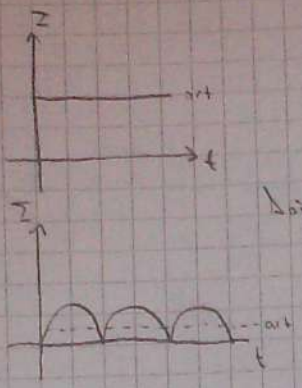
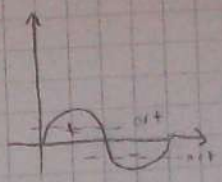
DEVRE TEORİSİ

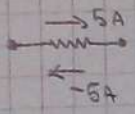




Alternatif akım

⇓

Ortalamalar toplamı sıfırdır



$i = \frac{dq}{dt}$ $\quad q = \int i \, dt$

↳ Belli bir zamanda geçen yük miktarı

$V_{ab} = V_a - V_b$ $\quad V = \frac{dw}{dq}$ $\quad P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt}$ (dw: V, dq: I)

$V_{ab} = -V_{ba}$

$P = q \cdot V$

$P = +V \cdot i$ $\quad$ Pasif

$P = -V \cdot i$ $\quad$ Aktif

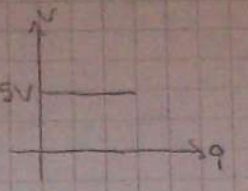
$R = \rho \cdot \frac{l}{A}$ $\quad \rho \to \Omega m$, $A \to m^2$ $\quad [\Omega]$ uzunluk ve alandaki uzunluk birimine dikkat et

ρ → Özdirenç (Ωm)

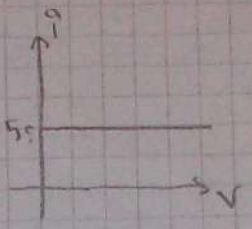
Örn: d = 1.63 mm çaplı 75 metrelik bakır telin direnci? $\rho = 1{,}723 \cdot 10^{-8}$ Ωm

$A = \pi r^2 = \pi \cdot \left(\frac{1.63 \cdot 10^{-3}}{2}\right)^2$

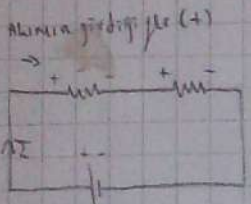
$R = 1.723 \ldots$



İdeal gerilim kaynağı



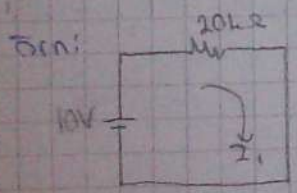
İdeal akım kaynağı

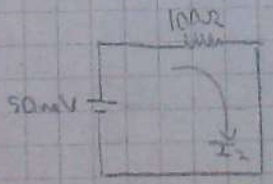


KVL

$\Sigma V = 0$ (kapalı devre için)

Örn:





a) $I_1, I_2 = ?$

b) Kaynağa 250Ω luk şönt direnç olan ampermetre bağlanırsa

$I_1, I_2 = ?$ ve yüklenme etkisini bulup a ve b de bulduğun sonuçların oranı (yüzde hatası)

a) $I_1 = \frac{10}{2000} = 0{,}5\,mA$

b) $I'_{1\text{için}} = \frac{10}{2000+250} = 0{,}444\,mA$

$I_2 = \frac{50 \cdot 10^{-3}}{100} = 0{,}5\,mA$

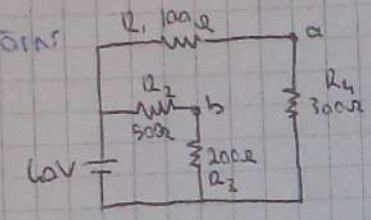
$I'_{2\text{için}} = \frac{50 \cdot 10^{-3}}{100+250} = 0{,}143\,mA$

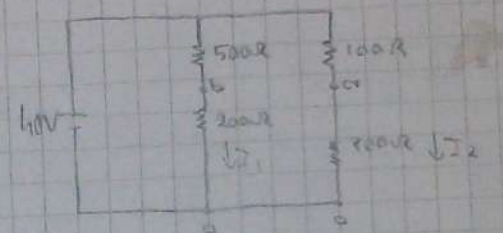
KCL

Düğüme giren akım çıkan akımların toplamına eşittir.

$\Sigma I = 0$ bir düğümde

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$ $\quad R_T = \frac{R_1 \cdot R_2}{R_1 + R_2}$

Örn: 

$\equiv$ 

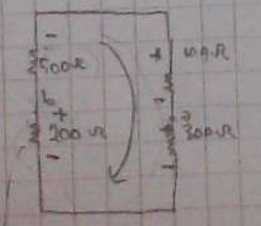
Devredeki V_{ab}'yi bulun

$I_1 = 0,1A$ $\quad V_b = V_b - V_a = I_1 \cdot R = 0,1 \cdot 200 = 32V$

$I_2 = 0,1A$ $\quad V_a = V_b - V_a = I_2 \cdot R = 0,1 \cdot 300 = 30V$

$V_{ab} = V_a - V_b = -2V$

veya



$V_{R_1} + V_{ab} + V_{R_2} = 0$

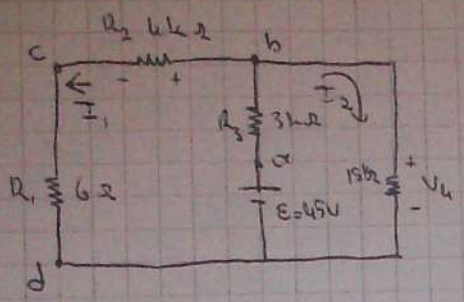
$0,1 \cdot 100 + V_{ab} + 50 \cdot 0,1 = 0$

