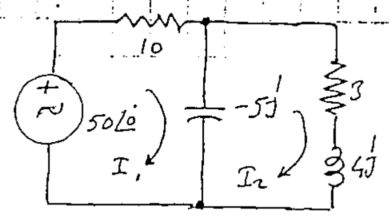
Mesh Analizi İle İlgili Örnekler

Örnek 1

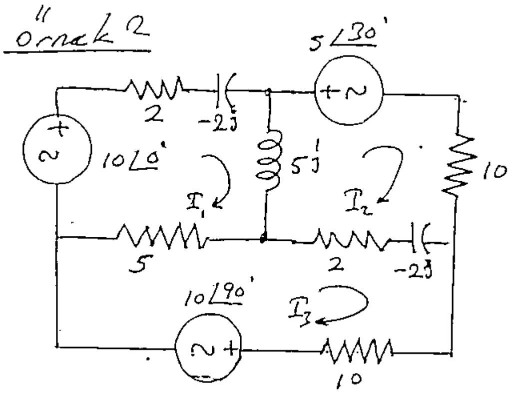


$$\begin{bmatrix} 50\angle 0^\circ \\ 0 \end{bmatrix} = \begin{bmatrix} 10-5j & 5j \\ 5j & 3-j \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$ Matris formunda göz denklemler

$$I_1 = \frac{\begin{vmatrix} 50\angle 0 & 5j \\ 0 & 3-j \end{vmatrix}}{\begin{vmatrix} 10-5j & 5j \\ 5j & 3-j \end{vmatrix}} = \frac{150-50j}{50-25j} = 2{,}83\angle 8{,}14^\circ\ A$$

Not: $I_2 = 4{,}47\angle -63{,}4^\circ\ A$

Örnek 2



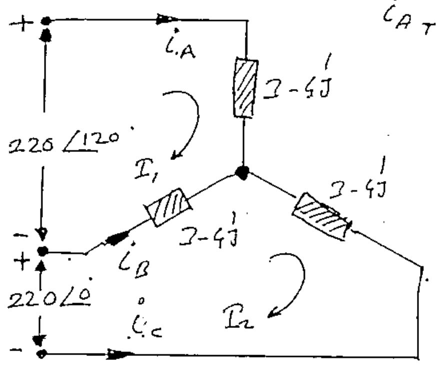
Devrenin çözüm denklemlerini matris formunda hazırlayınız.

$$\begin{bmatrix} 10\angle 0^\circ \\ -5\angle 30^\circ \\ -10\angle 90^\circ \end{bmatrix} = \begin{bmatrix} (7+3j) & -5j & -5 \\ -5j & (12+3j) & -(2-2j) \\ -5 & -(2-2j) & (17-2j) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

olarak hazırlanabilir.

Örnek 3

Yıldız bağlı eş-değer kol empedanslı devrenin i_A, i_B ve i_C kol akımlarını bulunuz.



$$\begin{bmatrix} 220\angle 120^\circ \\ 220\angle 0^\circ \end{bmatrix} = \begin{bmatrix} (6-8j) & -(3-4j) \\ -(3-4j) & (6-8j) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\Delta = \begin{bmatrix} (6-8j) & -(3-4j) \\ -(3-4j) & (6-8j) \end{bmatrix} = 75\angle -106^\circ$$

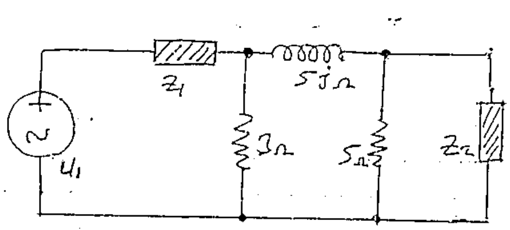
Denklemler çözülürse, $I_1 = 25{,}4\angle 143^\circ$, $I_2 = 25{,}4\angle 83^\circ$ elde edilir. Gözakımları yardımı ile de olarak göz akımları

