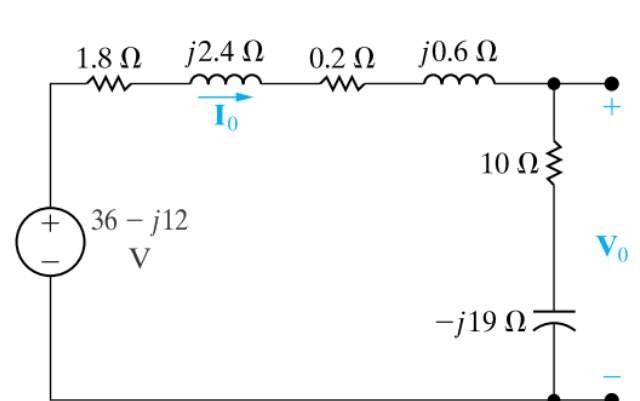
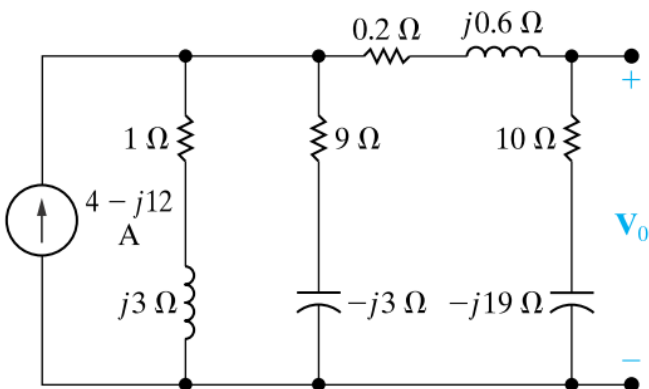
Kaynak Dönüşümü



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

49/68

Kaynak Dönüşümü

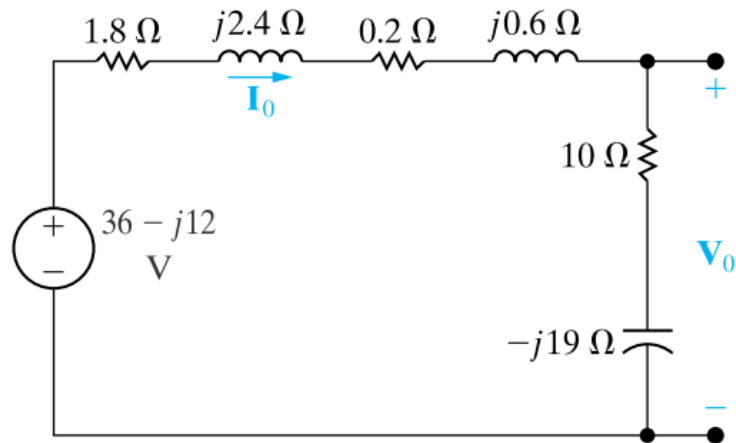


$$\mathbf{Z} = \frac{(1 + j3)(9 - j3)}{10} = 1.8 + j2.4 \text{ } \Omega,$$

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

50/68

Kaynak Dönüşümü



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

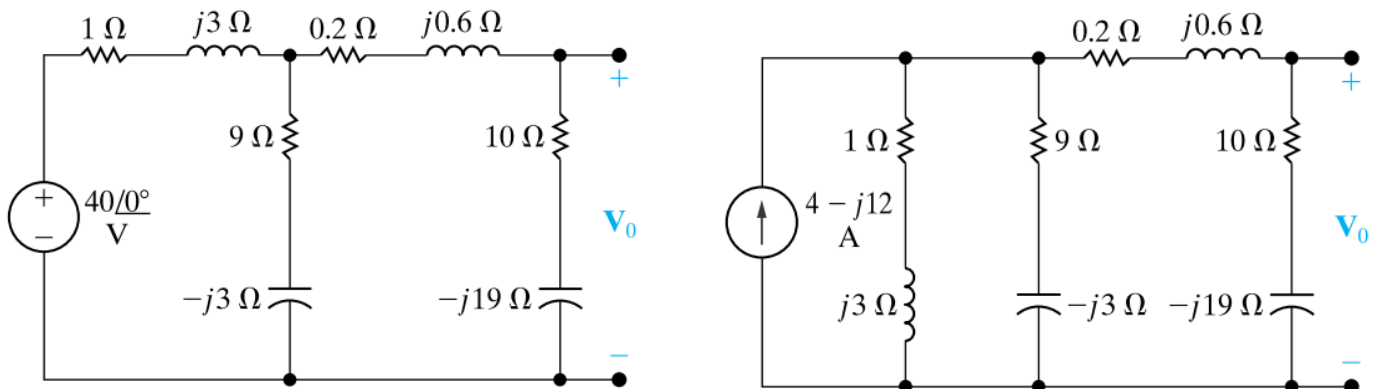
$$= \frac{39 + j27}{25} = 1.56 + j1.08 \text{ A.}$$