$10 - 8 + V_{ab} = 0$

$V_{ab} = -2V$

V_{ab} olmasının sebebi; V_{ab}'yi bütün alarak almamız

Örn:



a) $R_T = ?$

b) $I_1, I_2, I_T = ?$

c) $V_2, V_4 = ?$

d) $V_{bd} = ?$

a) $R_T = (4+6) // 15 + 3 = 9\,k\Omega$

$I_T = 45/9 = 5\,mA$

$I_1 = \frac{R_4}{(R_1+R_2)+R_4} \cdot I_T = 3\,mA$

$I_2 = \frac{R_1+R_3}{R_1+R_2+R_4} \cdot I_T = 1\,mA$

$V_2 = I_1 \cdot R_2 = 3 \cdot 4 = 12V$

$V_4 = I_2 \cdot R_4 = 2 \cdot 5 = 10V$

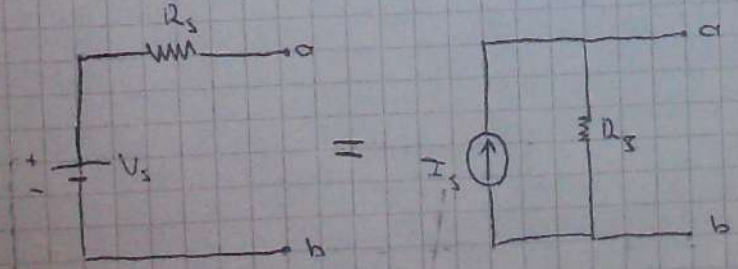
$V_{bd} = V_2 + V_1$

$= I_1 \cdot R_2 + I_1 \cdot R_1$

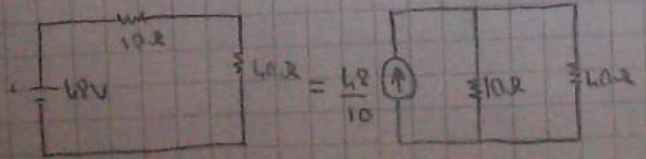
$= 12 + 18$

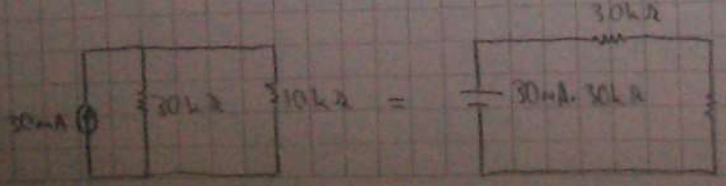
$= 30$

Kaynak Dönüşümü

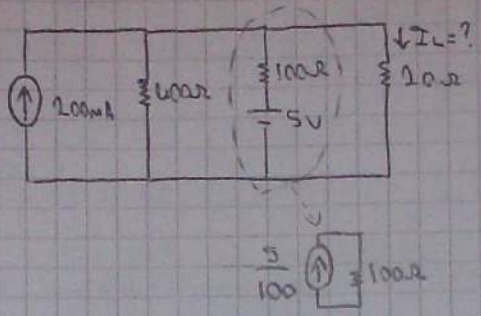


Akımın gidiş yönüne bakılır

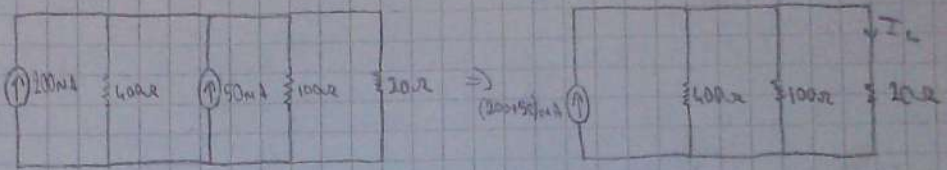




Örn:



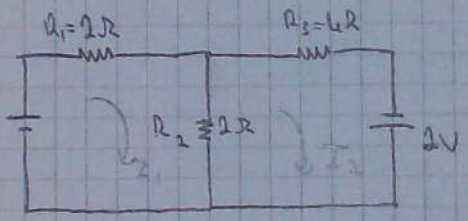
Tek bir akım kaynağına dönüştürerek çözün



$R_{eş}$=16Ω

V = 250mA · 16 = 4V

Örn:



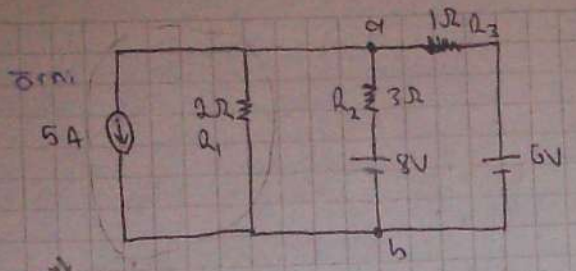
$R_1 \cdot I_1 + R_2 \cdot I_1 - R_2 \cdot I_2 + E_2 - E_1 = 0$ 1. Çevre

$I_2 \cdot R_3 - E_3 - E_2 + R_2 \cdot I_2 - R_2 I_1 = 0$ 2. Çevre

$6I_1 - 1I_2 = 2V$ $\quad I_1 = 1,1A$

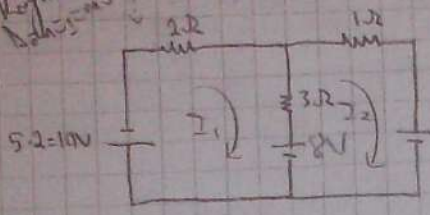
$-2I_1 + 6I_2 = 6V$ $\quad I_2 = 1,6A$

Örn:



8V'luk kaynaktan geçen akımı bulunuz

Kaynak Dönüşümü:



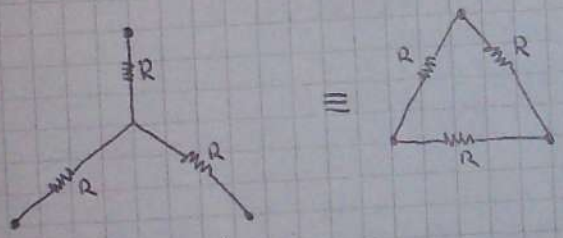
1. Çevre $I_1 \cdot 2 + (I_1 - I_2)3 + 8 + 10 = 0$