$$i_A = I_1 = 25{,}4\angle 143^\circ\ A$$

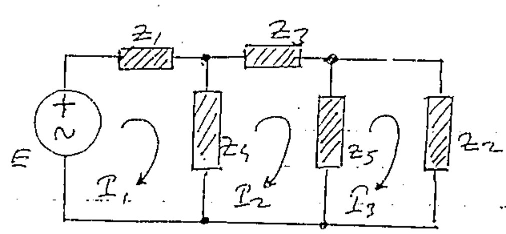
$$i_C = -I_2 = 25{,}4\angle -97^\circ\ A$$

ve $i_B = I_2 - I_1 = 25{,}4\angle 83^\circ - 25{,}4\angle 143^\circ = 25{,}4\angle 23{,}1^\circ$ olarak kol akımları bulunur.

Örnek 4 Verilen devrede I_2 ve I_3 akımlarını bulunuz.



$\Rightarrow$



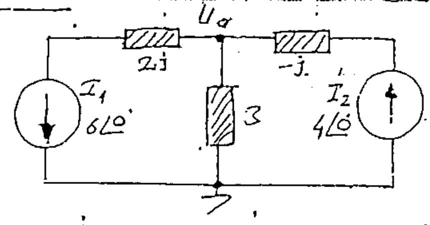
ara devre emp. dönüşü yapılmış durumu

$U_1 = 20\angle 30^\circ\ V$
$Z_1 = 5-2j$
$Z_2 = 2-2j$

$$\left.\begin{aligned} U_1 &= I_1(Z_1+Z_4) - I_2(Z_4) + 0 \\ 0 &= -I_1 Z_4 + I_2(Z_3+Z_4+Z_5) - I_3 Z_5 \\ 0 &= 0 - I_2(Z_5) + I_3(Z_2+Z_5) \end{aligned}\right\}$$ formatlı çözüm denklemleri

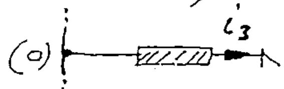
Denklemler çözülürse, $I_2 = 1{,}4\angle -20^\circ\ A$ ve $I_3 = 0{,}95\angle 13{,}7^\circ\ A$ bulunur.

Örnek 1 Verilen devrede "a" noktasının potansiyelini bulunuz ve orta kol akımını tanımlayınız.



$$-6\angle 0 + 4\angle 0 = U_a\left(\frac{1}{2j} + \frac{1}{3} + \frac{1}{-j}\right) \Rightarrow -2\angle 0 = U_a(0{,}33 + 0{,}5j)$$

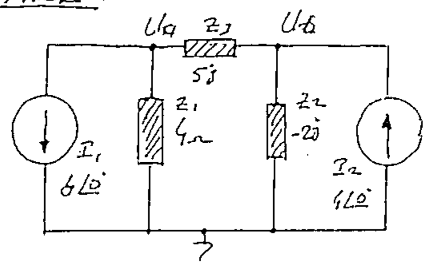
$$2\angle 180 = U_a(0{,}6\angle 56{,}5) \Rightarrow U_a = \frac{2\angle 180}{0{,}6\angle 56{,}5} = 3{,}33\angle 123{,}5\ V$$



$$i_3 = \frac{3{,}33\angle 123{,}5}{3\angle 0} = 1{,}11\angle 123{,}5\ A \text{ olur.}$$

Örnek 2

U_a ve U_b düğüm gerilimlerini bulunuz.



$$\text{KAK} \Rightarrow \begin{cases} U_a\left(\frac{1}{5j} + \frac{1}{4}\right) - U_b\left(\frac{1}{5j}\right) = -I_1 \\ U_b\left(\frac{1}{5j} + \frac{1}{-2j}\right) - U_a\left(\frac{1}{5j}\right) = I_2 \end{cases}$$

$$\left.\begin{aligned} -6\angle 0 &= U_a\left(\frac{1}{4} + \frac{1}{5j}\right) - U_b\left(\frac{1}{5j}\right) \\ 4\angle 0 &= -U_a\left(\frac{1}{5j}\right) + U_b\left(\frac{1}{5j} + \frac{1}{-2j}\right) \end{aligned}\right\} \text{Çözüm denklemleri}$$

