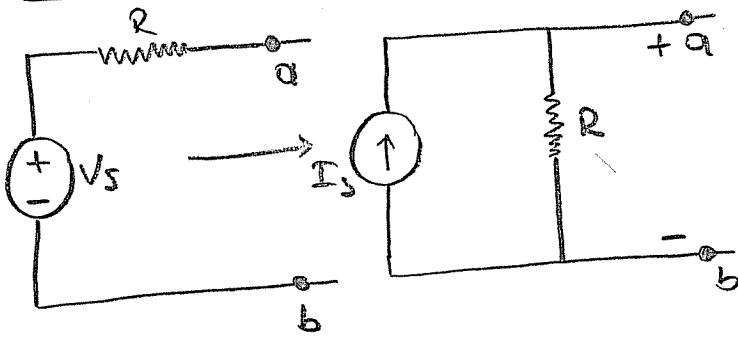


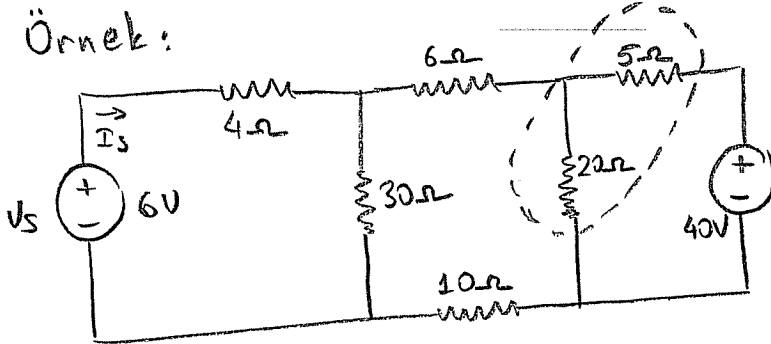
KAYNAK DÖNÜŞÜMLERİ:



DEVRED-II. Bölüm
Kaynak Dönüşümleri
Thevenin ve Norton
Maksimum Güç Transferi
Süper Pozisyon

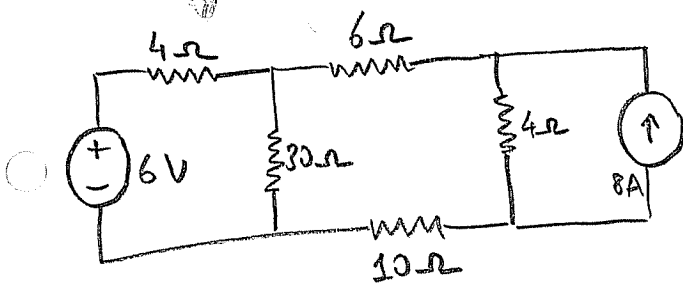
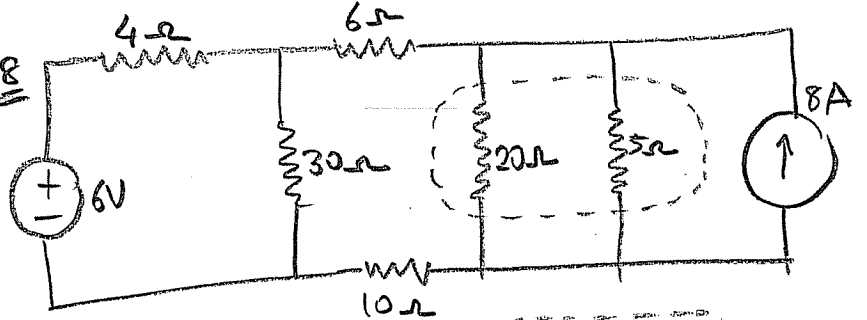
$$V_S = I_S \cdot R$$

Örnek:

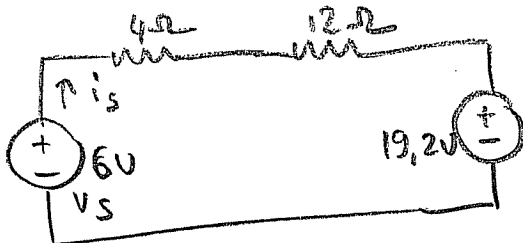
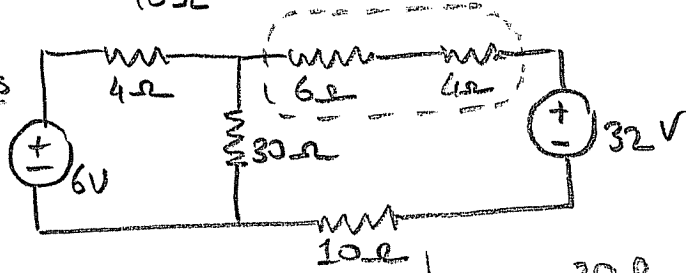


$$P_{6V} = ? (6 \cdot I_S)$$

$$V = IR \Rightarrow 40 = I \cdot 5 \Rightarrow I = 8$$

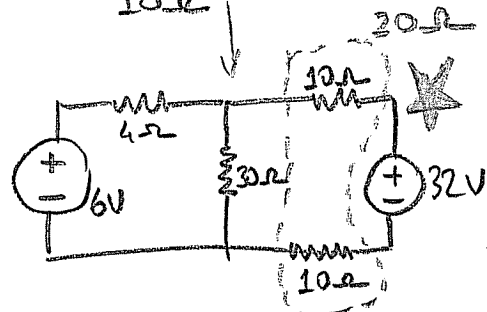


$$I_{40V} = I_S$$



6V'la 4Ω'ya
dokunmuyoruz

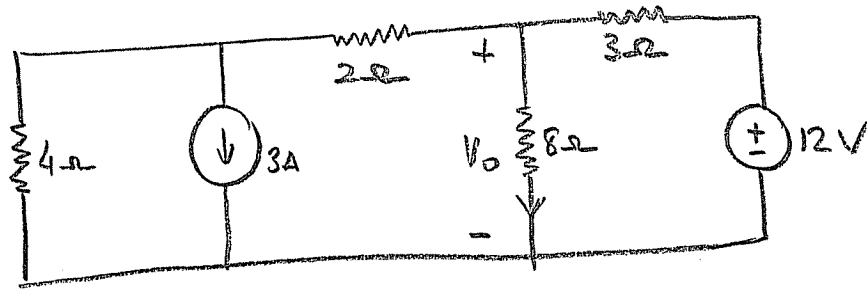
4Ω; Is'in üzerindeki
akım



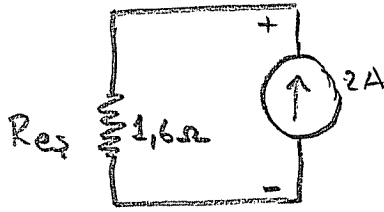
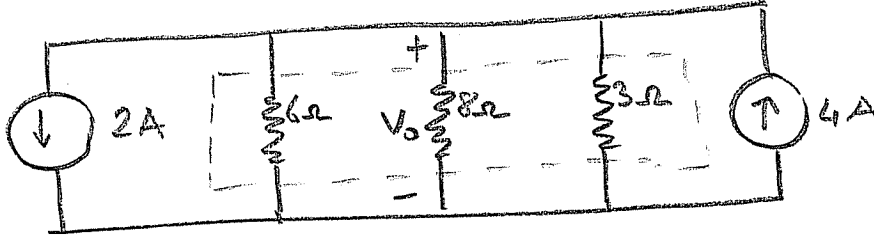
$$-6 + 16 I_S + 19.2 = 0$$