2. Çevre $I_2 \cdot 1 + 6 - 8 + (I_2 - I_1)3 = 0$

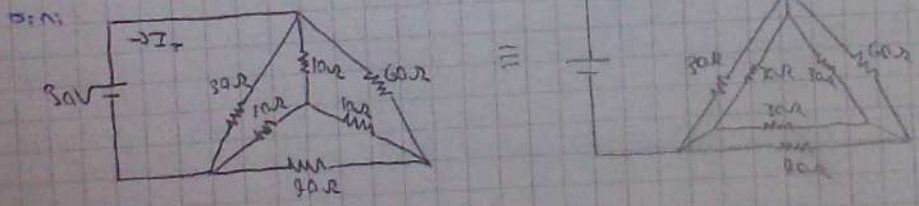
$5I_1 - 3I_2 = -18 \quad I_1 = -6A$

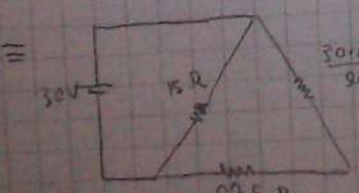
$-3I_1 + 4I_2 = 2 \quad I_2 = -4A$

Yıldız Üçgen Dönüşümü

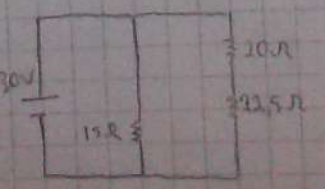


Örn:



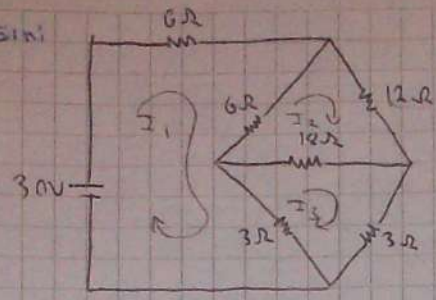


$\frac{30 \cdot 60}{90} = 20\Omega$



$R_T = 11,09\Omega$

Örn:



1. Çevre / $I_1 \cdot 6 + (I_1 - I_2)6 + (I_1 - I_3)\cdot 3 - 30 = 0$

2. Çevre / $I_2 \cdot 12 + (I_2 - I_3)18 + (I_2 - I_1)6 = 0$

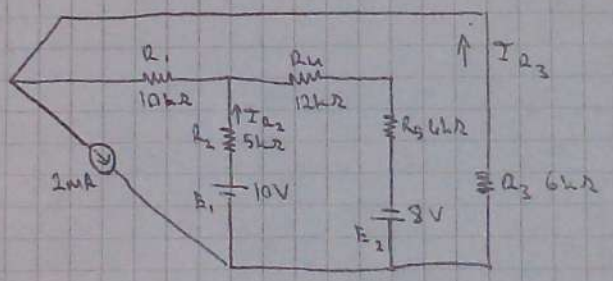
3. Çevre / $(I_3 - I_2)18 + I_3 \cdot 3 + (I_3 - I_1)3 = 0$

$6I_1 + 6I_1 - 6I_2 + 3I_1 - 3I_3 = 30 \Rightarrow 15I_1 - 6I_2 - 3I_3 = 30$

$12I_2 + 18I_2 - 18I_3 + 6I_2 - 6I_1 = 0 \Rightarrow 36I_2 - 6I_1 - 18I_3 = 0$

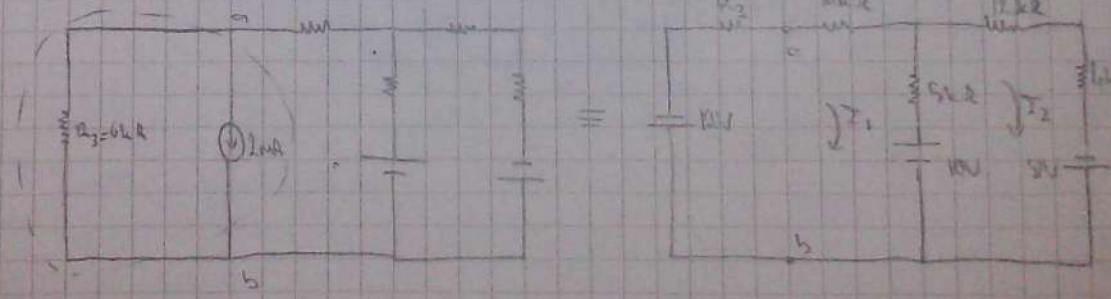
$18I_3 - 18I_2 + 3I_3 + 3I_3 - 3I_1 = 0 \Rightarrow 24I_3 - 18I_2 - 3I_1 = 0$

Örn:



$I_{R_2} = ?$

$I_{R_3} = ?$

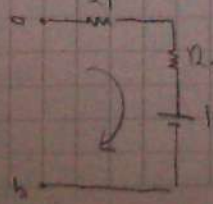


1. Çevre $6I_1 + 10I_1 + 5(I_1 - I_2) + 10 + 12 = 0 \Rightarrow 21I_1 - 5I_2 = -22$

2. Çevre $16I_2 - 8 - 10 + (I_2 - I_1)5 = 0 \Rightarrow 21I_2 - 5I_1 = 18$

$I_1 = -0,814mA$

$I_2 = +0,666mA$



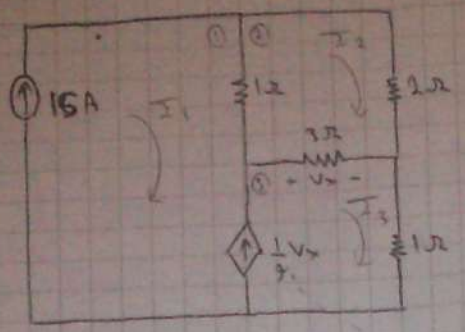
I_{R_2}'ye bakabilmemiz için Vab gerekli

