SERİ PARALEL DİRENÇ BİRLEŞTİRMELERİ

Şimdiye kadar KGK (tek gözlü) veya KAK (tek düğüm çiftli) uygulaması ile analiz edilebilen devreleri inceledik,

Bazı durumlarda, bir devrenin analizini basitleştirmek için dirençleri birleştirmenin avantajlı olduğunu gördük

Şimdi dirençleri birleştirme tekniğini kullanarak analizi basitleştirebileceğimiz bazı daha karmaşık devreleri inceleyeceğiz ...

SERİ BİRLEŞTİRMELER

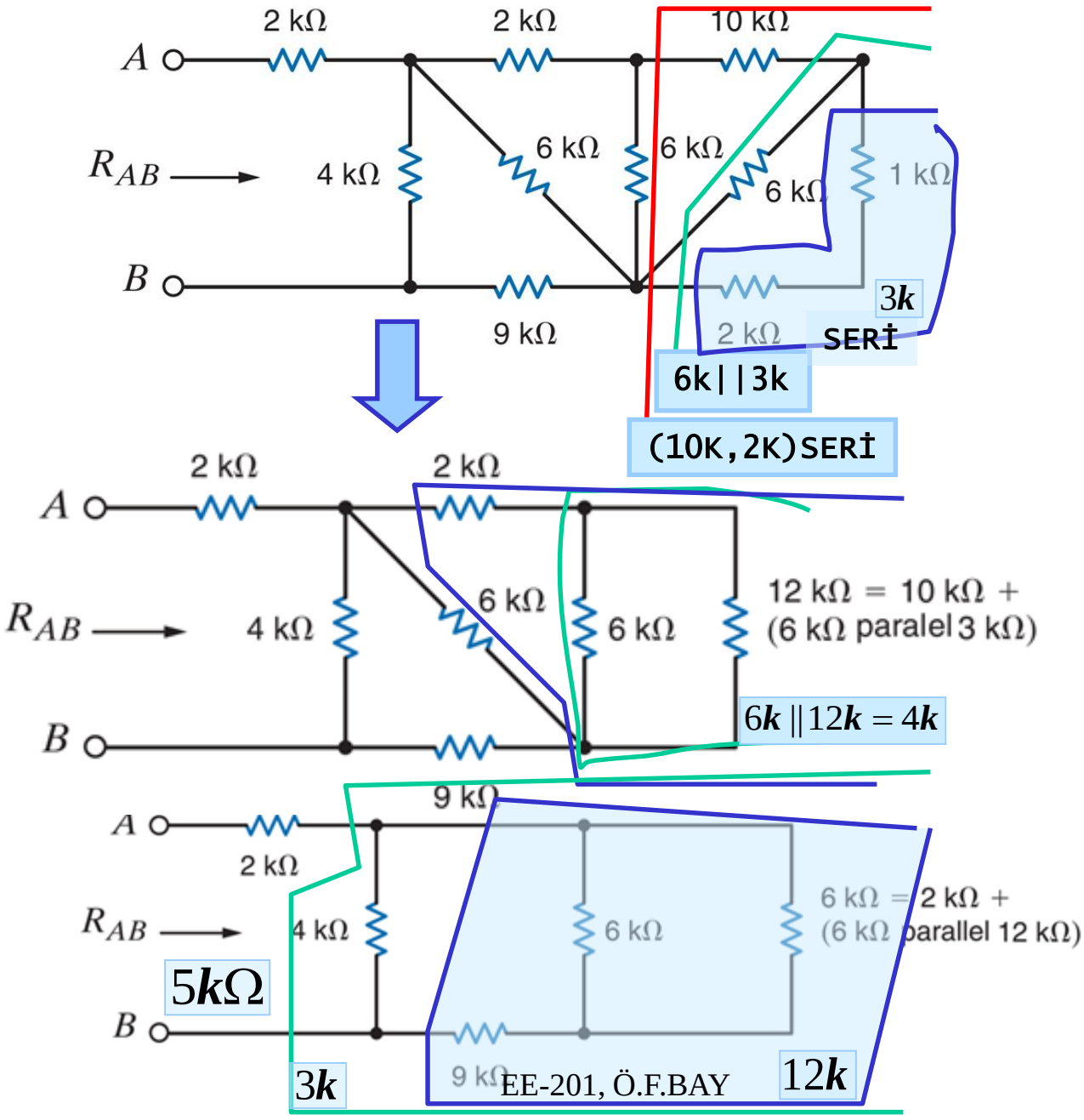
$$R_S = R_1 + R_2 + \cdots + R_N$$

PARALEL BİRLEŞTİRMELER

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

$$G_p = G_1 + G_2 + \ldots + G_N$$

İLK ÖNCE DİRENÇLERİN BİRLEŞTİRİLMESİ İŞLEMİNİ YAPIYORUZ



PROBLEM-SOLVING STRATEGY

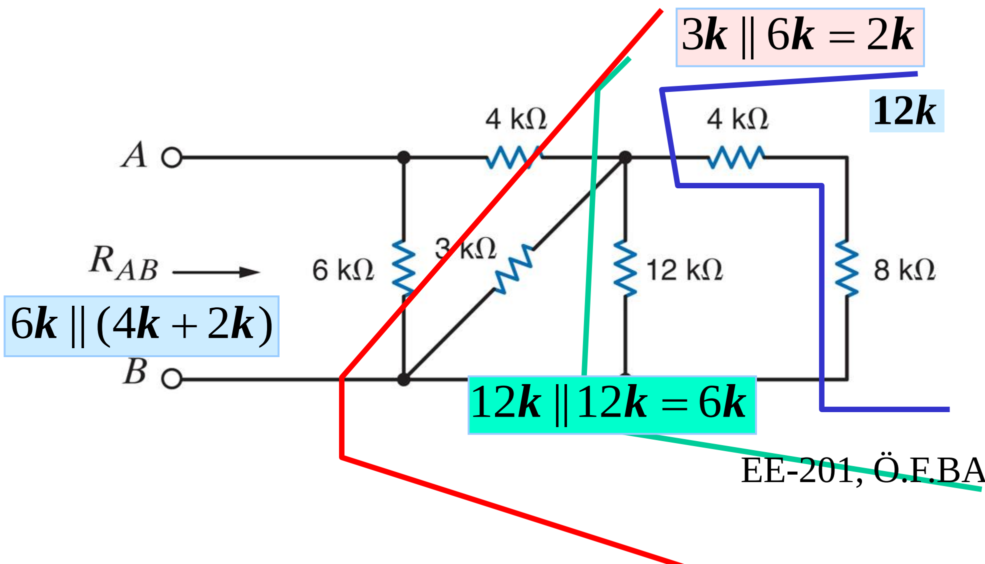
SIMPLIFYING RESISTOR COMBINATIONS

When trying to determine the equivalent resistance at a pair of terminals of a network composed of an interconnection of numerous resistors, it is recommended that the analysis begin at the end of the network opposite the terminals. Two or more resistors are combined to form a single resistor, thus simplifying the network by reducing the number of components as the analysis continues in a steady progression toward the terminals. The simplification involves the following:

STEP 1. ***Resistors in series.*** Resistors R_1 and R_2 are in series if they are connected end to end with one common node and carry exactly the same current. They can then be combined into a single resistor R_S, where $R_S = R_1 + R_2$.