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

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

51/68

Kaynak Dönüşümü

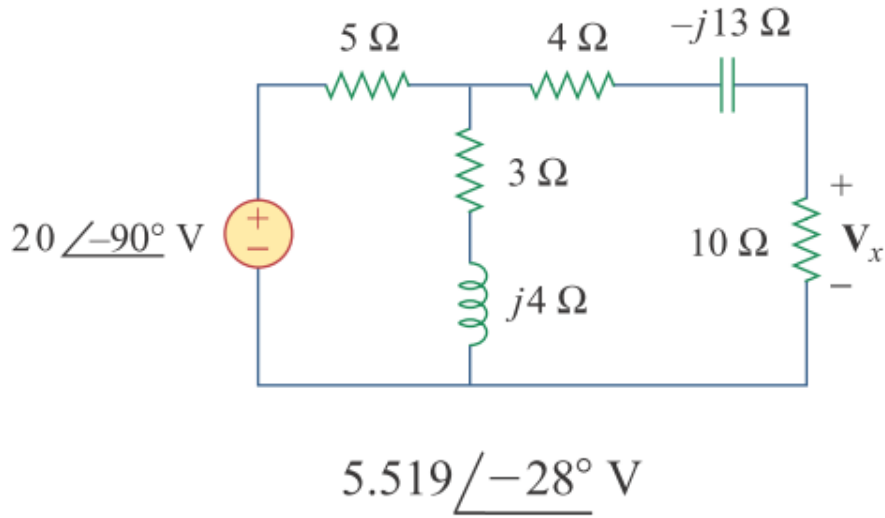


$$\mathbf{I} = \frac{40}{1 + j3} = \frac{40}{10}(1 - j3) = 4 - j12 \text{ A.}$$

52/68

Kaynak Dönüşümü

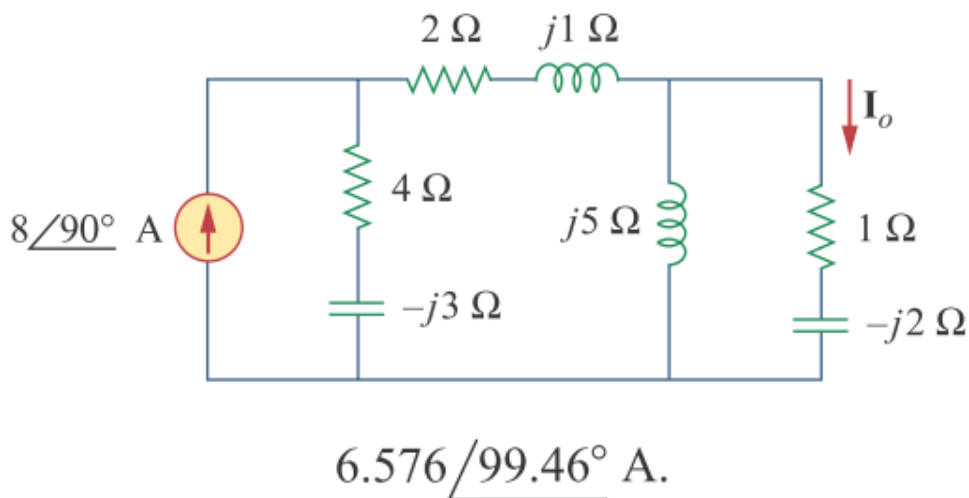
Ödev: Verilen devrede kaynak dönüşümü yöntemi kullanılarak V_x fazör voltajını bulunuz.