$$I_S = 0.825 \text{ A}$$

Örnek:



$$V_0 = 1,6 \times 2 = 3,2V$$

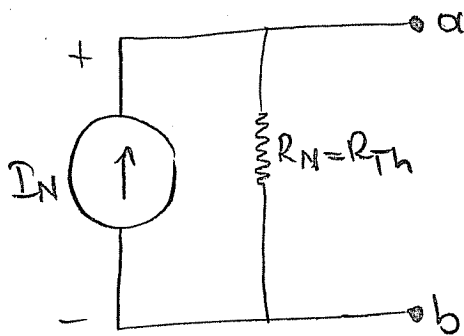


$$V_0 = 1,6 \times 2 = 3,2V$$

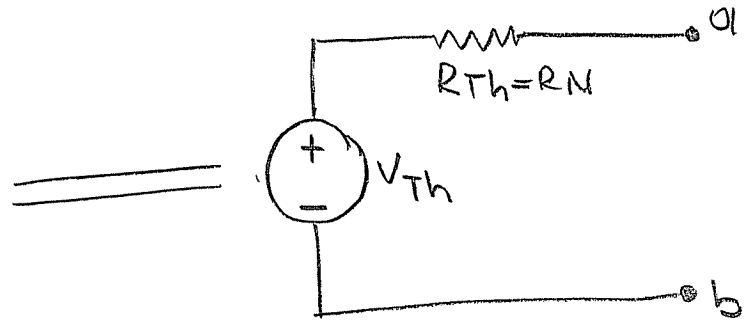
* Yukarıdaki paralellikte tüm voltajlar eşittir.

- * Voltajı akıma dönüştürürken ilk seriyi paralel yap.
- * Akımı voltaja çevirirken ilk paraleli seri yap.

THEVENİN VE NORTON:



Norton

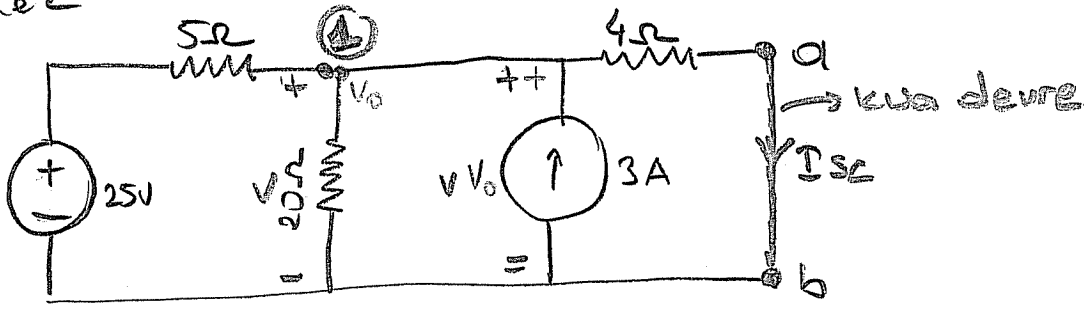


Thevenin

- (I_N (I_{sc}) akım bulunur)
- * Kısa devre yaparak düğüm yöntemiyle çözülebilir.
- * Kaynak dönüşümüyle bulunabilir.
- * Kısa devre yapmadan düğüm yapılır. (Bu seferde V_{Th} bulunur.)

Örnek

3



I. yol : V_{Th} bulma

$$\frac{V_0 - 25}{5} + \frac{V_0}{20} - 3A = 0 \Rightarrow V_0 = 32V = \underline{\underline{V_{Th}}}$$

* a ve b uçları açık.

II. yol : I_N bulma

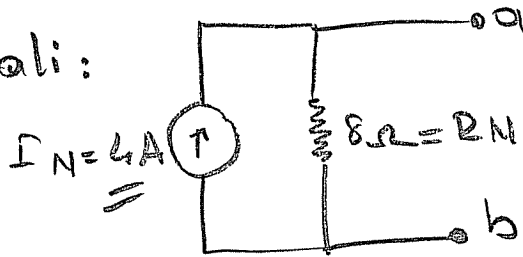
* Kısa devre uyguluyoruz.

$$1: \frac{V - 25}{5} + \frac{V}{20} - 3 + \frac{V}{4} = 0 \Rightarrow V = 16V$$

$$I_{sc} = V/4 = 16/4 = \underline{\underline{4A}}$$

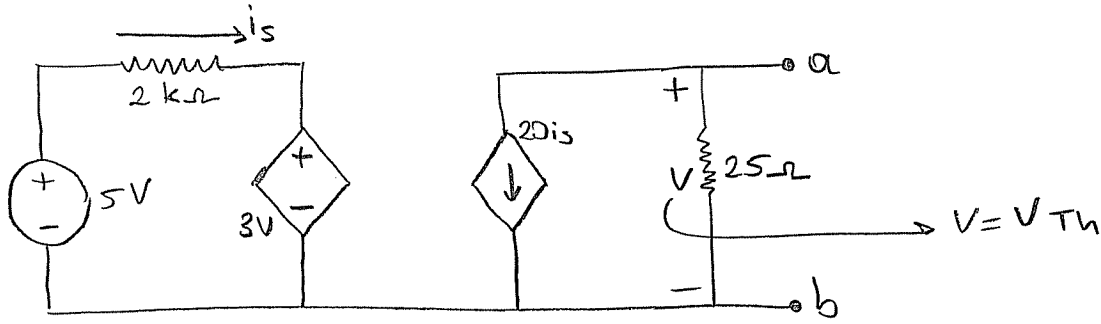
III. yol : Kaynak dönüşümü

Son hali:



(4)

Örnek:



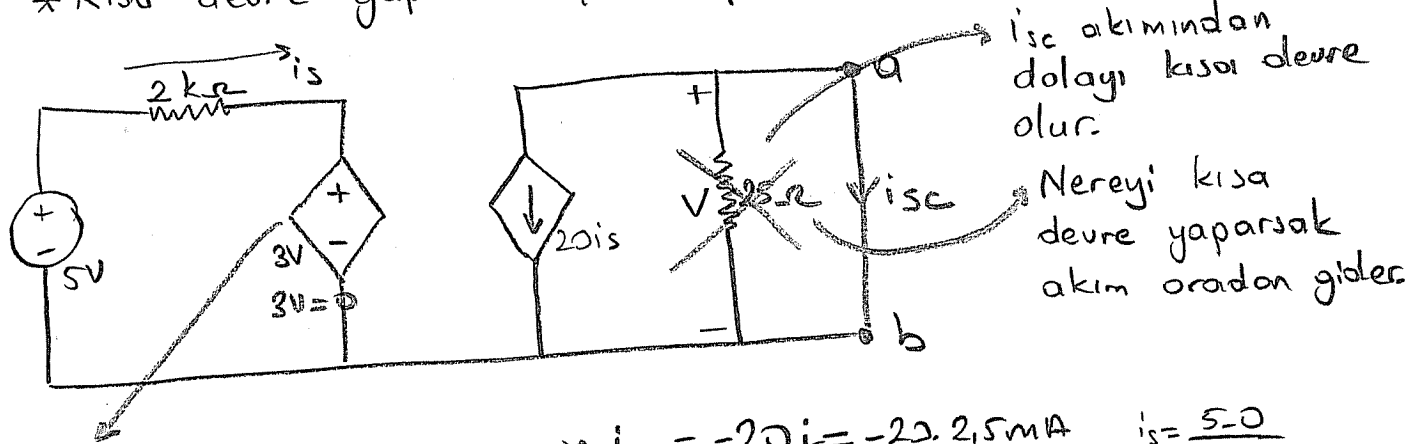
$$V_{Th} = -(25 \times 20i_s) = -500i_s$$

(-) 'den (+)' ya aktığı için

$$i_s = \frac{5 - 3V}{2000} = \frac{5 - 3V_{Th}}{2000}$$

$$\left. \begin{array}{l} V_{Th} = -5V \\ i_s = 10mA \end{array} \right\}$$

* Kısa devre yaparak çözüm (I_{sc} akıncak oradan)

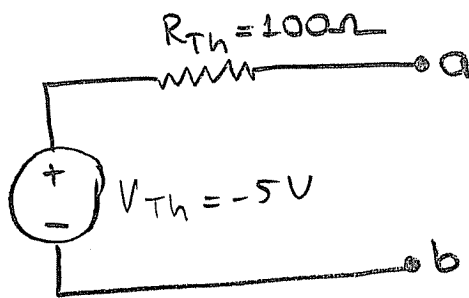


Kısa devre yüzünden V sıfır olur. Haliyle 3V'de sıfır olur.

$$* I_{sc} = -20i_s = -20 \cdot 2,5mA = -50mA$$

$$i_s = \frac{5-0}{2000} = 2,5mA$$

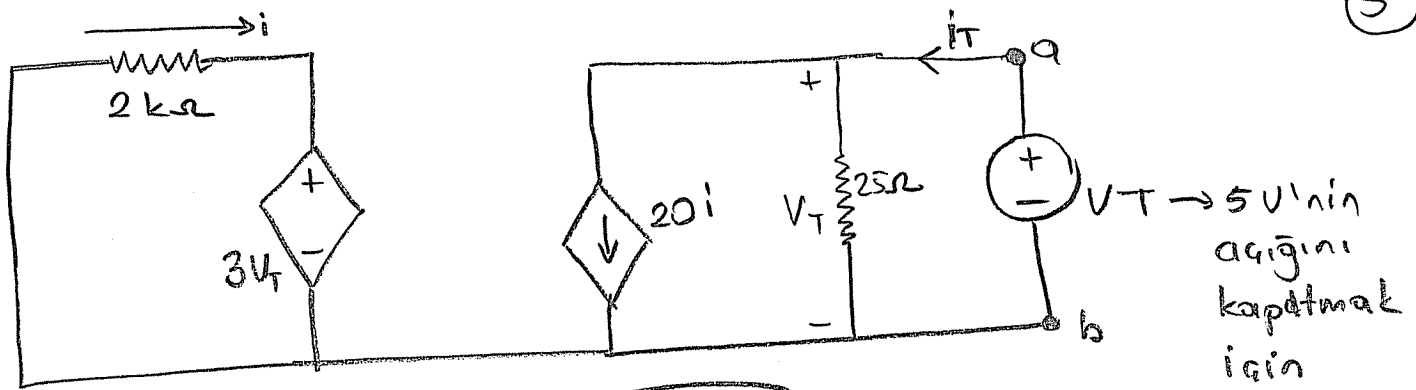
$$R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{-5V}{-50mA} = 100\Omega$$



* Bağımlı kaynak varsa ya kısa devre ya test yöntemini kullanıyoruz. Test yönteminde ba-

ğımsız kaynakları kapatıyoruz ve yine değişiklikleri göz önüne alıyoruz. Bunu bu soruda uygulayarak;

(5)



$$i = \frac{0 - 3V_T}{2000}$$

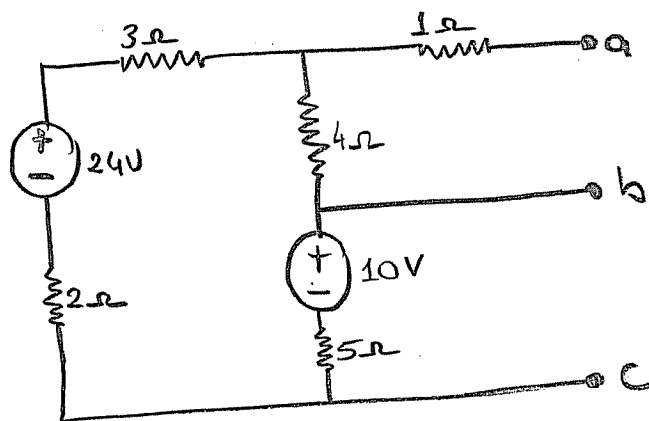
$$-i_T + \frac{V_T}{25} + 20i = 0$$

$$i_T = V_T \left(\frac{1}{25} - \frac{3}{1000} \right) = V_T \cdot \frac{1}{100}$$

2 yeni
0 birşey
yaptık.

$$\frac{i_T}{V_T} = \frac{1}{100} \Rightarrow \frac{V_T}{i_T} = R_{Th} = 100\Omega$$

Örnek:

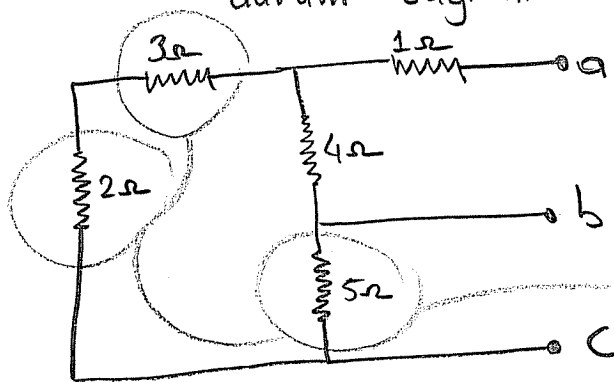


$$V_{ab} = ?$$

$$V_{bc} = V_{Th} = ?$$

$$R_{bc} = ?$$

3. YOL: Bağımsız kaynakları kapatarak yapıyoruz. (Bu durum bağımlı kaynak olmadığında geçerli.)



$$R_{Th1} = 1 + 4 \parallel (3 + 2 + 5)$$

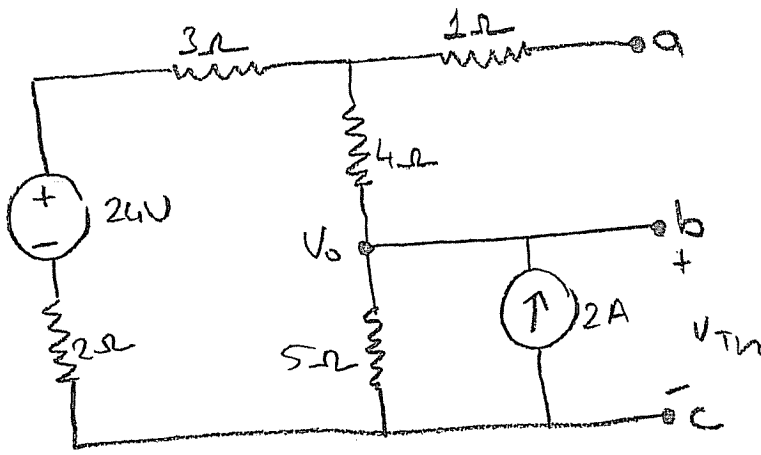
$$R_{eq} = R_{Th} = 3,856\Omega$$

Birbirlerine seri bağlılar.

$$R_{Th2} = R_{eq} = 5 \parallel (2 + 3 + 1) = 3,214\Omega$$

$$-24 + 14i + 10 = 0 \Rightarrow i = 1A$$

$$V_{Th} = 4i = 4V$$



(6)

$$\frac{V_0}{5} - 2 + \frac{V_0 - 24}{2 + 3 + 4} = 0$$

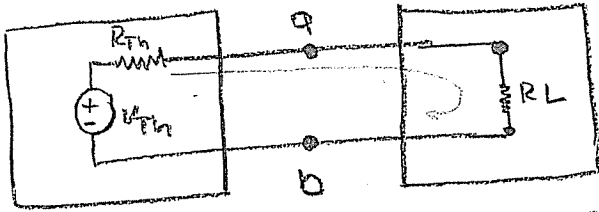
$$V_0 = 15V = V_{TH}$$

→ Devrenin ilk halyle düğüm yaparsak;

$$\frac{V_0 - 10}{5} + \frac{V_0 - 25}{4 + 3 + 2} = 0 \Rightarrow V_0 = V_{TH} = V_{ab} = 15V$$

Maksimum Güç Transferi:

(7)



$$-V_{Th} + iR_{Th} + iR_L = 0$$

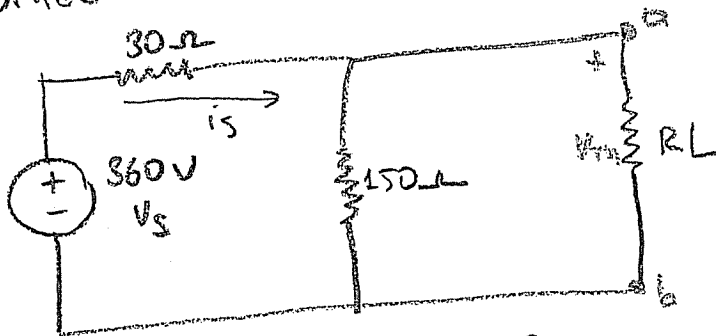
$$i = \frac{V_{Th}}{R_{Th} + R_L}$$

$$P_{max} = i^2 R_L = \left(\frac{V_{Th}}{R_{Th} + R_L} \right)^2 \cdot R_L = V_{Th}^2 \cdot \frac{R_L}{(R_{Th} + R_L)^2}$$

$$\frac{dP}{dR_L} = V_{Th}^2 \left[\frac{1(R_{Th} + R_L)^2 - 2(R_{Th} + R_L) \cdot R_L}{(R_{Th} + R_L)^4} \right] = 0$$

$$(R_{Th} + R_L)^2 - 2(R_{Th} + R_L) \cdot R_L = 0 \Rightarrow \boxed{R_L = R_{Th}}$$

Örnek:



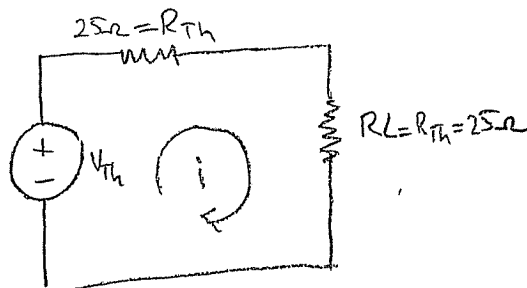
$R_{Th} = ?$
 $P_{max} = ?$
 $V_{ab} = ?$
 $P_{V_s} = ?$

$$V_{ab} = V_{Th} = 150 \cdot I$$

$$(KVL) -360 + (30 + 150)I = 0$$

$$I = \frac{360}{180} = 2$$

$$V_{Th} = 150 \times 2 = 300$$



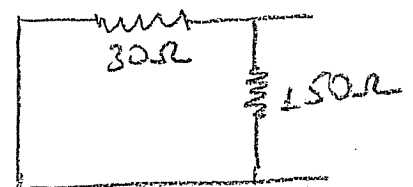
$$-300 + (25 + 25)i = 0$$

$$i = \frac{300}{50} = 6A$$

$$V_{ab} = i \cdot R_L = 6 \cdot 25 = 150$$

$$P_{max} = \left(\frac{300}{25 + 25} \right)^2 \cdot 25 = 900W$$

Kaynağı kapattık



$$R_{Th} = 30\Omega // 150\Omega$$

$$= \frac{30 \times 150}{30 + 150}$$

$$= 25\Omega$$

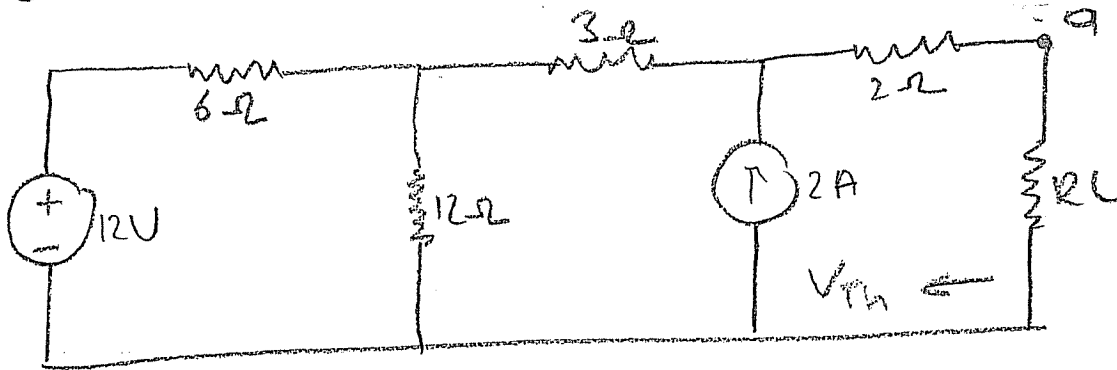
→ Devreyi ik haline getirirsek

(8)