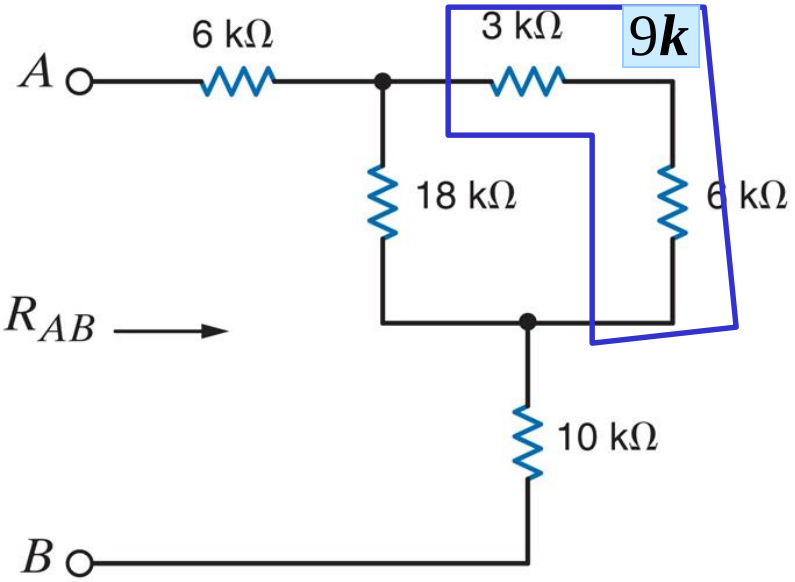
STEP 2. ***Resistors in parallel.*** Resistors R_1 and R_2 are in parallel if they are connected to the same two nodes and have exactly the same voltage across their terminals. They can then be combined into a single resistor R_p, where $R_p = R_1R_2/(R_1 + R_2)$.

These two combinations are used repeatedly, as needed, to reduce the network to a single resistor at the pair of terminals.

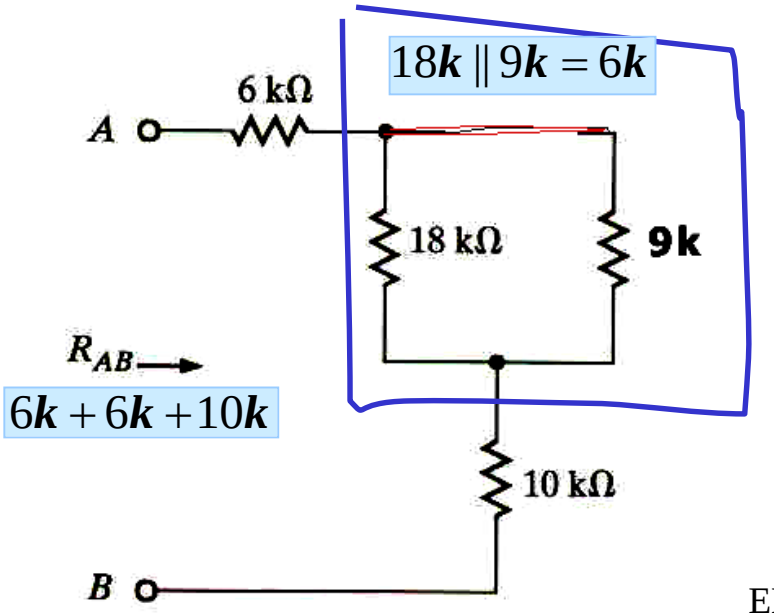


İşler kafa karıştırıcı gelirse…

ÖRNEKLER: SERİ-PARALEL BİRLEŞTİRMELER



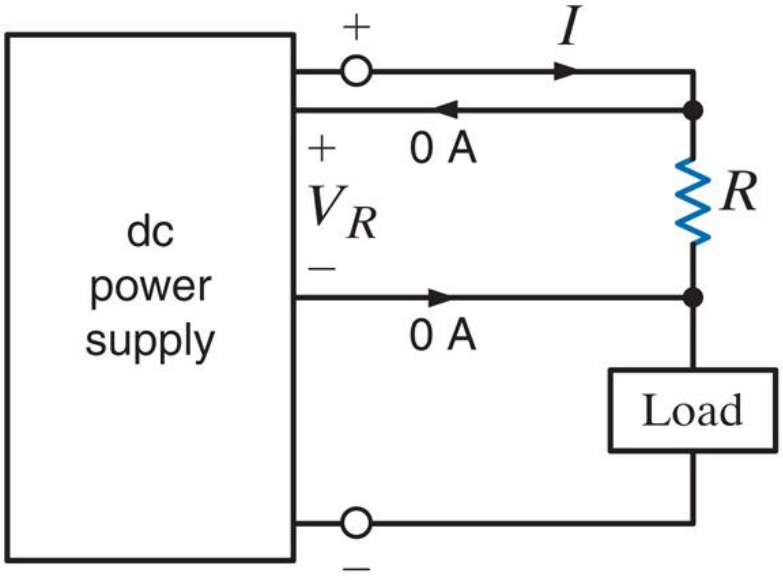
Çizim kafa karıştırıcı olursa ... Sadeleştirilmiş devreyi yeniden çizip tekrar başlayın



Dirençler tam olarak aynı akımı taşıyorsa seri haldedirler

Dirençler aynı iki düğüm arasına bağlandıklarında paraleldirler

"TERS SERİ PARALEL BİRLEŞTİRMELER"



BASİT ÖRNEK

V_R 600mV olmali, $I = 3A$ iken

ELIMIZDE SADECE 0.1Ω DIRENC BULUNMAKTA

GEREKLI $R = \dfrac{0.6V}{3A} = 0.2\Omega \Rightarrow$ $\boldsymbol{R = 0.1\Omega + 0.1\Omega}$

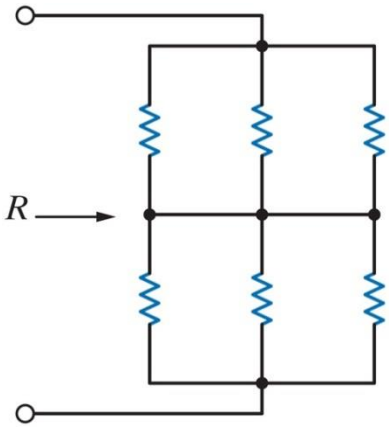
Son değeri göz önüne alarak doğru kombinasyonu bulun