53/68

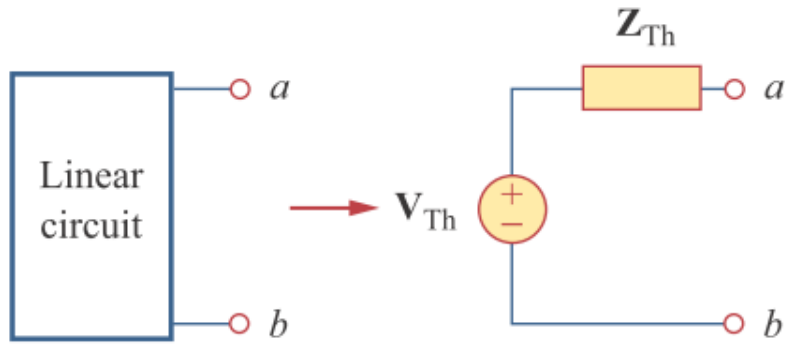
Kaynak Dönüşümü

Ödev: Verilen devrede kaynak dönüşümü yöntemi kullanılarak I_o fazör akımını bulunuz.



54/68

Thevenin Eşlenik Devreleri

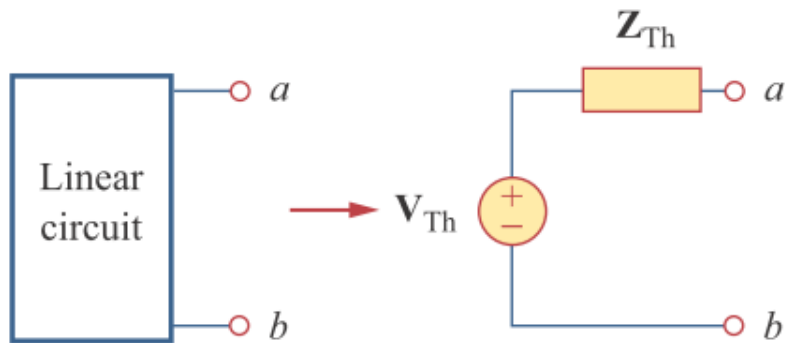


Genel Çözüm

- 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

55/68

Thevenin Eşlenik Devreleri

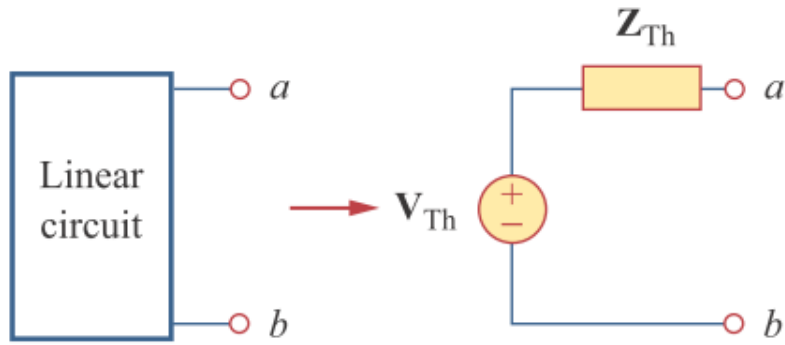


Bağımlı kaynak yok ise

- 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

56/68

Thevenin Eşlenik Devreleri

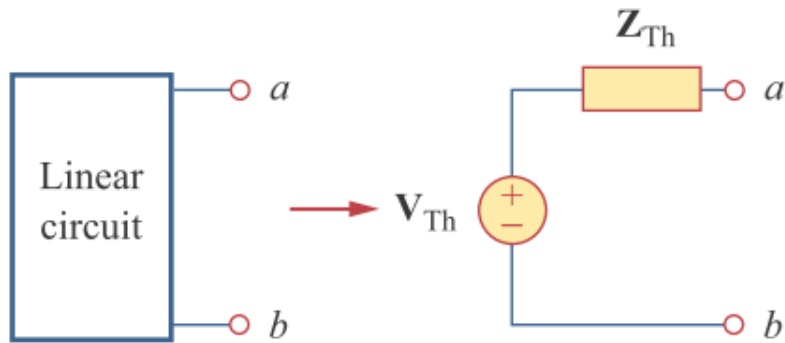


Bağımlı kaynak var ise

- Thevenin eşlenik devre bulunmak istenilen terminal açık devre yapılır.