$V_{R_1} + V_{R_2} + 10 - V_{ab} = 0$

$V_{ab} = -6,666V$

$I_{R_2} = I_1 - I_2$

Örn:



$V_x = ?$

$I_1 = 16A$

$I_3 - I_1 = \frac{1}{9} V_x$

$V_x = (I_3 - I_2) R_3 = 3(I_3 - I_2)$

$I_3 - I_1 = \frac{1}{9} 3(I_3 - I_2)$

$3I_3 - 3I_1 + I_3 - I_2$

$2I_3 - I_2 = 45$

1. Çevre

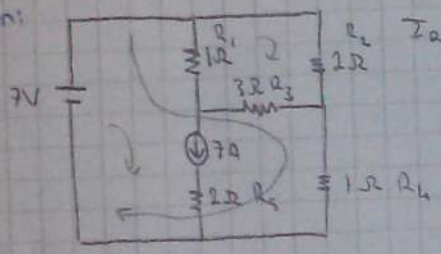
$-1 \cdot I_1 + 6I_2 - 3I_3 = 0$

$6I_2 - 3I_3 = 15$

$I_2 + 2I_3 = 45$

$V_x = (17 - 11) \cdot 3 = 18V$

Örn:



$I_{R_3} = ?$ $\quad I_1 - I_3 = 7A$

$V_{R_1} + V_{R_3} + V_{R_4} - 7 = 0$

$-I_1 \cdot 1 + (6I_2 - 3I_3) = 0$

$V_{R_1} = (I_1 - I_2) \cdot 1\Omega$

$V_{R_3} = (I_3 - I_2) \cdot 3\Omega$

$V_{R_4} = I_3$

Düğüm Gerilimleri Yöntemi

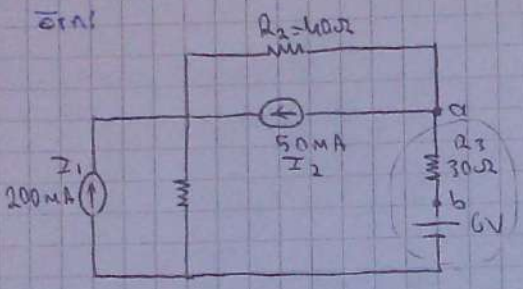
1- Referans düğüm belirliyoruz.

2- Referans düğüm hariç her bir düğüm numaralandırıyoruz

3- Düğüme bağlı elemanlar için akım yönü seçiyoruz

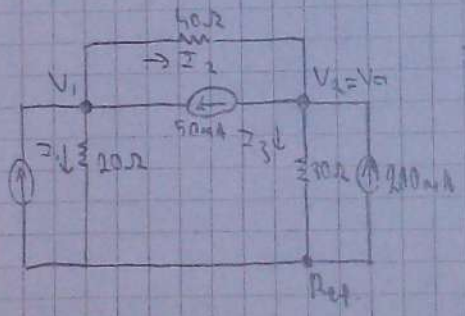
4- KCL -> Her bir düğüme Kirchoff Akım Kanunu uygulıyoruz

Örnek



Vab gerilimini düğüm gerilimleri yöntemini kullanarak çözünüz

$\equiv$ 



I1, I2, I3' ü kolaylığına göre seçtik

1. Düğüme KCL uygulayın

$+200mA + 50mA - I_1 - I_2$

2. Düğüme KCL uygulayın

$200mA + I_2 - I_3 - 50mA = 0$

$I_1 = \frac{V_1 - V_{ref}}{20\Omega} = \frac{V_1}{20}$ ($V_{ref} = 0V$)

$I_2 = \frac{V_1 - V_2}{40}$

$I_3 = \frac{V_2 - V_{ref}}{30} = \frac{V_2}{30}$

1. Denklem $250 \cdot 10^{-3} - \frac{V_1}{20} - \frac{V_1 - V_2}{40} = 0$

2. Denklem $150 \cdot 10^{-3} + \frac{V_1 - V_2}{40} - \frac{V_2}{30} = 0$

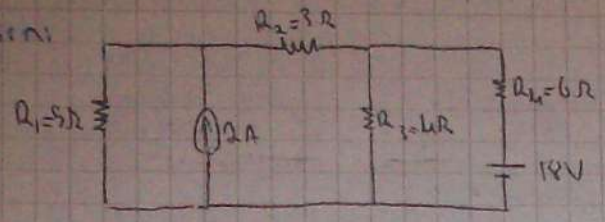
$V_1 = 4.89V$

$V_2 = 4.67V$

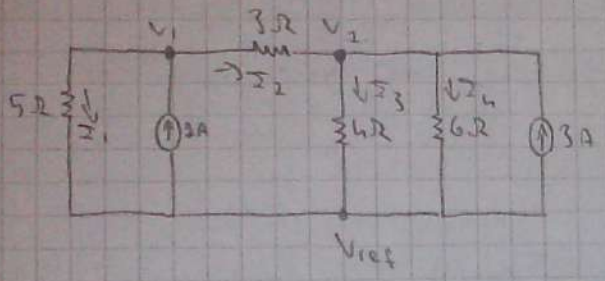
$V_3 - V_{ref} = 6$ $V_3 = 6$

$V_{AB} = V_A - V_B = V_2 - 6 = 4.67 - 6 = -1.33V$

Örn:



Düğüm gerilimleri yönteminde çözüm yaparken akımlar üzerinde çalıştığımız için, kaynak dönüşümü yapıp V'yi A'ya çevir