$$P_{Vs} = -V_s \cdot i_s = -360 \times 7 = -2520 \text{ W}$$

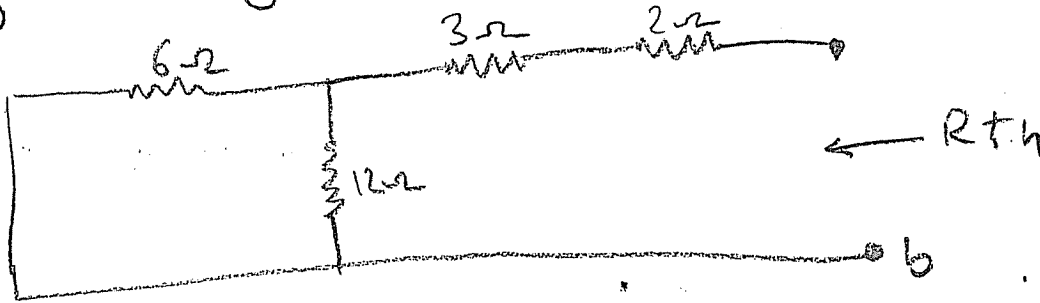
$$i_s = \frac{360 - 150}{30} = 7 \text{ A} \Rightarrow \frac{900}{2520} \times 100 = \%35,7$$

Örnek:

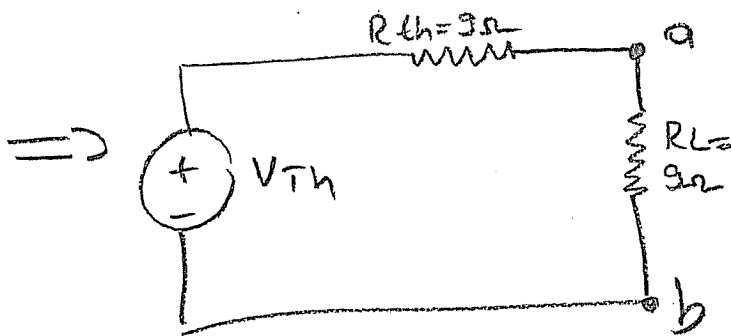


* Eş değeri bulmak için R_L 'yi çıkar.

* Bağımsız kaynakları çıkarttık. (Devrede bağımlı kaynak olmaydı yapamazdık.)