 - $V_{oc} = V_{Th}$ olur.
- Thevenin eşlenik devre bulunmak istenilen terminale test kaynağı bağlanır. Bu kaynağın terminalindeki voltaj ve akım değerleri kullanılarak Z_{Th} bulunur. $V_t/I_t = Z_{Th}$

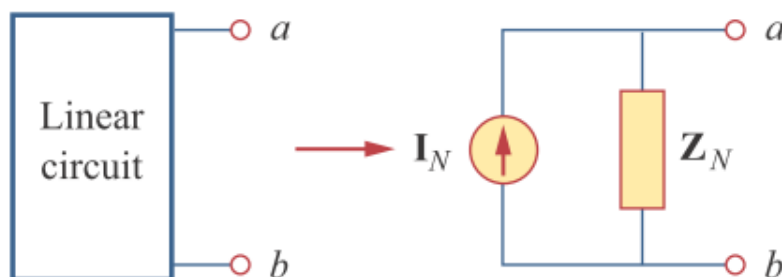
57/68

Norton Eşlenik Devreleri



Thevenin Eşlenik bulunduktan sonra Norton Eşlenik devre kaynak çevrimi ile bulunabilir.

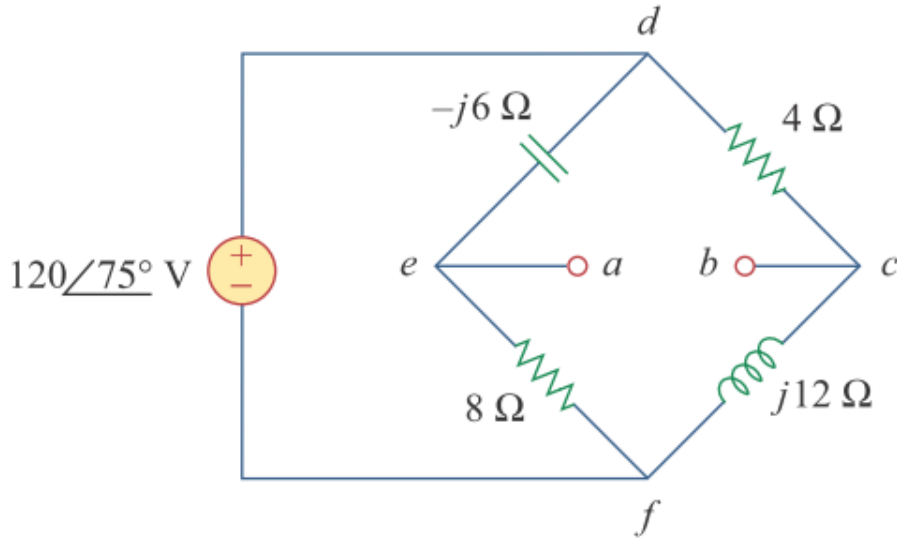
Veya $Z_N = Z_{Th}$ ve I_N terminal kısa devre yapılarak bulunur.



58/68

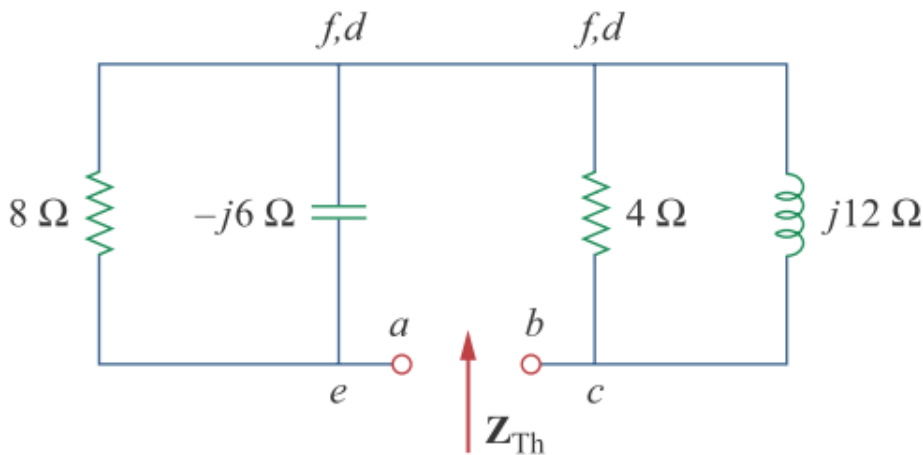
Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