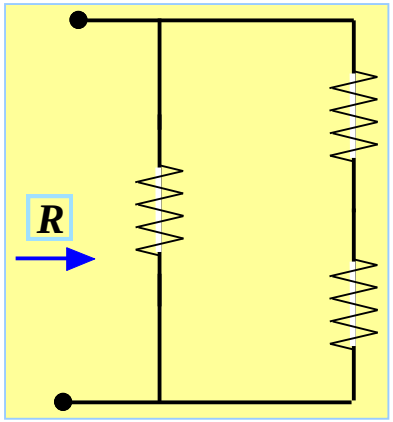
BASİT OLMAYAN ÖRNEK

V_R 600mV olmali, $I = 9A$ iken

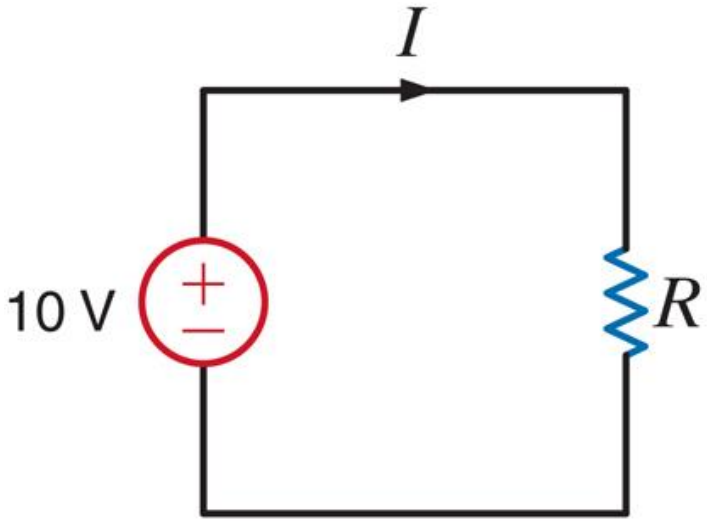
SADECE 0.1Ω DIRENC MEVCUTTUR

GEREKLI $R = \dfrac{0.6V}{9A} = 0.0667\Omega \Rightarrow$





DİRENÇ TOLERANSININ ETKİSİ



NORMAL DIRENC DEGERI : 2.7kΩ

DIRENC TOLERANSI : 10%

AKIM VE GÜÇ ARALIKLARI?

NORMAL AKIM : $\bar{I} = \frac{10}{2.7k} = 3.704\,mA$

NORMAL GUC : $\bar{P} = \frac{(10)^2}{2.7k} = 37.04\,mW$

MINIMUM AKIM : $I_{\min} = \frac{10}{1.1 \times 2.7k} = 3.367\,mA$

MAKSIMUM AKIM : $I_{\max} = \frac{10}{0.9 \times 2.7k} = 4.115\,mA$

MINIMUM GUC($VI_{\min}$) : $33.67\,mW$

MAKSIMUM GUC : $41.15\,mW$

**AKIM VE GÜÇ ARALIKLARI TOLERANSLA BELİRLENİR,
ANCAK DEĞİŞİM YÜZDESİ TOLERANS YÜZDESİNDEN FARKLI OLABİLİR.
ARALIKLAR SİMETRIK OLMAYABİLİR**

SERİ-PARALEL DİRENÇ KOMBİNASYONLU DEVRELER

ELEMANLARIN BİRLEŞTİRİLMESİ, BİR DEVRENİN KARMAŞIKLIĞINI AZALTABİLİR VE ŞİMDİYE KADAR GELİŞTİRİLEN TEMEL ARAÇLARI KULLANARAK ANALİZ İÇİN UYGUN HALE GETİRİLEBİLİR.

SERİ OLARAK BİRLEŞTİRİLEN DİRENÇLER DEVREDEN BİR DÜĞÜMÜ ORTADAN KALDIRIR.

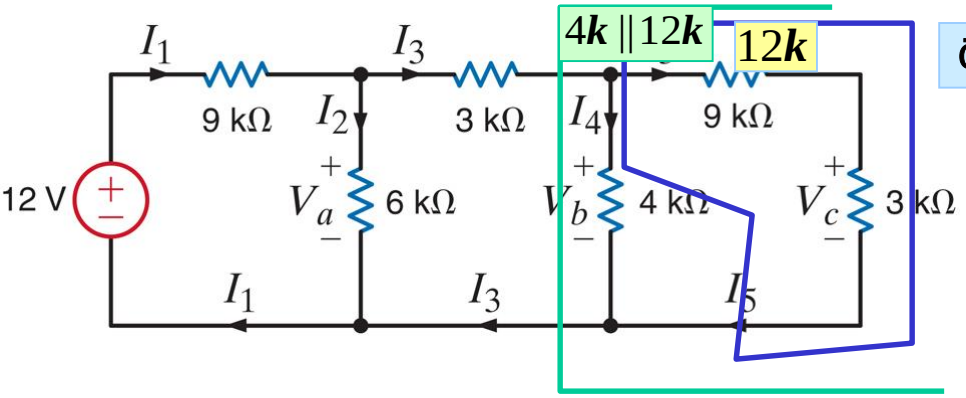
PARALEL OLARAK BİRLEŞTİRİLEN DİRENÇLER DEVREDEN BİR ÇEVREYİ ORTADAN KALDIRIR.

GENEL STRATEJİ:

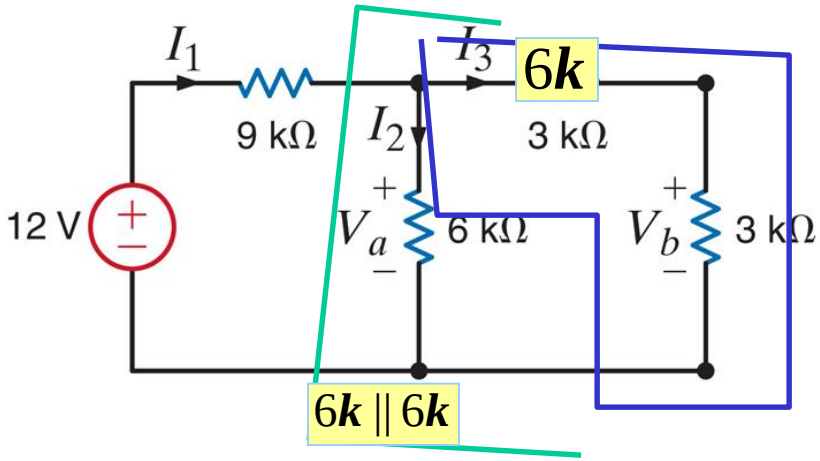
- DEVRENİN ANALİZ EDİLEBİLMESİ İÇİN YETERİNCE BASİT HALE GELİNCEYE KADAR KARMAŞIKLIĞINI AZALTIN.
- ORİJİNAL DEVREDEKİ İSTENEN DEĞİŞKENLERİ HESAPLAMAK İÇİN BASİTLEŞTİRİLMİŞ DEVREDEKİ VERİLERİ KULLANIN

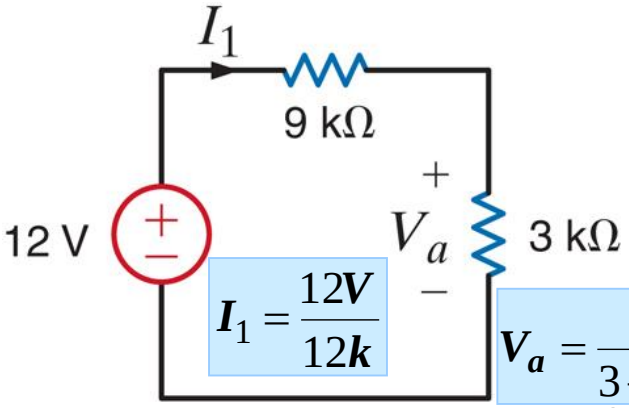
-BU NEDENLE DEĞİŞKENLER ARASINDAKİ HERHANGİ BİR İLİŞKİYİ TAKİP ETMENİZ GEREKİR.