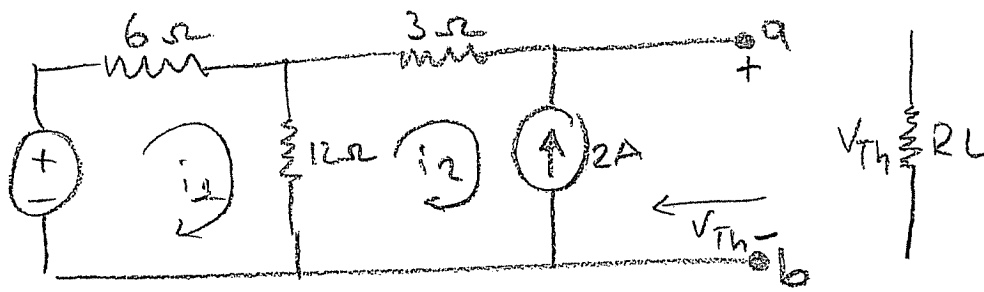


$$R_{Th} = 6 // 12 + 3 + 2 = 9 \Omega$$



$$P_{\max} = \frac{V_{Th}^2}{4R_L} = \frac{(22)^2}{4 \cdot 9} = 13,44$$

Formülden



9

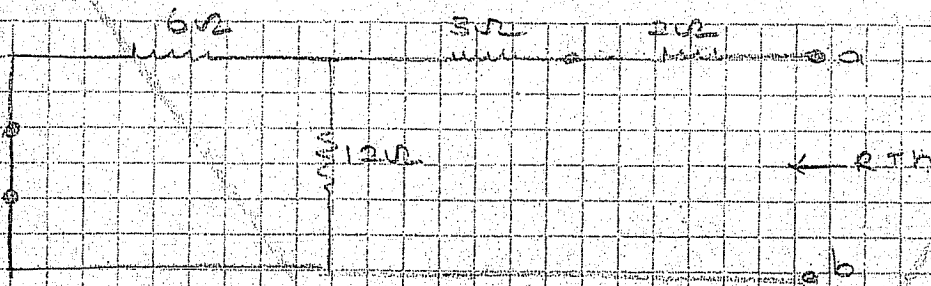
$$i_2 = 2A$$

$$i_1 = -2/3A$$

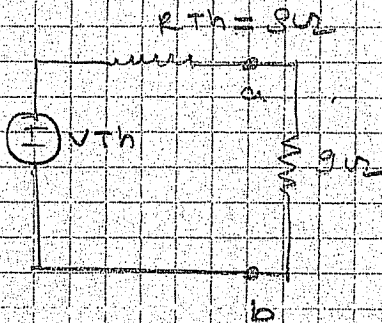
$$-12 + 6i_1 + 12(i_1 - i_2) = 0$$

$$\text{süper ag} : -12 + 6i_1 + 3i_2 + V_{Th} = 0 \quad V_{Th} = 22V$$

SÜPER POZİSYON

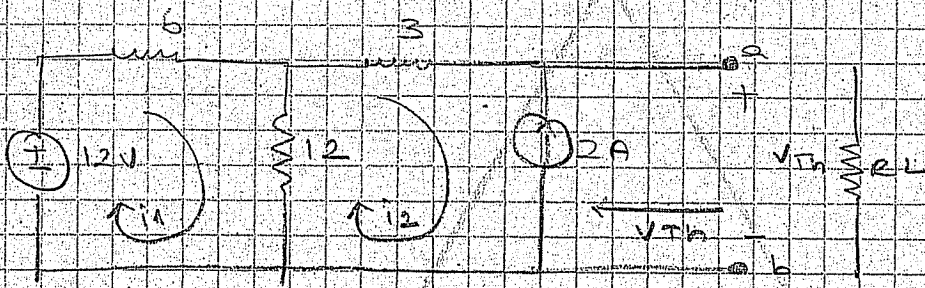


$$R_{Th} = 6 // 12 + 3 + 2 = 9\Omega$$



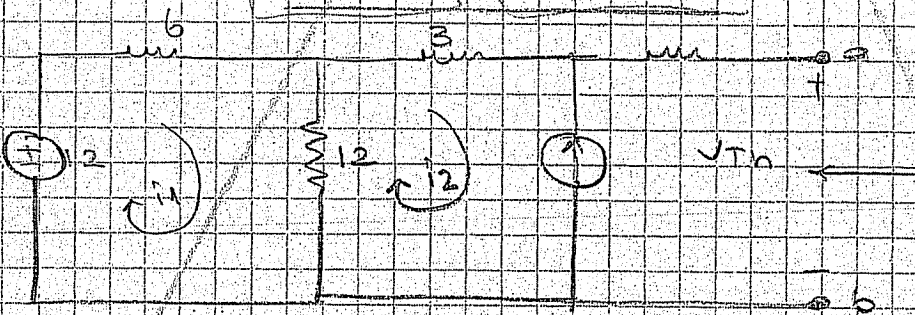
$$P_{max} = \frac{V_{Th}^2}{4R_L} = \frac{2^2}{4 \times 9} = 18 \text{ mW}$$

↓
Formülden



$$-12 + 6i_1 + 12(i_1 - i_2) = 0$$

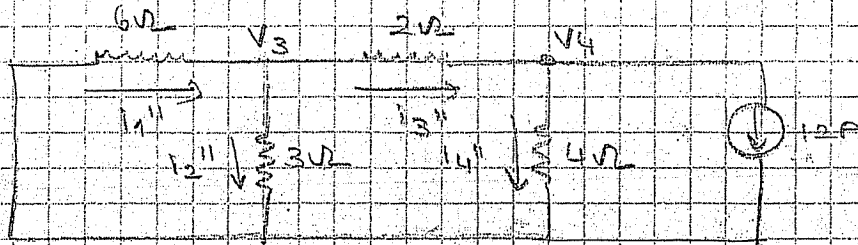
$$i_2 = 2A, i_1 = -2/3A$$



$$\text{super op: } -12 + 6i_1 + 3i_2 + V_{Th} = 0$$

$$V_{Th} = 22V$$

11



$$\left. \begin{aligned} V_3 &= \frac{V_3}{6} + \frac{V_3}{3} + \frac{V_3 - V_4}{2} = 0 \\ V_4 &= \frac{V_4}{4} + \frac{V_4 - V_3}{2} + 12 = 0 \end{aligned} \right\} \begin{aligned} V_3 &= -12V \\ V_4 &= -24V \end{aligned}$$

$$i_1'' = \frac{0 - V_3}{6} = \frac{12}{6} = 2A$$

$$i_2'' = \frac{V_3 - 0}{3} = \frac{-12}{3} = -4A$$

$$i_3'' = \frac{V_3 - V_4}{2} = \frac{-12 - (-24)}{2} = 6A$$

$$i_4'' = \frac{V_4}{4} = \frac{-24}{4} = -6A$$

$$i_1 = i_1' + i_1'' = 15 + 2 = 17A$$

$$i_2 = i_2' + i_2'' = 10 - 4 = 6A$$

$$i_3 = i_3' + i_3'' = 5 + 6 = 11A$$

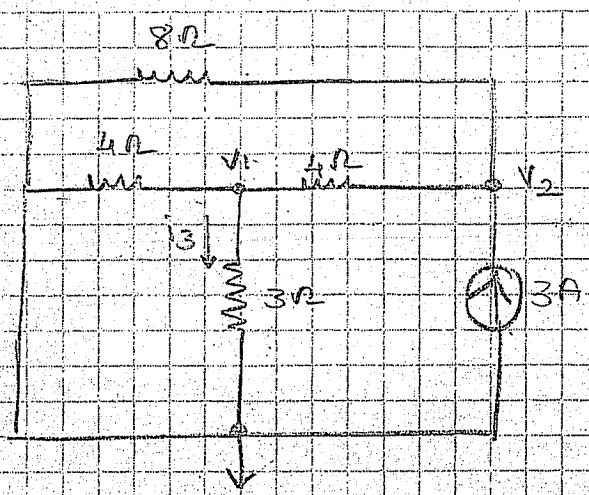
$$i_4 = i_4' + i_4'' = 5 - 6 = -1A$$

* Akım kaynaklarını sıfırladık.

Voltajla kısa devre uyguladık.

13

3)



$$V_1 = \frac{V_1}{4} + \frac{V_1}{3} + \frac{V_1 - V_2}{4} = 0$$

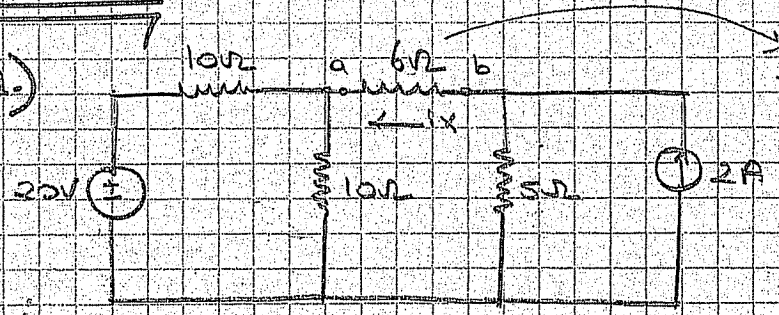
$$V_2 = \frac{V_2 - V_1}{4} + \frac{V_2}{8} - 3 = 0$$

$$\begin{aligned} V_1 &= 3V & V_2 &= 10V \\ i_3 &= \frac{V_1}{3} = \frac{3}{3} = 1 \end{aligned}$$

$$I = i_1 + i_2 + i_3 = 2 - 1 + 1 = 0$$

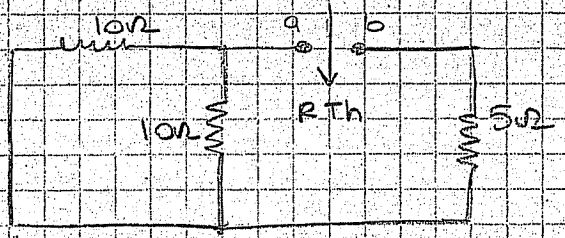
QUIZ:

1.)