59/68

Thevenin Eşlenik Devreleri



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

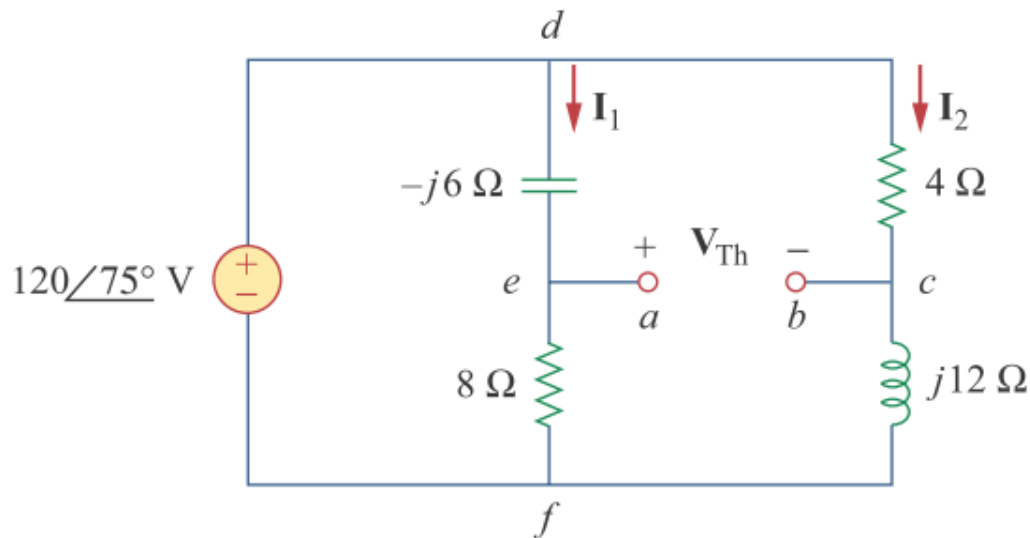
$$\mathbf{Z}_2 = 4 \parallel j12 = \frac{j12 \times 4}{4 + j12} = 3.6 + j1.2 \, \Omega$$

$$\begin{aligned} \mathbf{Z}_{Th} &= \mathbf{Z}_1 + \mathbf{Z}_2 = \\ & 6.48 - j2.64 \, \Omega \end{aligned}$$

60/68

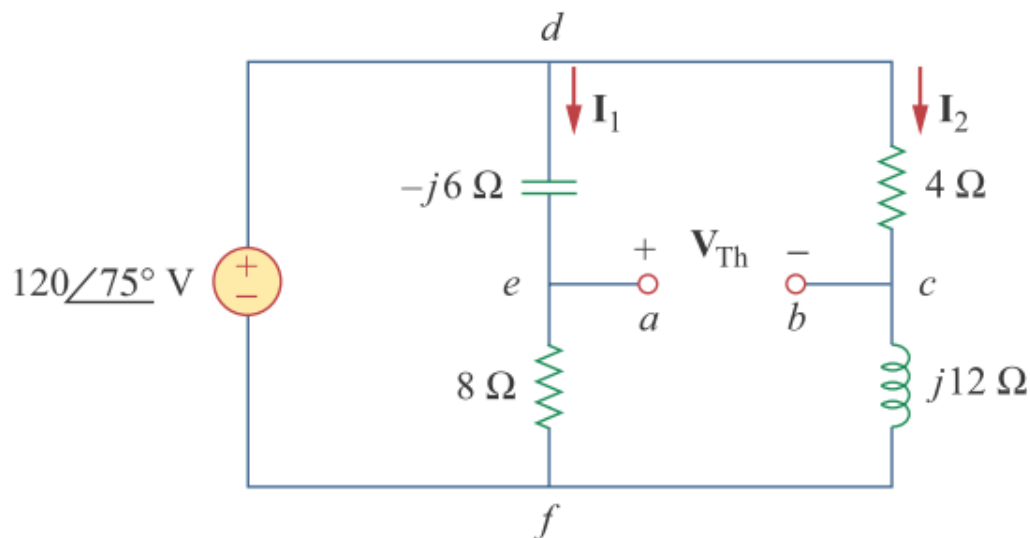
Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