AŞAĞIDAKİ DEVREDE ETİKETLENMİŞ BÜTÜN AKIM VE GERİLİMLERİ BULMAK İSTİRORUZ



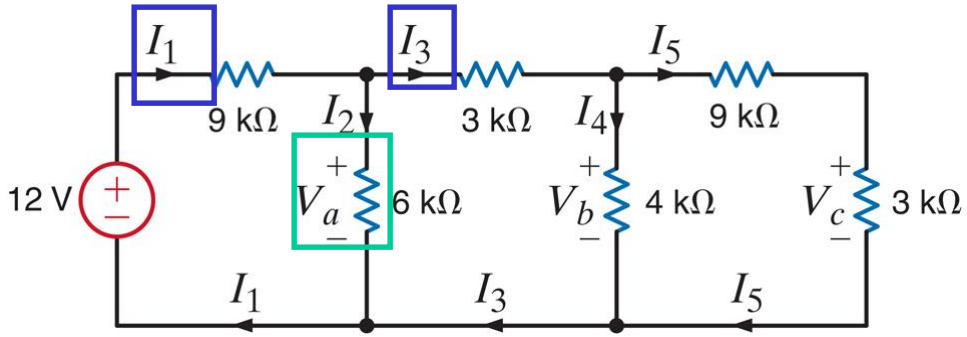
Önce onu tek gözlü bir devreye indirgeyin





AŞAĞIDAKİ DEVREDE ETİKETLENMİŞ BÜTÜN AKIM VE GERİLİMLERİ BULMAK İSTİRORUZ

Sonra: OHM KANUNU, KGK VE KAK KULLANIN



OHM KANUNU : $I_2 = \frac{V_a}{6k}$

KAK : $I_1 - I_2 - I_3 = 0$

OHM KANUNU : $V_{3k} = 3k * I_3$

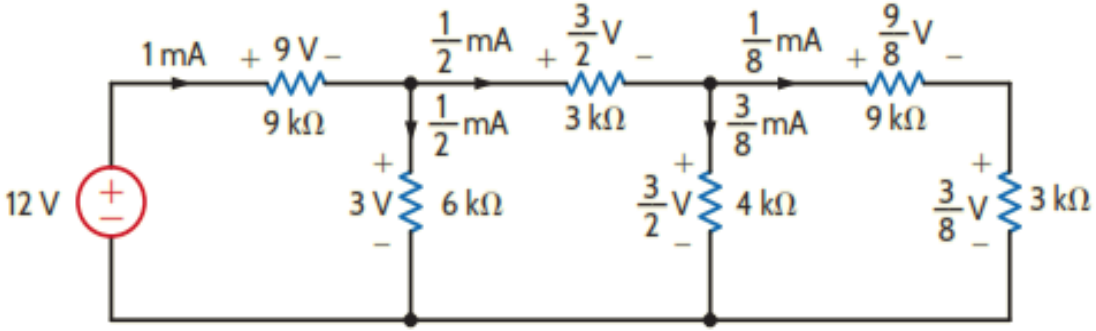
…DİĞER OPSİYONLAR...

$$\boldsymbol{I_4 = \frac{12}{4+12} I_3}$$

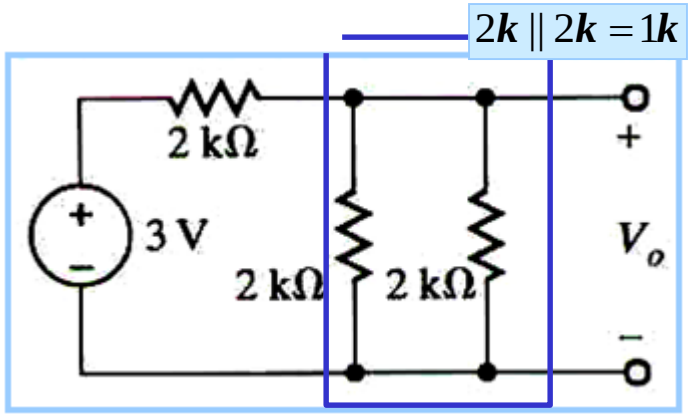
$$\boldsymbol{V_b = 4k * I_4}$$

KAK : $I_5 + I_4 - I_3 = 0$

OHM KANUNU : $V_C = 3k * I_5$



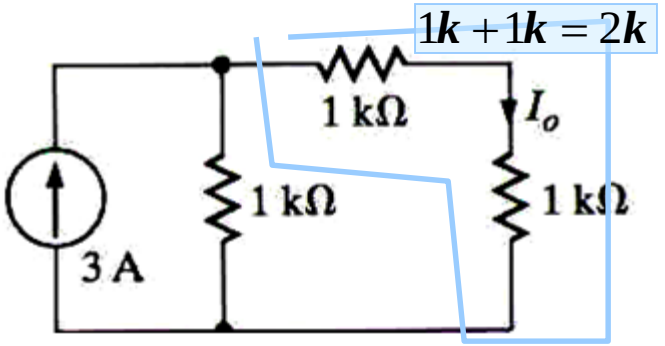
Vo değerini bulun



GERILIM BOLUCU : $V_O = \frac{1k}{1k + 2k}(3V) = 1V$

YAPARAK ÖĞRENİN

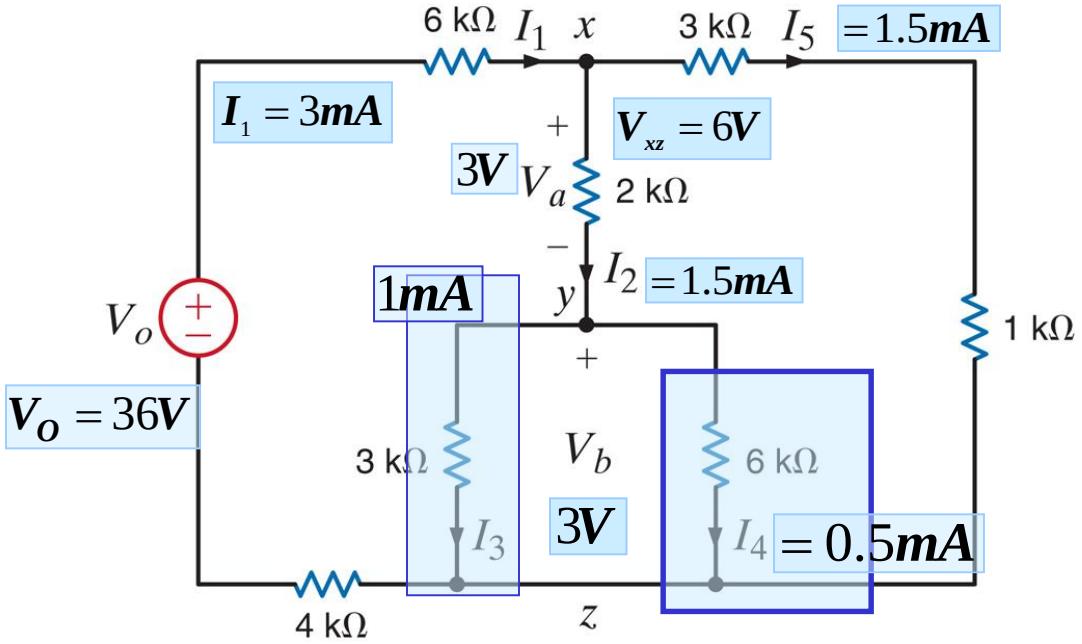
Io değerini bulun



AKIM BOLUCU : $I_O = \frac{1k}{1k + 2k}(3A) = 1A$

ÖRNEK "SONDAN BAŞA DOĞRU"