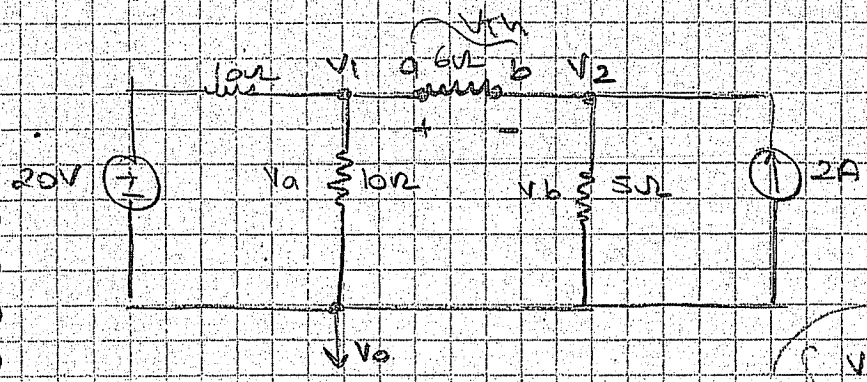
Thevenin deynce

mutlaka sources



$$R_{Th} = 10 // 10 + 5 \Omega$$

$$= \frac{10 \times 10}{10 + 10} + 5 = 5 + 5 = 10 \Omega = R_{Th}$$



$$-V_a + V_{Th} + V_b = 0$$

$$V_{Th} = V_a - V_b$$

$$V_{Th} = 10 - 10 = 0$$

$$V_a = \frac{10 \times 20}{10 + 10} = 10V$$

$$V_b = 2 \times 5 = 10V$$

$$I_x = \frac{V_b - V_a}{6 \Omega} = 0$$

1

Kaynak dönüşümleri Thevenin ve Norton Maksimum Güç Transferi Süper Pozisyon

Düğüm voltaj metodu:

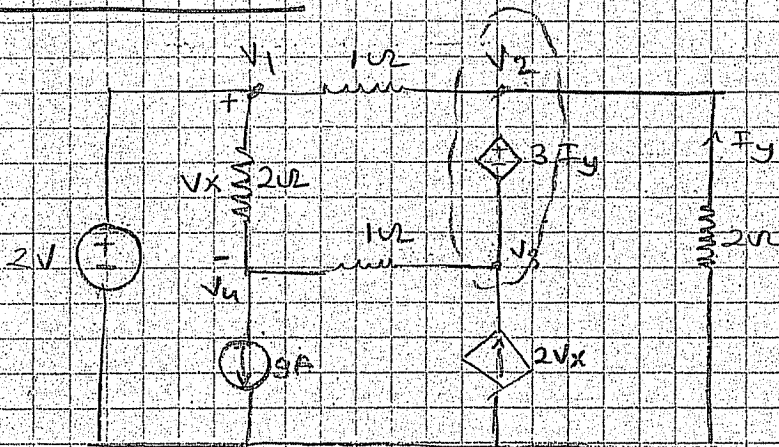
(Hangi düğüme referans alırsanız o önemlidir).

$$\frac{V_a - 25b}{150} + \frac{V_a - V_b}{100} + \frac{V_a}{200} + \frac{V_a - V_c}{300} = 0$$

$$V_b = 50 \text{ V}$$

$$\frac{V_c - V_a}{300} + \frac{V_c - V_b}{250} + \frac{V_c - (-128)}{500} + \frac{V_c}{400} = 0$$

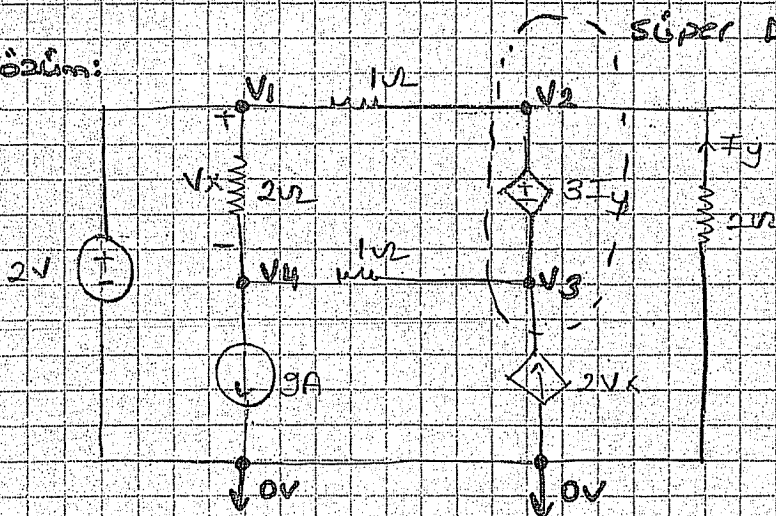
QUIZ SORULARI:



$$V_x = ?$$

$$I_y = ?$$

Çözüm:



$$V_1 = 2 \text{ V}$$

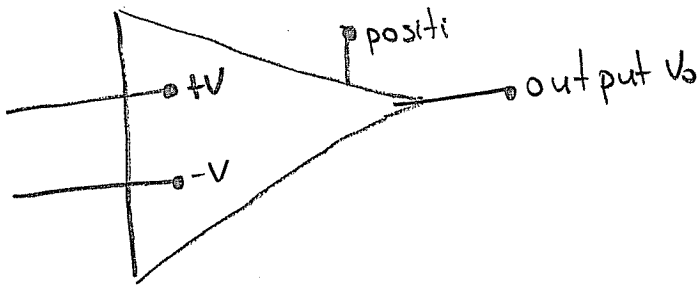
$$V_2 - V_3 = 3I_y$$

$$V_1 - V_4 = V_x$$

$$V_2 = -2I_y$$

• KVL uygularken akım yönünü al.

İşlemsel Yükselteçler:



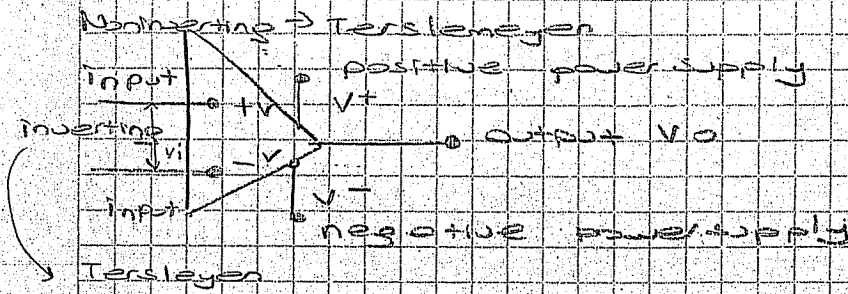
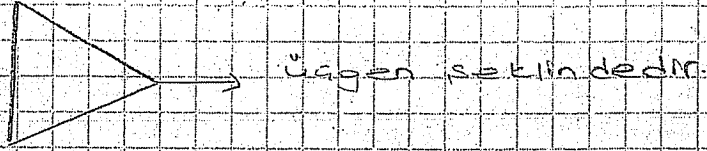
DEVREI-III Bölüm

1

İşlemsel Yükselteçler
Wheatstone Bridge
Bobin Kondansatör Türleri
Güç ve Enerji
Step response
RL Devreleri
RC Devresi

- * Pozitif terminale giren akım I_P , negatife giren akım I_N 'dir.
- * i_o çıkış akımıdır.
- * i_{c+} kaynak akımıdır.
- * Transistörün besleme karşılığı iki tane harf kullanılır. V_{cc} 'de olabilir bu, ya da V_{ee} . Tek harfler 0 noktasından alınan potansiyele karşılık gelir.
- * Entegre devreyi düğüm gibi göreceğiz.
- * Akımları toplayıp sifıra eşitleriz.
- * Bulamayacağımız voltaj değerleri V_{cc+} ve V_{cc-} arasında olmalıdır.
- * Satürnasyon girişlere ne verersen ver sabit kalıyor. Her zaman satürnasyonun altında kalacağız.