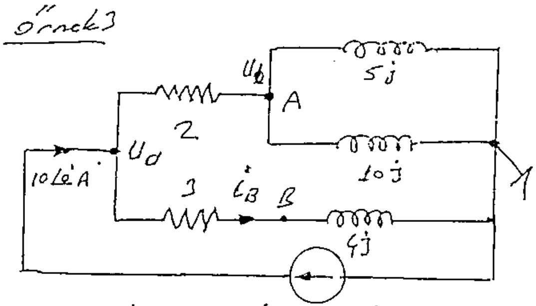
$$\left.\begin{aligned} -6\angle 0 &= U_a(0{,}32\angle -38{,}6) + U_b(0{,}2j) \\ 4\angle 0 &= U_a(0{,}2j) + U_b(0{,}3j) \end{aligned}\right\} \Rightarrow \begin{aligned} (-6\angle 0 &= U_a 0{,}32\angle -38{,}6 + U_b 0{,}2j) \cdot (1\angle 0) \\ (4\angle 0 &= U_a 0{,}2j + U_b 0{,}3j) \cdot \left(-\tfrac{2}{3}\angle 0\right) \end{aligned}$$

$$\left.\begin{aligned} -6\angle 0 &= U_a(0{,}32\angle -38{,}6) \\ -2{,}66\angle 0 &= -U_a 0{,}133j \end{aligned}\right\} -8{,}66\angle 0 = U_a(-0{,}133j + 0{,}25 - 0{,}2j)$$

$$U_a = \frac{-8{,}66\angle 0}{0{,}25 - 0{,}333j} = \frac{8{,}66\angle 180}{0{,}41\angle -53} = 21\angle 233\ V \quad \text{ve} \quad U_b = 4\angle 0\ V \text{ denklemlerden bulunur.}$$

Örnek 3

U_{AB} gerilimini bulunuz.



$$\text{KAK} \Rightarrow \begin{cases} 10\angle 0 = \frac{U_a - U_b}{2} + \frac{U_a}{3+4j} \\ 0 = \frac{U_b - U_a}{2} + \frac{U_b}{5j} + \frac{U_b}{10j} \end{cases}$$

$$\left.\begin{aligned} 10\angle 0 &= U_a\left(\frac{1}{2} + \frac{1}{3+4j}\right) - U_b\left(\frac{1}{2}\right) \\ 0 &= -U_a\frac{1}{2} + U_b\left(\frac{1}{2} + \frac{1}{5j} + \frac{1}{10j}\right) \end{aligned}\right\} \text{şeklinde düzenlenebilir}$$

$$U_a = \frac{\begin{vmatrix} 10\angle 0 & -0{,}5 \\ 0 & (0{,}5 - 0{,}3j) \end{vmatrix}}{\begin{vmatrix} (0{,}62 - 0{,}16j) & -0{,}5 \\ -0{,}5 & (0{,}5 - 0{,}3j) \end{vmatrix}} = \frac{5{,}83\angle -31}{0{,}267\angle 87{,}4} = 21{,}8\angle 56{,}4\ V$$

Payda determinantı $(\Delta) = 0{,}267\angle 87{,}4$

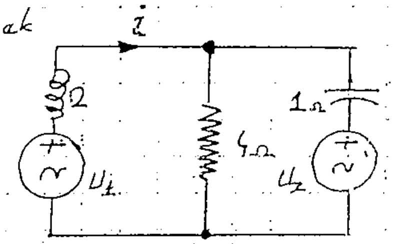
$$U_b = \frac{\begin{vmatrix} (0{,}62 - 0{,}16j) & 10\angle 0 \\ -0{,}5 & 0 \end{vmatrix}}{\Delta} = \frac{5\angle 0}{0{,}267\angle 87{,}4} = 18{,}7\angle 87{,}4\ V, \qquad i_B = \frac{U_a}{3+4j}$$

$$U_B = \frac{U_a}{3+4j} \cdot 4j = \frac{21{,}8\angle 56{,}4}{3+4j} \cdot 4j = 17{,}45\angle 93\ V$$

$$U_{AB} = U_A - U_B = 18{,}7\angle 87{,}4 - 17{,}45\angle 93 = 2{,}23\angle 34\ V \text{ bulunur.}$$