I4=0.5mA ise kaynak gerilimi Vo'ı bulun



STRATEJİ. HER ZAMAN SORUN: "BAŞKA NEYİ HESAPLAYABİLİRİM?"

$$V_b = 6k * I_4$$

$$I_3 = \frac{V_b}{3k}$$

$$I_2 = I_3 + I_4$$

$$V_a = 2k * I_2$$

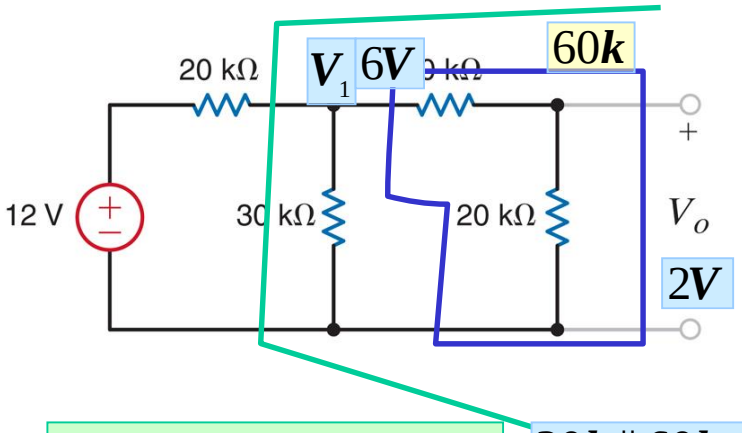
$$V_{xz} = V_a + V_b$$

$$I_5 = \frac{V_{xz}}{4k}$$

$$I_1 = I_2 + I_5$$

$$V_o = 6k * I_1 + V_{xz} + 4k * I_1$$

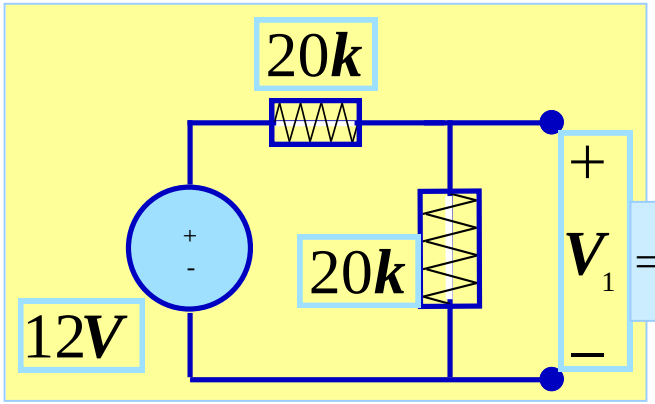
V_O'*i* bulun



STRATEJI : V_1'i bul

Gerilim Bolucu kullan

$30k \parallel 60k = 20k$

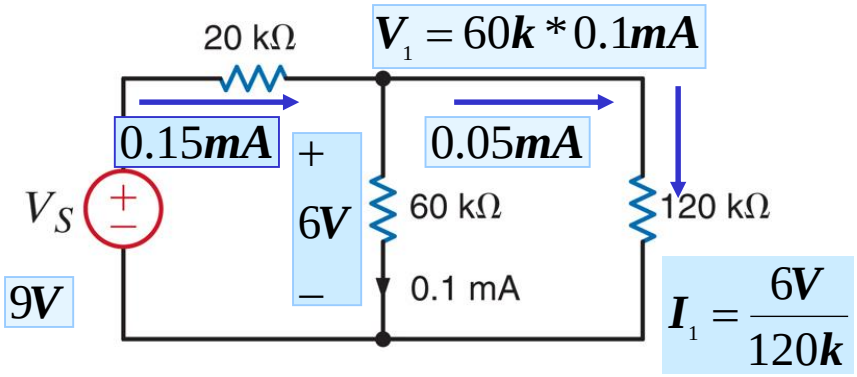


$$V_1 = \frac{20k}{20k + 20k}(12) = 6V$$

GERILIMBOLUCU

$$V_O = \frac{20k}{20k + 40k} V_1$$

V_S'yi bulun



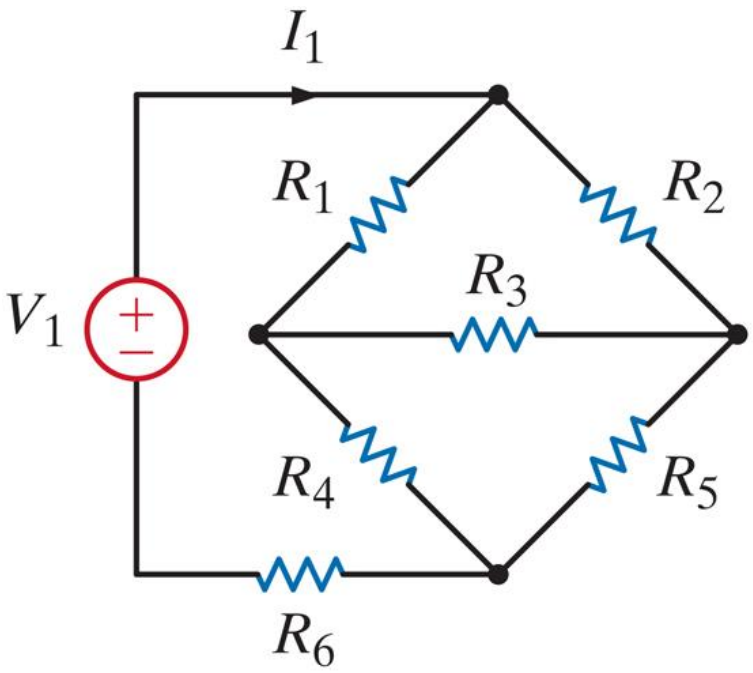
Bu tersden bir sorudur, ne hesaplanabilir?