61/68

Thevenin Eşlenik Devreleri

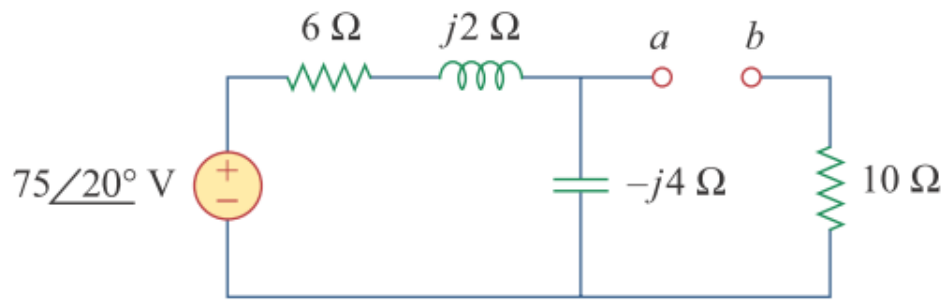


$$\mathbf{I}_1 = \frac{120\angle 75^\circ}{8 - j6} \text{ A}, \quad \mathbf{I}_2 = \frac{120\angle 75^\circ}{4 + j12} \text{ A} \quad \text{bcdeab}$$
$$\mathbf{V}_{\text{Th}} - 4\mathbf{I}_2 + (-j6)\mathbf{I}_1 = 0$$
$$= 37.95\angle 220.31^\circ \text{ V}$$

62/68

Thevenin Eşlenik Devreleri

Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.

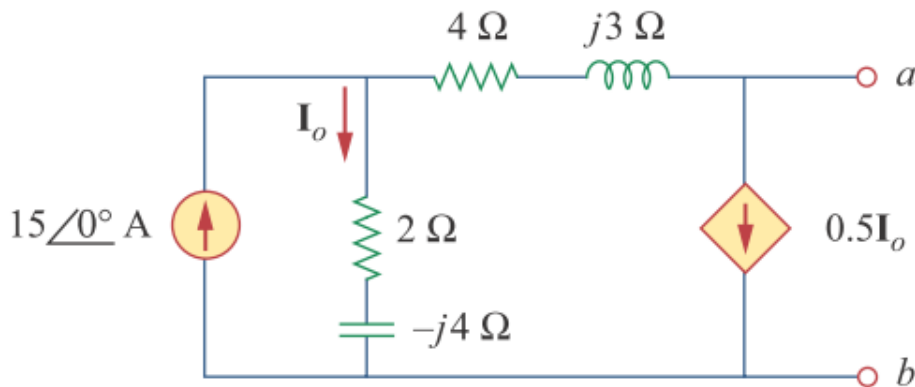


$$\mathbf{Z}_{Th} = 12.4 - j3.2 \, \Omega, \mathbf{V}_{Th} = 47.42 \angle -51.57^\circ \text{ V}.$$