Çevre ve Düğüm Analizi ile ilgili örnekler

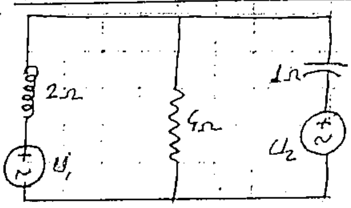
Örnek



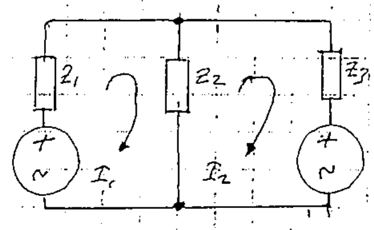
Örneği,
1) Mesh analizi ile,
2) Nodal analizle,
3) Süperpozisyonla,
4) Thevenin teoremi ile
5) Norton teoremi ile çözünüz
ve i akımını bulunuz.

$U_1 = 2{,}82 \sin(314t + 0)$
$U_2 = 8{,}46 \sin(314t + 0)$

1) Çevre ile çözüm



$\Rightarrow$



$Z_1 = 2j$
$Z_2 = 4$
$Z_3 = -j$
$U_1 = 2\angle 0$
$U_2 = 6\angle 0$

$$\left.\begin{aligned} 2\angle 0 &= (4+2j)I_1 - 4I_2 \\ -6\angle 0 &= -4I_1 + (4-j)I_2 \end{aligned}\right\} \quad \begin{aligned} 2\angle 0 &= 4{,}47\angle 26{,}5\, I_1 - 4I_2 \\ -6\angle 0 &= -4\, I_1 + 4{,}12\angle{-14}\, I_2 \end{aligned}$$

a) Yok etme kuralına göre çözüm,

$$\left.\begin{aligned} (2\angle 0 &= 4{,}47\angle 26{,}5\, I_1 - 4I_2)\cdot(1\angle 0) \\ (-6\angle 0 &= -4I_1 + 4{,}12\angle{-14}\, I_2)\cdot(0{,}97\angle 14) \end{aligned}\right\} \quad \begin{aligned} 2\angle 0 &= 4{,}47\angle 26{,}5\, I_1 - 4I_2 \\ -5{,}82\angle 14 &= -3{,}88\angle 14\, I_1 + 4\angle 0\, I_2 \end{aligned}$$

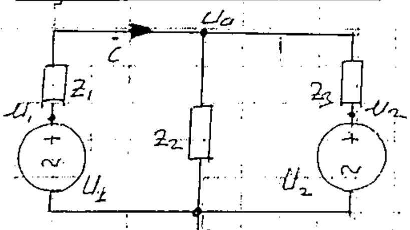
Not, istenirse "$-\sin\alpha$" $\Rightarrow$ "$\sin(\alpha \mp 180)$" dönüşümü uygulanarak denklemler düzenlenebilir

$$\left.\begin{aligned} 2\angle 0 &= 4{,}47\angle 26{,}5\, I_1 \\ 5{,}82\angle 194 &= 3{,}88\angle 194\, I_1 \end{aligned}\right\} \; I_1 = \frac{3{,}9}{1{,}08}\angle{-236} \text{ veya } \frac{3{,}9}{1{,}08}\angle 124 \text{ A bulunur.}$$

b) Determinant yöntemi ile çözüm,

$$I_1 = \frac{\begin{vmatrix} 2\angle 0 & -4 \\ -6\angle 0 & 4-j \end{vmatrix}}{\begin{vmatrix} 4+2j & -4 \\ -4 & 4-j \end{vmatrix}} = \frac{(2\angle 0)\cdot(4-j) - (-4\cdot -6)}{(4+2j)\cdot(4-j) - (-4\cdot -4)} = \frac{-16-2j}{2+4j} = 3{,}6\angle{-236{,}5}\text{ A}$$