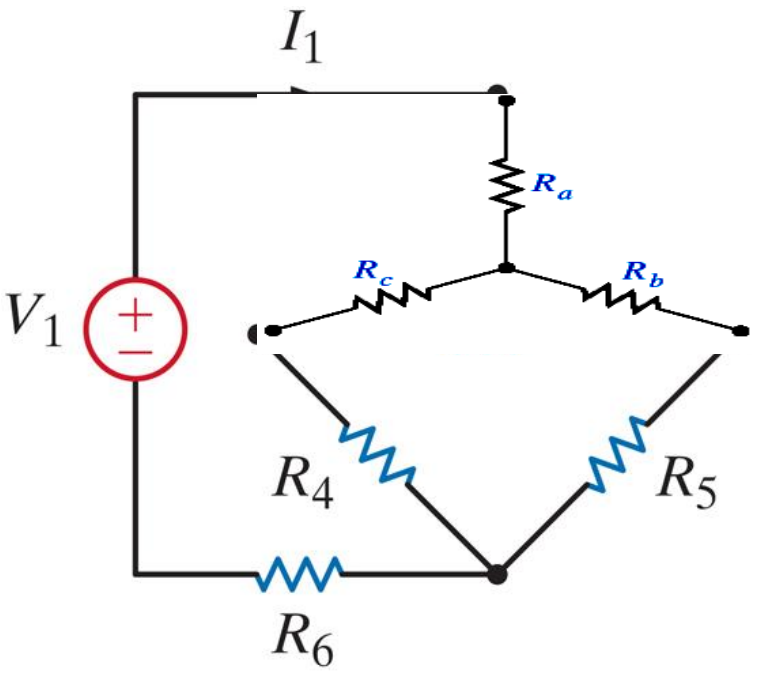
$$V_s = 20k * 0.15mA + 6V$$

http://www.wiley.com/college/irwin/0470128690/animations/swf/D2Y.swf

YILDIZ ÜÇGEN DÖNÜŞÜMLERİ

Y – Δ DÖNÜSÜMLERI

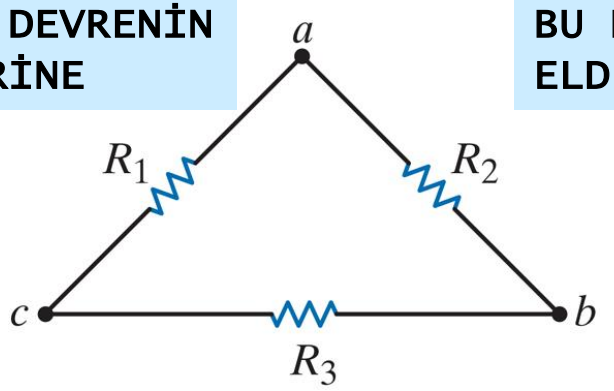




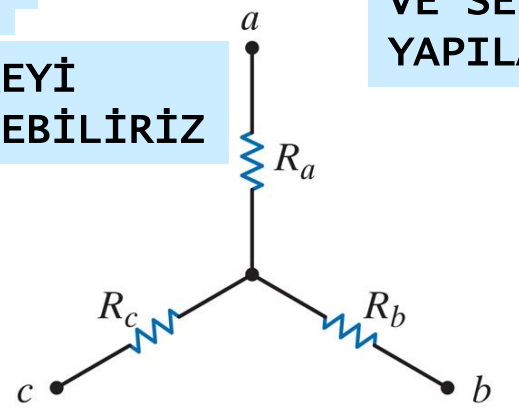
BU DEVRE SERİ YA DA PARALEL DİRENÇ İÇERMEMEMEKTEDİR

SONRA DEVRE BU HALE GELİR VE SERİ PARALEL DÖNÜŞÜMLER YAPILABİLİR

BU DEVRENİN YERİNE



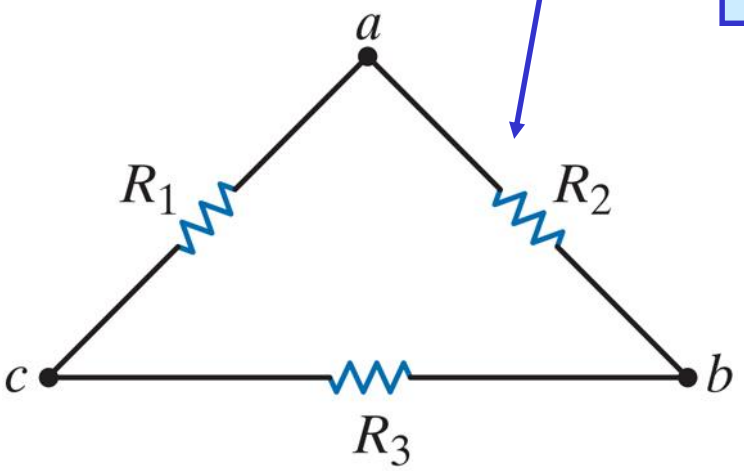
BU DEVREYİ ELDE EDEBİLİRİZ

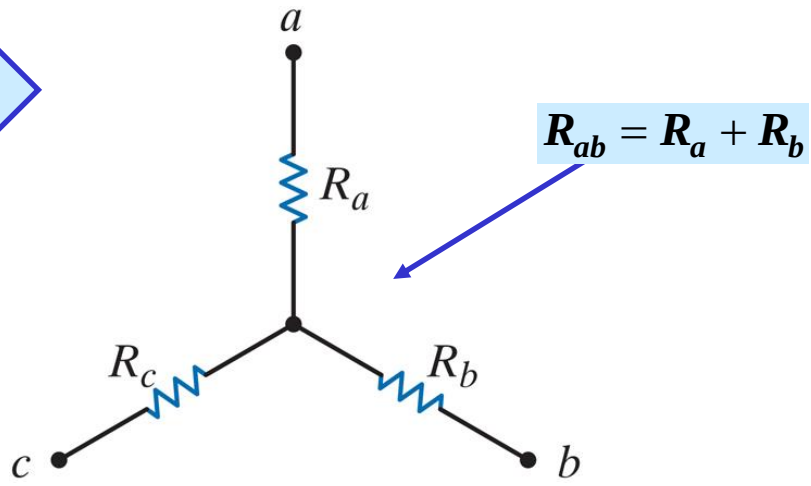


ÜÇGEN YILDIZ DÖNÜŞÜMÜ

$$R_{ab} = R_2 \parallel (R_1 + R_3)$$

$\Delta \rightarrow Y$





$$R_{ab} = R_a + R_b = \frac{R_2(R_1 + R_3)}{R_1 + R_2 + R_3}$$

$$R_{bc} = R_b + R_c = \frac{R_3(R_1 + R_2)}{R_1 + R_2 + R_3}$$

$$R_{ca} = R_c + R_a = \frac{R_1(R_2 + R_3)}{R_1 + R_2 + R_3}$$

$$R_a + R_b + R_c = \frac{R_1R_2 + R_1R_3 + R_2R_3)}{R_1 + R_2 + R_3}$$

$$R_a = (R_a + R_b + R_c) - (R_b + R_c)$$

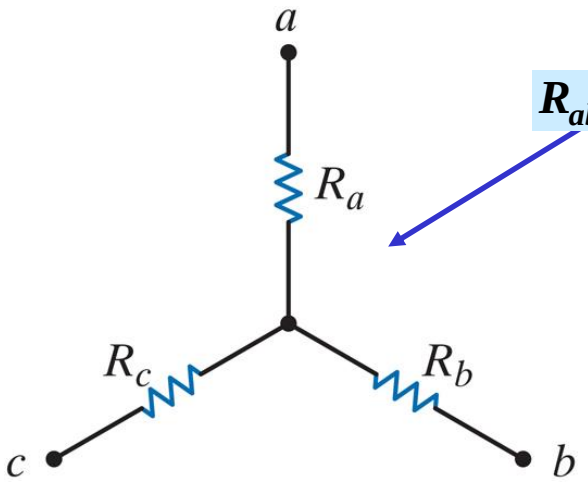
$$R_a = \frac{R_1R_2}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_2R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_3R_1}{R_1 + R_2 + R_3}$$