1. Düğüm

$2 - I_1 - I_2 = 0$

2. Düğüm

$3 + I_2 - I_3 - I_4 = 0$

$V_1 = 8,65V$

$V_2 = 7,85V$

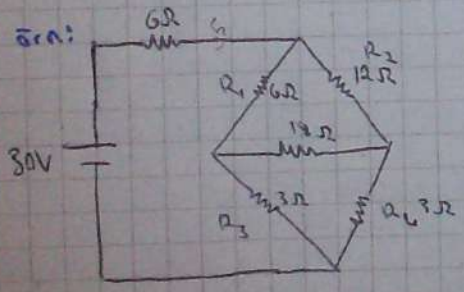
$I_1 = \frac{V_1 - V_{ref}}{R_1}$

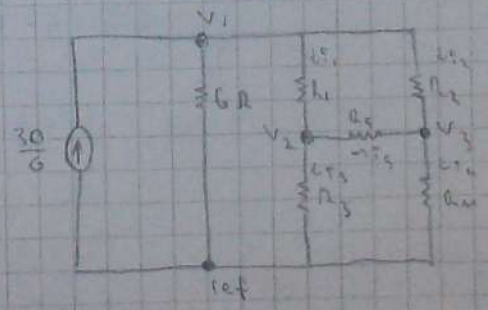
$I_2 = \frac{V_1 - V_2}{3}$

$I_3 = \frac{V_2 - V_{ref}}{4}$

$I_4 = \frac{V_2 - V_{ref}}{6}$

Örn:





Düğüm gerilimleri yöntemiyle V_{R_3}=? $V_{ref} = 0$

$\Sigma I_{gelen} = \Sigma I_{giden}$

V_1 için

$5 = \frac{V_1 - V_{ref}}{6} + \frac{V_1 - V_2}{6} + \frac{V_1 - V_3}{12}$

V_2 için

$\frac{V_1 - V_2}{6} = \frac{V_2 - V_{ref}}{3} + \frac{V_2 - V_3}{12}$

V_3 için

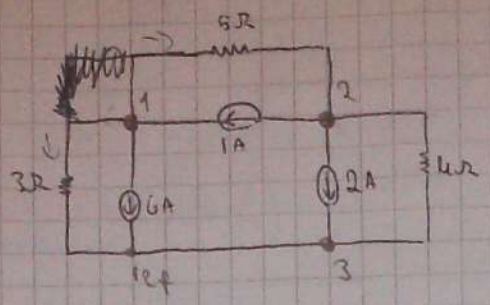
$\frac{V_2 - V_{ref}}{3} = \frac{V_1 - V_3}{12} + \frac{V_2 - V_3}{12}$

$V_1 = 14,48V$

$V_2 = 4,66V$

$V_3 = 3,10V$

Örn:



1. Bağım

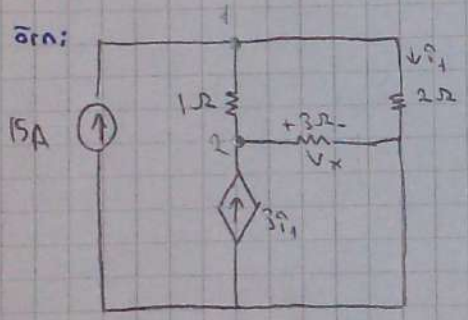
$$I = \frac{V_1 - V_2}{5} + \frac{V_1 - V_{ref}}{3} + 6$$

⇨ Aşağıya giden akımların toplamı hem kaynak

$$\left(\frac{1}{3} + \frac{1}{5}\right) V_1 - \frac{1}{5} V_2 = 1 - 6 \quad \rightarrow \quad \left(\frac{1}{3} + \frac{1}{5}\right) V_1 - \frac{1}{5} V_2 = -5$$

$$\left(-\frac{1}{5}\right) V_1 + \left(\frac{1}{4} + \frac{1}{5}\right) V_2 = -1 - 2 \quad \rightarrow \quad -\frac{1}{5} V_1 + \left(\frac{1}{4} + \frac{1}{5}\right) V_2 = -3$$

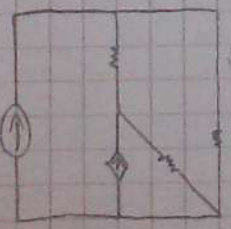
Örn:



Bağımlı akım kaynağı tarafından harcanan güç nedir?

$$i_1 = \frac{V_1 - V_{ref}}{2} = \frac{V_1}{2}$$

$$3i_1 = \frac{3}{2} V_1$$



2 Nolu bağım

$$\frac{V_1 - V_2}{1} + \frac{(3i_1)}{} + \frac{(V_2 - V_{ref})}{3} = 0$$

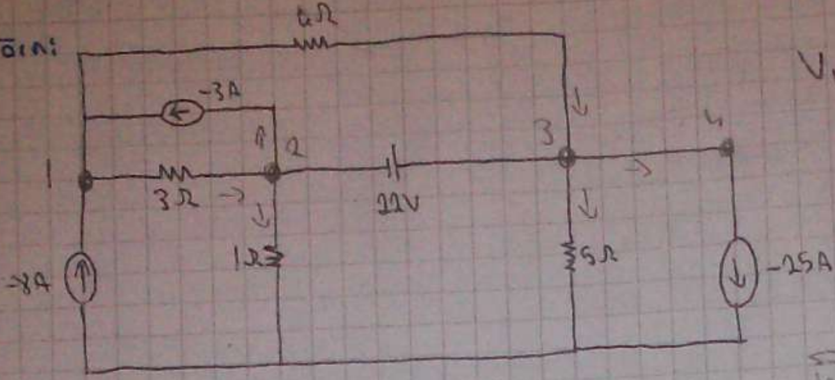
1 Nolu bağım

$$15 - \frac{(V_1 - V_2)}{1} - \frac{(V_1 - V_{ref})}{2} = 0$$

$$\begin{aligned} -15V_1 + 8V_2 &= \\ 12V_1 - 8V_2 &= 120 \end{aligned} \Bigg\} \begin{aligned} V_1 &= -40V \\ V_2 &= -75V \end{aligned}$$

$$P = \frac{3}{2} V_1 (V_1 - V_{ref}) = -4,5\,kW$$

örn:

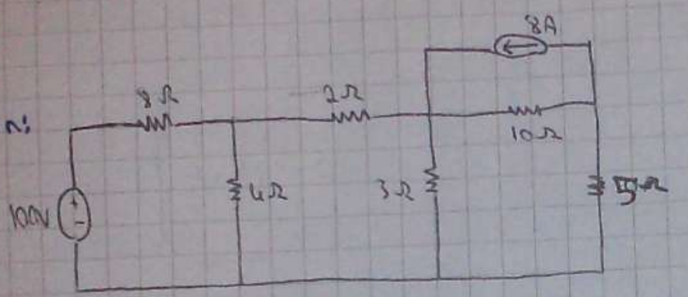


$V_1 = ?$

İki düğüm arasında sadece gerilim kaynağı varsa 1. ve 3. düğümler süper düğüm. Bunları tek düğüm kabul et

$V_2 - V_3 = -22$ $\quad \frac{V_1 - V_2}{3} + \frac{V_1 - V_3}{4} = \frac{V_2}{1} + \frac{V_3}{5} - 25 - 3$

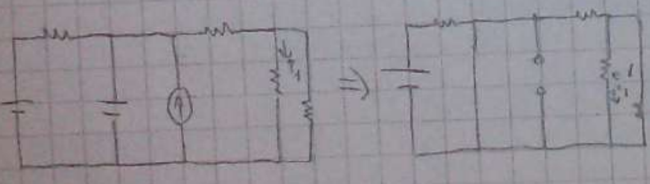
örn:



$i_x = ?$

TOPLAMSALLIK TEORİSİ

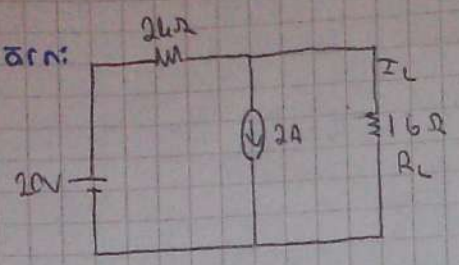
* Lineer devrelerde kullanılabilir



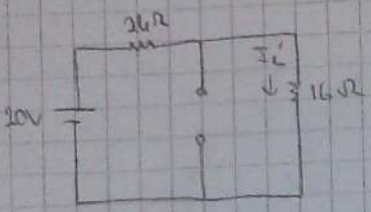
$i_1 = i_1' + i_1'' + i_1'''$

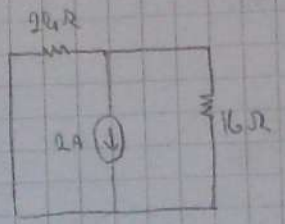
* Bağımlı akım kaynağına uygulanmaz

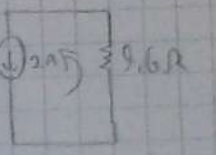
Örn:



$I_L = ?$





$2k \,//\, 1,6$ $\Rightarrow$ 

$R_{eş} = 9,6$

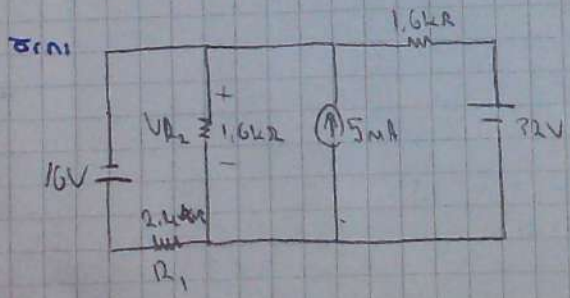
$I_L' = \frac{20}{40} = 0,5\,A$

$2 \cdot 9,6 = 19,2\,V \Rightarrow I_L'' = \frac{19,2}{16} = 1,2\,A$

$I_L = I_L' + I_L''$

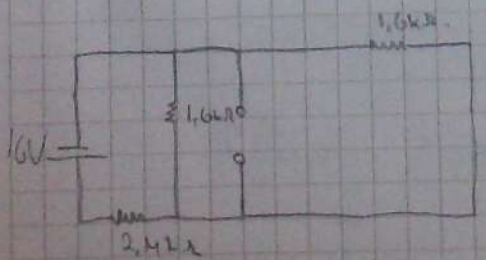
$= 0,5 + 1,2 = 1,7\,A$

Örn:

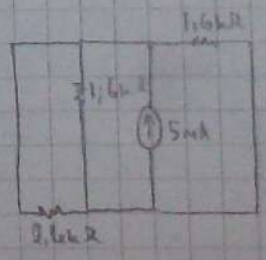


$V_{R_2} = ?$

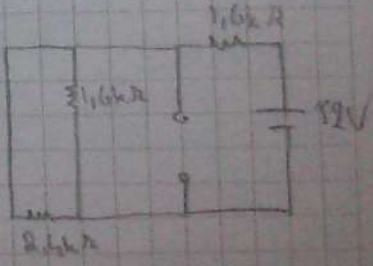
$V_{R_2} = V_{R_2}' + V_{R_2}'' + V_{R_2}'''$