2) Düğüm ile çözüm



$U_1 = 2\angle 0$
$U_2 = 6\angle 0$

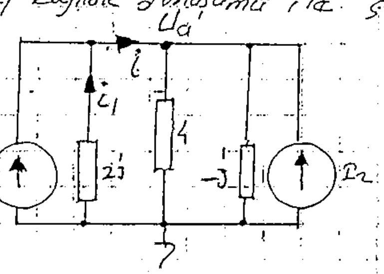
$$\frac{2\angle 0 - U_a}{2j} + \frac{-U_a}{4} + \frac{6\angle 0 - U_a}{-j} = 0$$

$$\frac{2\angle 0}{2j} + \frac{6\angle 0}{j} = U_a\left(\frac{1}{4} + \frac{1}{2j} + \frac{1}{-j}\right)$$

$$5j = U(0{,}25 + j(-0{,}5+1)) \Rightarrow 5j = U(0{,}25 + 0{,}5j)$$

$$U_a = \frac{5\angle 90}{0{,}56\angle 63{,}5} = 8{,}93\angle 26{,}5\text{ V}, \quad i = \frac{2\angle 0 - 8{,}93\angle 26{,}5}{2\angle 90} \Rightarrow i = 3{,}6\angle{-236}\text{ A} = 3{,}6\angle 124\text{ A}$$

Not; kaynak dönüşümü ile çözüm yapılabilir



$I_1 = \frac{2\angle 0}{2\angle 90} = -j\text{ A}$

$I_2 = \frac{6\angle 0}{1\angle 90} = 6j\text{ A}$

$$-j + 6j = U_a\left(\frac{1}{4} + \frac{1}{2j} + \frac{1}{-j}\right)$$

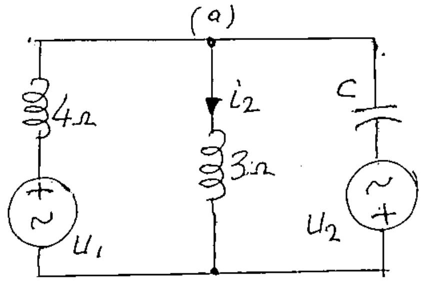
$$5j = U_a(0{,}25 + 0{,}5j) \Rightarrow U_a = 8{,}93\angle 26{,}5\text{ V}$$

$$i_1 = -U_a/2j = 4{,}46\angle 116{,}5\text{ A}$$

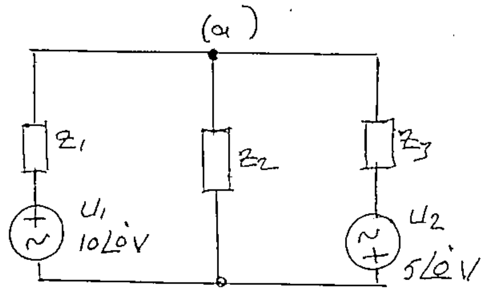
$$i = I_1 + i_1 = -j + (4{,}46\angle 116{,}5) = -2 + 3j = 3{,}6\angle 123\text{ A}$$

Toplamsallık Teoremi ile AC Devre Örnekleri

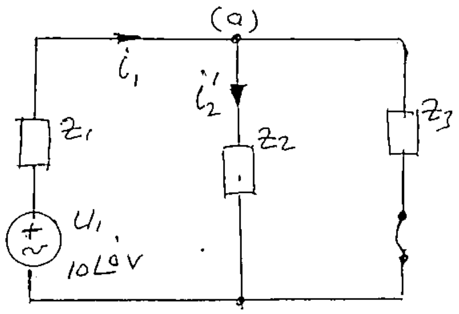
Örnek 1. i_2 ortakol akımını toplamsallığı kullanarak bulunuz.



$C = 500\mu F$
$U_1 = 10\angle 0^\circ V$
$U_2 = 5\sqrt{2}\sin 500t$ Volt
$U_2 = 5\angle 0^\circ V$
$Z_1 = 4j\ \Omega$
$Z_2 = 3j\ \Omega$
$Z_3 = \dfrac{1}{wC}$
$Z_3 = -4j\ \Omega$