$\Delta \rightarrow Y$

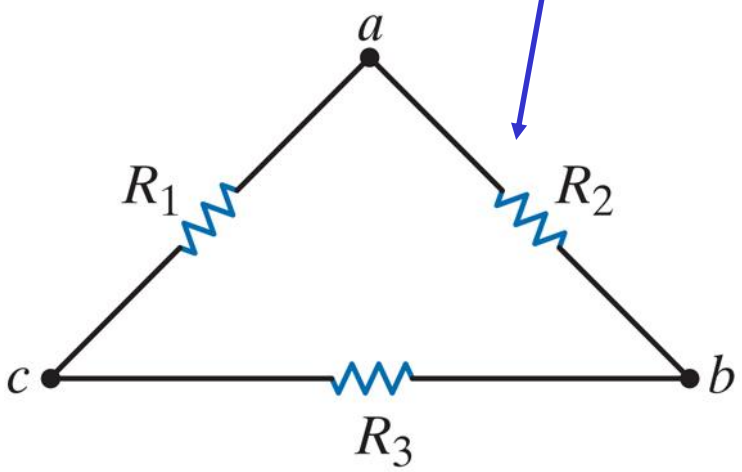
YILDIZ ÜÇGEN DÖNÜŞÜMÜ



$$R_{ab} = R_a + R_b$$

$$Y \rightarrow \Delta$$

$$R_{ab} = R_2 \,\|\, (R_1 + R_3)$$



$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

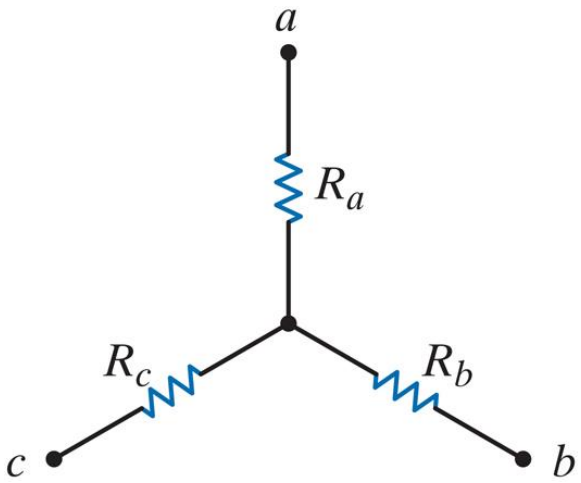
$$R_b = \frac{R_2 R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_3 R_1}{R_1 + R_2 + R_3}$$

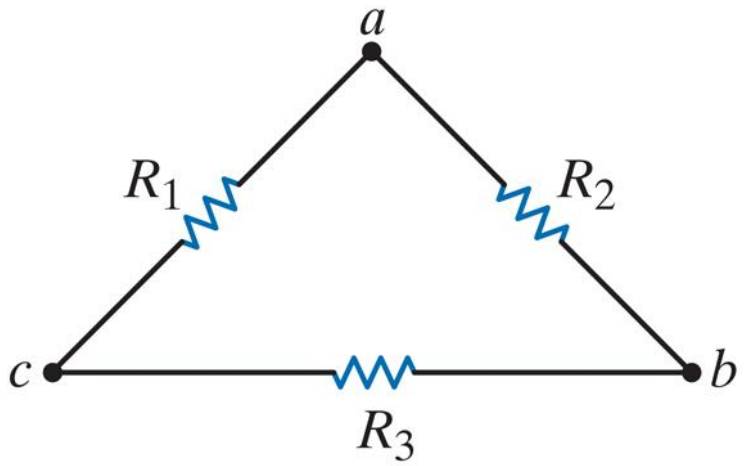
$$\Delta \rightarrow Y$$

$$R_a R_b + R_b R_c + R_c R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3} * \frac{R_2 R_3}{R_1 + R_2 + R_3} + \frac{R_2 R_3}{R_1 + R_2 + R_3} * \frac{R_3 R_1}{R_1 + R_2 + R_3} + \frac{R_3 R_1}{R_1 + R_2 + R_3} * \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

YILDIZ ÜÇGEN DÖNÜŞÜMÜ -Devam



$Y \rightarrow \Delta$



$$R_aR_b + R_bR_c + R_cR_a = \frac{R_1R_2^2R_3 + R_1R_2R_3^2 + R_1^2R_2R_3}{(R_1+R_2+R_3)^2} = \frac{R_1R_2R_3(R_2+R_3+R_1)}{(R_1+R_2+R_3)^2}$$

$$R_aR_b + R_bR_c + R_cR_a = \frac{R_1R_2R_3}{(R_1+R_2+R_3)}$$

$$\frac{R_aR_b + R_bR_c + R_cR_a}{R_b} = \frac{R_1R_2R_3}{(R_1+R_2+R_3)} \Big/ \frac{R_2R_3}{R_1+R_2+R_3}$$

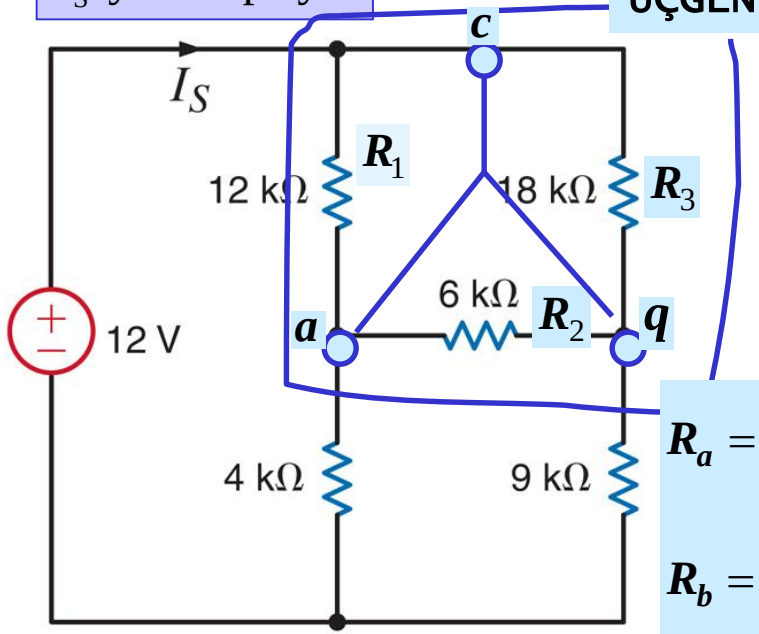
$$R_1 = \frac{R_aR_b + R_bR_c + R_cR_a}{R_b}$$

$$R_2 = \frac{R_aR_b + R_bR_c + R_cR_a}{R_c}$$

$$R_3 = \frac{R_aR_b + R_bR_c + R_cR_a}{R_a}$$

ÖRNEK: YILDIZ-ÜÇGEN DÖNÜŞÜMÜ UYGULAMASI

I_S'yi Hesaplayin



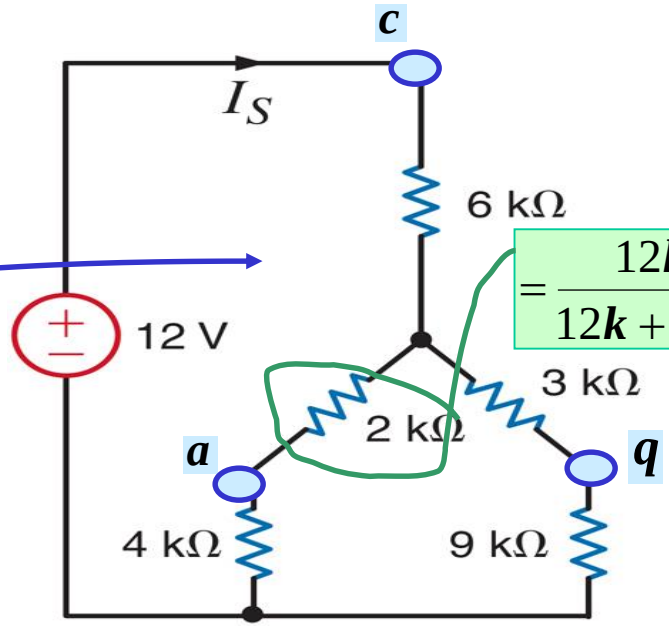
ÜÇGEN BAĞLANTI

$$R_a = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_2 R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_3 R_1}{R_1 + R_2 + R_3}$$