63/68

Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



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

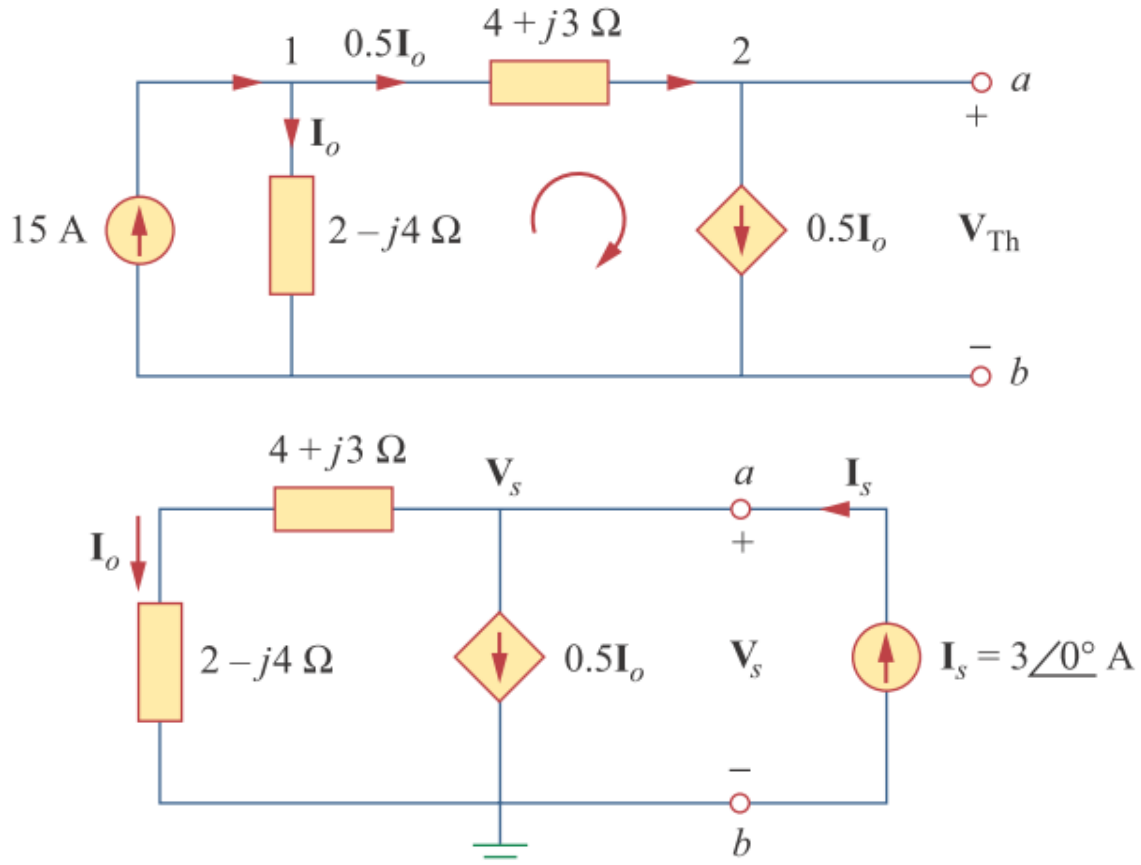
$$\mathbf{V}_{Th} = 10(2 - j4) - 5(4 + j3) = -j55$$

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

64/68

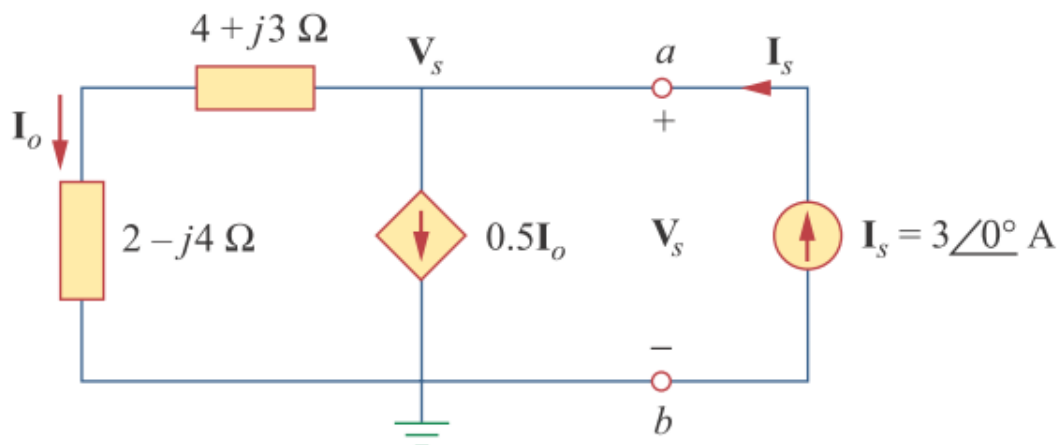
Thevenin Eşlenik Devreleri

Soru: a-b terminalinden Thevenin eşlenik devresini bulunuz.