1. Adım (U_2 pasif, diğeri aktif)



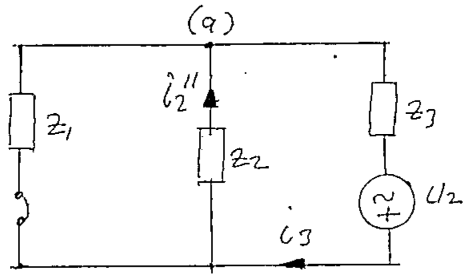
$$i_1 = \frac{U_1}{Z_t} = \frac{10\angle 0^\circ V}{Z_1 \to Z_2 // Z_3} = \frac{10\angle 0^\circ V}{(4j + (3j // -4j))\Omega}$$

$$i_1 = \frac{10\angle 0^\circ V}{16\angle 90^\circ \Omega} = 0{,}625\angle -90^\circ A$$

$$A.B.K \Rightarrow i_2' = 0{,}625\angle -90^\circ A \ \frac{-4j}{3j - 4j} = \frac{2{,}5\angle -180}{-j}$$

$$i_2' = 2{,}5\angle -90^\circ = -2{,}5j\ A \qquad (1\angle -90^\circ)$$

2. Adım (U_2 aktif, diğeri pasif)



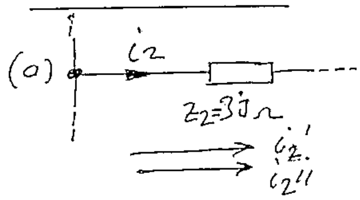
$$i_3 = \frac{U_2}{Z_t} = \frac{5\angle 0^\circ V}{(Z_3 \to Z_1 // Z_2)\Omega} = \frac{5\angle 0^\circ V}{-4j + (4j // 3j)}$$

$$i_3 = \frac{5\angle 0^\circ V}{-4j + 1{,}71j} = \frac{5\angle 0^\circ V}{(-2{,}286j)\Omega} = \frac{5\angle 0^\circ V}{2{,}286\angle -90\Omega} = 2{,}189\angle 90^\circ A$$

$$A.B.K \Rightarrow i_2'' = 2{,}189\angle 90^\circ A \ \frac{4\angle 90^\circ \Omega}{(4j + 3j)\Omega} = \frac{8{,}756\angle 180^\circ}{7\angle 90^\circ \Omega} = 1{,}25\angle 90\ A$$

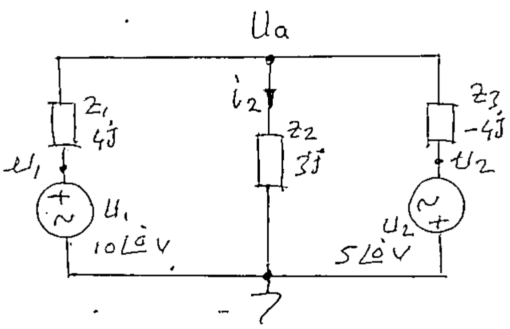
$$i_2'' = 1{,}25j\ A$$

Sonuç Adımı



$$i_2 = +i_2' - i_2'' = ((-2{,}5j\ A) - (1{,}25j))\ A = -3{,}75j\ A = 3{,}75\angle -90\ A$$

Nodal analiz ile çözümleme



$e_1 = +10\angle 0^\circ V$
$e_2 = -5\angle 0^\circ V$

K.A.K a serbest düğümüne $\Rightarrow$

$$0 = \frac{10\angle 0^\circ V - U_a}{4j} + \frac{0 - U_a}{3j} + \frac{-5\angle 0^\circ - U_a}{-4j}$$

$$(2{,}5\angle -90 - 1{,}25\angle 90)_A = U_a \left(\frac{1}{4j} + \frac{1}{3j} + \frac{1}{-4j}\right)\mho$$

$$(-2{,}5j - 1{,}25j)_A = U_a(-0{,}25j - 0{,}33j + 0{,}25j)\mho$$

$$-3{,}75j = U_a(-0{,}33j)\mho \Rightarrow \frac{3{,}75\angle -90\ A}{0{,}33\angle -90\mho} = U_a$$

$$U_a = 11{,}25\angle 0^\circ V$$

$$i_2 = \frac{U_a - 0}{Z_2} = \frac{11{,}25\angle 0}{3\angle 90} = 3{,}75\angle -90\ A$$