+



+



$V_R' = -\frac{16}{2,4+0,8} \cdot 0,8 = -4V$

$2,4 \,//\, 1,6 \,//\, 1,6 \,//$

$2,4 \,//\, 0,8 + 1,6 = 2,5k\Omega$

$2,4 \,//\, 0,8 = 0,6k\Omega$

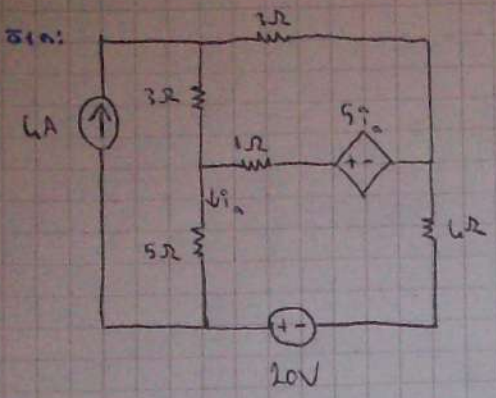
$I = \frac{32}{2,5}$

$0,6k\Omega \cdot 5mA = 3V$

$V_2'' = 12V$

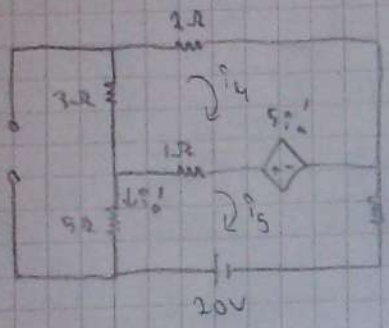
$V_{R_2}'' = 3V$

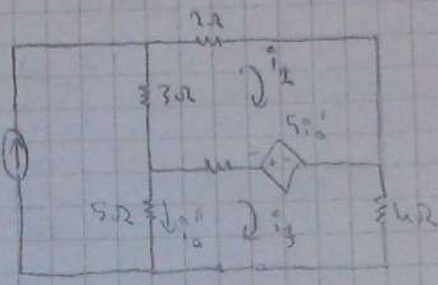
Örn:



i_a akımını toplamsallık teoremiyle hesaplayın

* Bağımlı kaynakların dokunmadan çözüm yapıyoruz





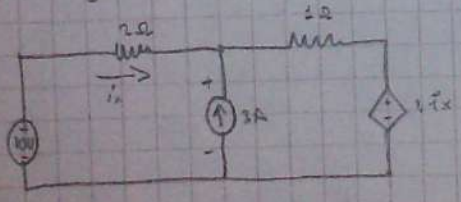
1. çevre

$6i_4 - 1\cdot i_5 = 5i_a'$

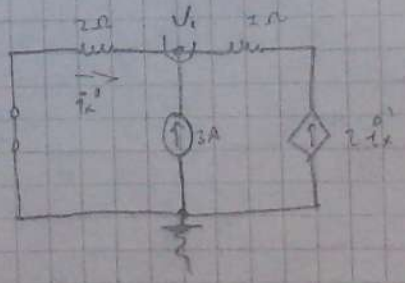
2. çevre

$-1\cdot i_4 + 10\cdot i_5 = 20 - 5i_a'$

$i_a' = -i_5$



İki çevreli toplamsallık teoremiyle bulunacak bulunur



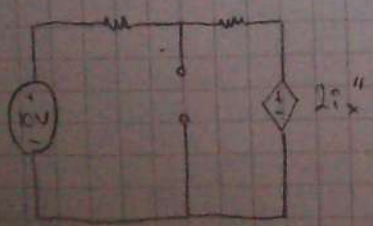
$$\frac{0 - V_1}{2} + \left(\frac{V_1 - 2i_x'}{1}\right) + 3 = 0$$

Gelen akım pozitif alınırsa

$$-\frac{V_1}{2} - \frac{V_1}{1} + \frac{2i_x'}{1} + 3 = 0$$

$i_x' = -0.6A$

$I = i_x''$

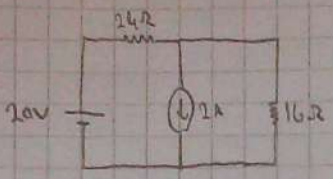


$i_x' = -\frac{V_1}{2}$

$2I + 12 + 2i_x'' - 10 = 0$

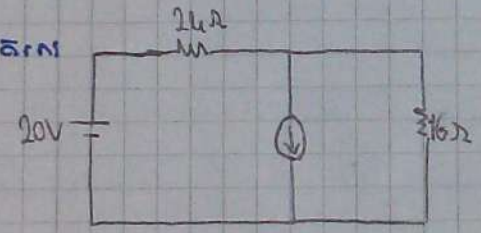
$2i_x'' + -1i_x'' + 2i_x'' = 10 \quad i_x'' = 10/5 = 2A$

THEVENIN TEOREMİ

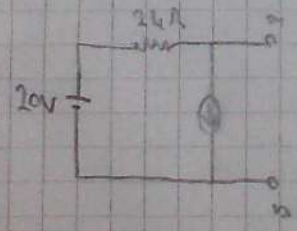


İlk adım → Yükü devreden çıkartıyoruz

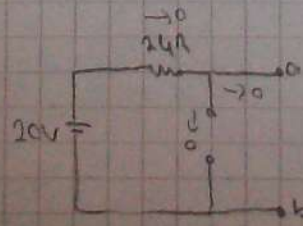
Örnek



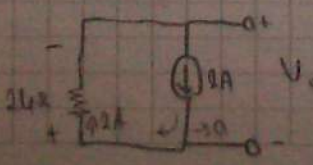
16Ω luk direnç üzerinden geçen akımı Thevenin'den bulun



Toplamsallığı kullanıyoruz

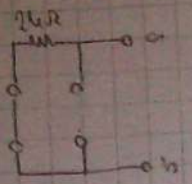


$V_{ab}' = 20V$



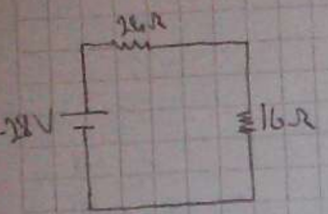
$V_{ab}'' = -48V$

$V_{ab} = V_{ab}' + V_{ab}'' = -28V$



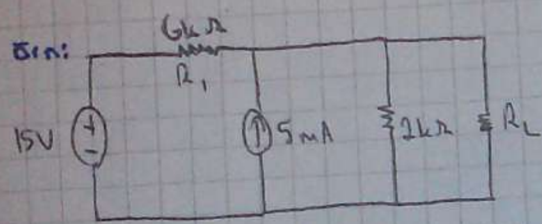
Bağımsız kaynakları aynı anda sıfırlıyoruz