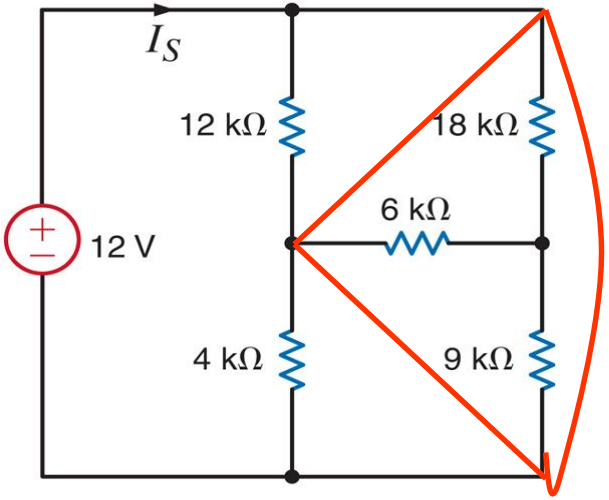
$$\Delta \rightarrow Y$$



$$= \frac{12k \times 6k}{12k + 6k + 18k}$$

$$R_{EQ} = 6k + (3k + 9k) \| (2k + 6k) = 10k$$

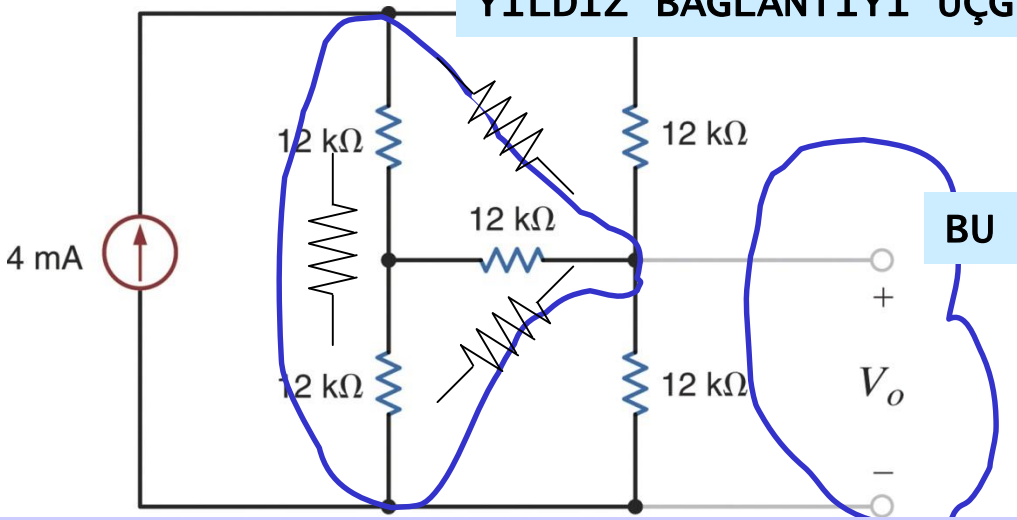
$$I_S = \frac{12V}{10k} = 1.2mA$$



Yıldız-Üçgen dönüşümü de kullanılabilirdi ...

ÖRNEK

YILDIZ BAĞLANTIYI ÜÇGEN BAĞLANTIYA DÖNÜŞTÜRÜN?



BU DÜĞÜMLER KAYBEDİLMEMELİ!

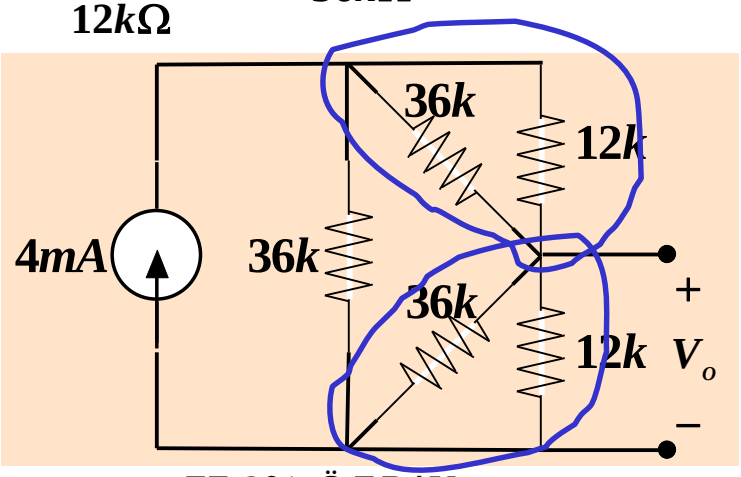
EĞER YILDIZ BAĞLANTIYI ÜÇGEN BAĞLANTIYA DÖNÜŞTÜRÜRSEK, SERİ PARALEL SADELEŞTİRMELER OLUR!

$$R_1 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_b} = \frac{3*12k\Omega*12k\Omega}{12k\Omega} = 36k\Omega$$

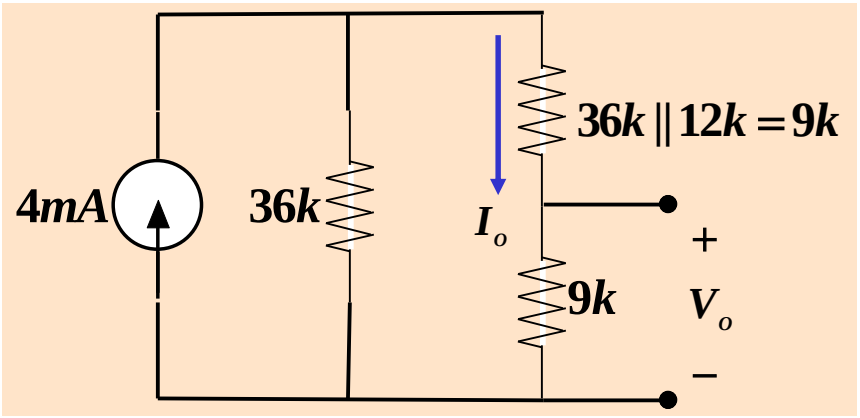
$$R_2 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_c}$$

$$R_3 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_a}$$

$Y - \Delta$



Sonuçtaki devre bir akım bölücüdür



PARALEL SADELEŞTİRME SONRASI DEVRE

$$I_o = \frac{36k}{36k + 18k} \times 4mA = \frac{8}{3} mA$$

$$V_o = 9k\Omega \times I_o = 9k\Omega \times \frac{8}{3} mA = 24V$$