65/68

Thevenin Eşlenik Devreleri



$$3 = I_o + 0.5I_o \quad \Rightarrow \quad I_o = 2 \text{ A}$$

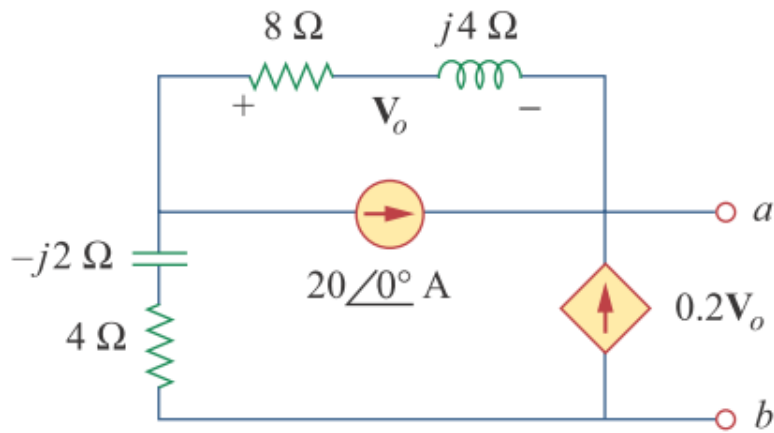
$$V_s = I_o(4 + j3 + 2 - j4) = 2(6 - j)$$

$$Z_{Th} = \frac{V_s}{I_s} = \frac{2(6 - j)}{3} = 4 - j0.6667 \Omega$$

66/68

Thevenin Eşlenik Devreleri

Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.

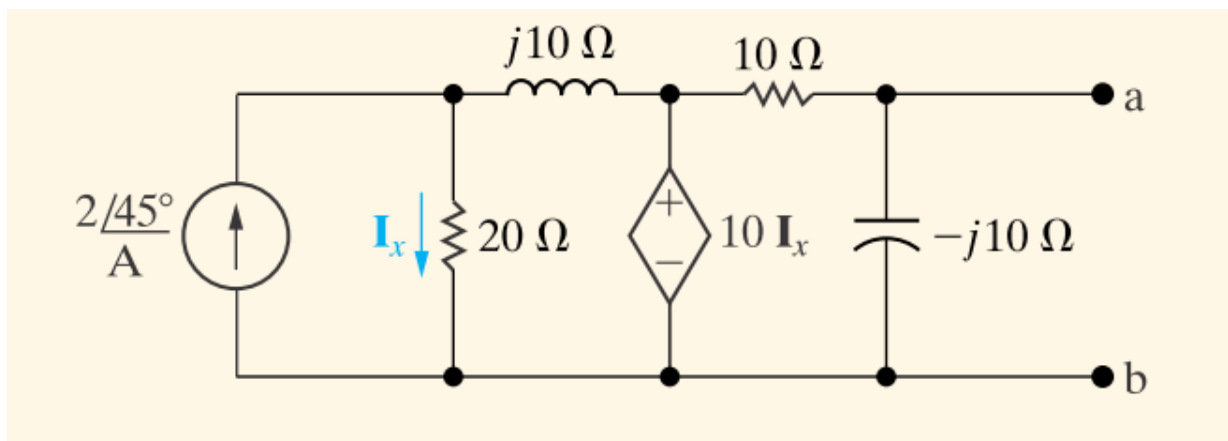


$$\mathbf{Z}_{\text{Th}} = 4.473 \angle -7.64^\circ \Omega, \mathbf{V}_{\text{Th}} = 29.4 \angle 72.9^\circ \text{ V}.$$

67/68

Thevenin Eşlenik Devreleri

Ödev: a-b terminalinden Thevenin eşlenik devresini bulunuz.



$$\begin{aligned} \mathbf{V}_{\text{Th}} &= \mathbf{V}_{\text{ab}} = 10 \angle 45^\circ \text{ V}; \\ \mathbf{Z}_{\text{Th}} &= 5 - j5 \Omega. \end{aligned}$$

68/68