$R_{eş} = 24k\Omega = R_{TH}$



$I = \frac{-28}{16+24} = -0{,}7\ A$

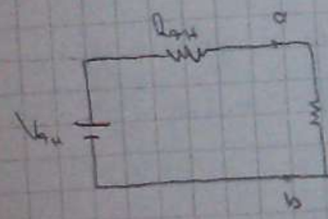
Örn:

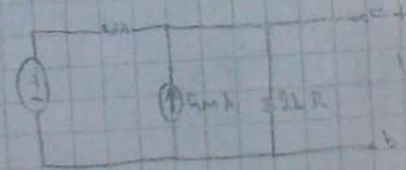


$R_L \to 0\Omega \to I_1$

$R_L \to 2k\Omega \to I_2$

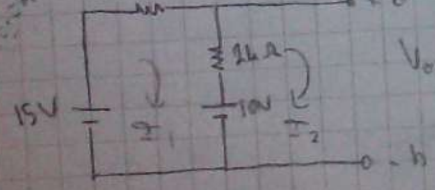
$R_L \to 5k\Omega \to I_3$





V_{ab} (?)

Kaynak dönüşümü:



V_{ab}'

$I_2 = 0$

$(6+2)I_1 - 2I_2 + 10 - 15 = 0$

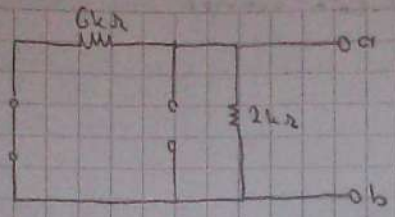
$8I_1 = 5 \quad I_1 = 5/8 = 0{,}625\ A$

$2I_2 - 2I_1 + V_{ab} - 10 = 0$

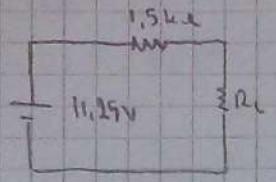
$-2I_1 + V_{ab} = 10$

$V_{ab} = 2(0{,}625) + 10$

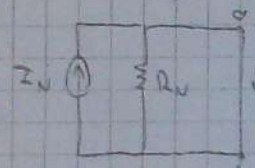
$= 11{,}25V = V_{TH}$



$R_{eş} = \frac{6 \cdot 1}{2+6} = 1,5\,k\Omega = R_{Th}$

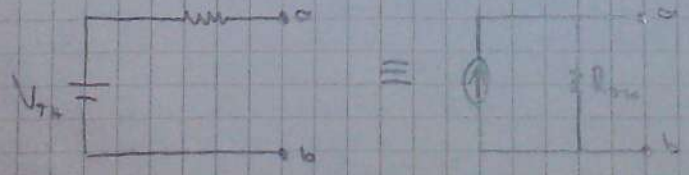


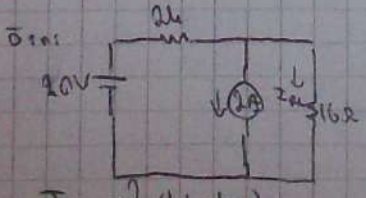
NORTON TEOREMİ

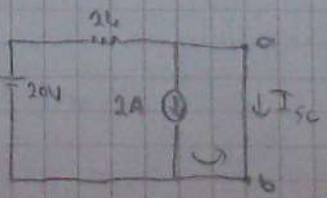


- İlk olarak yükü devreden çıkartıyoruz
- a-b uçlarını kısa devre yaparak I_{sc} akımını hesaplıyoruz. $I_{sc} = I_N$

- Bütün bağımsız kaynakları sıfırlıyoruz ve a-b uçlarından görüle $R_{eş}$ hesaplıyoruz. $R_N = R_{eş} = R_{Th}$

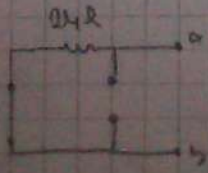




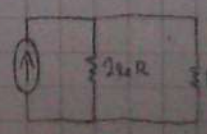


$\frac{20}{2\Omega} - 2 = 0,83 - 2, = -1,167A$

$I_{sc} = -1,167A$

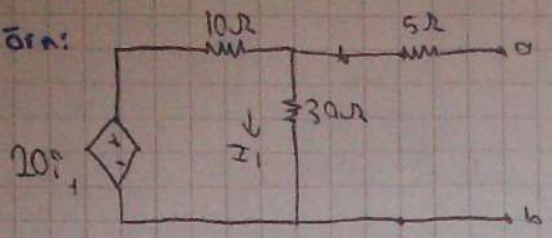


$R_{eş} = 2k\Omega$



$\frac{2k}{2k+1k}(-1,167) = -0,7A$

Örn:

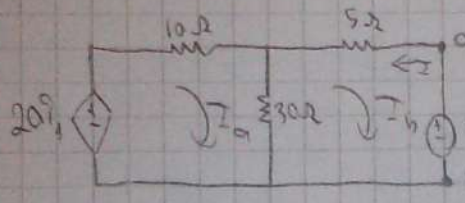


Thevenin eşdeğer devresini bulun

* Bağımlı kaynağı sıfırlamayız

İlk durum için devreye gücü veren bir kaynak yok $I_1=0 \Rightarrow V_{ab}=0$

$V_{ab}=0 \Rightarrow$



$\frac{V_{test}}{I} = R_{eş} = R_{TH}$ $I=?$

1. çevre

$i_1 = I_a - I_b$

$10I_a + 30(I_a - I_b) = 20i_1$

$40I_a - 30I_b = 20i_1$

$20I_a - 10I_b = 0$

$2I_a = I_b$

2. çevre

$5I_b + 30(I_b - I_a) + V_{test} = 0$

$35I_b - 30I_a = -V_{test}$

$35I_b - 30I_a = -1$

$I_b = -0,03 \Rightarrow I = 0,05A$

$I_a = -0,02$

$\frac{V_{test}}{I} = \frac{1}{0,05} = 20\Omega$