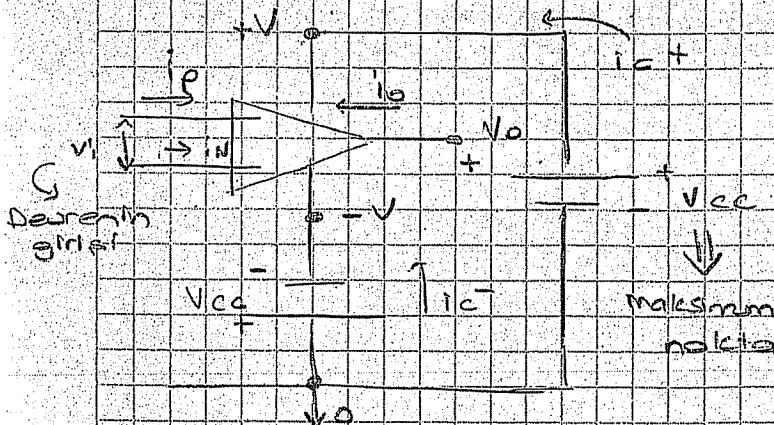
İşlemsel Yükselteçler:



offset null	1	8	N_c
inverting input	2	7	V_+
noninverting input	3	6	output (V_o)
V_-	4	5	offset null

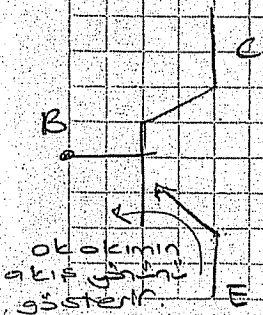
eight-lead DIP package
DIP = Dual in line package

* Pozitif terminale giran akım I_P , negatiften I_N .



I_O = çıkış akımı
 I_C = kaynak akımı

Transistörün besleme
karsılığı için V_{ee}
kayıtlı kullanılır. V_{ee} -de
olabilir tek kayıtlar
o noktadan alınan
potansiyel karışıklık
geliir.



DEVRE DEĞİŞKENLERİ

* $i = \frac{dq}{dt}$ (Amper)

* $V = \frac{dE}{dq}$

* $P = \frac{dE}{dt}$

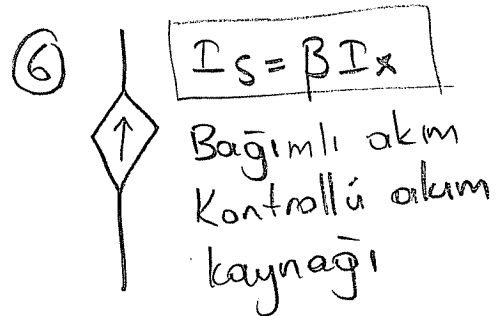
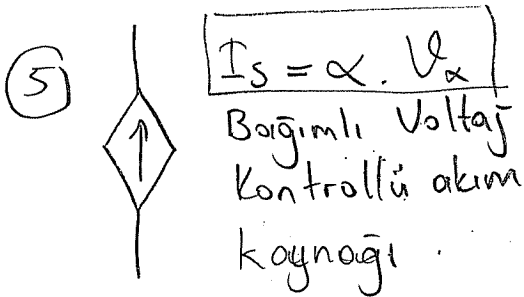
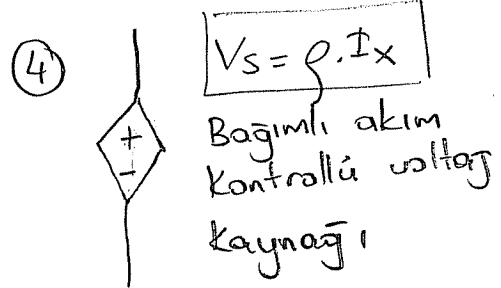
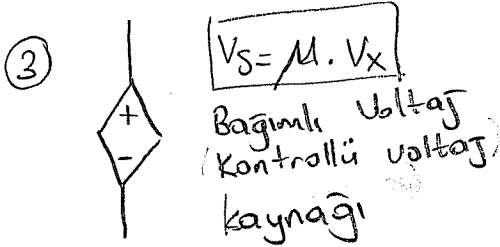
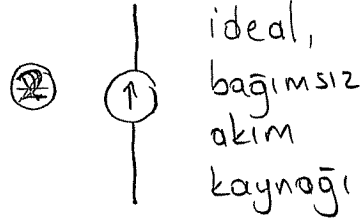
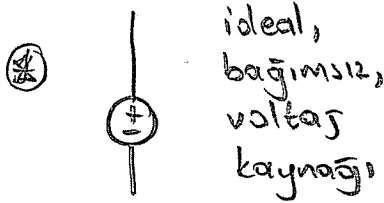
$P = V \cdot i$

• Akım negatif yüklere ters yönde hareket eder.

$P = V \cdot -i ; V \cdot i ; -V \cdot i ; -V \cdot -i$

Akımın ve voltajın yönüne göre değişiyor.

DEVRE ELEMANLARI

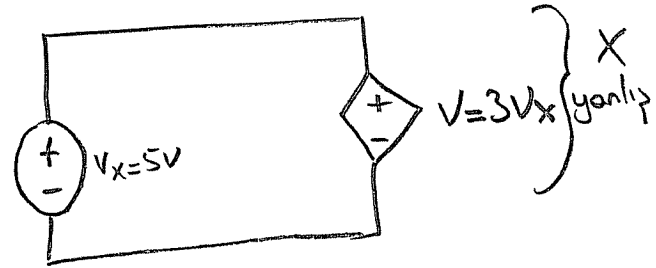
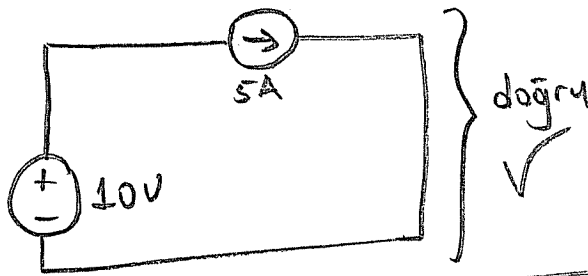
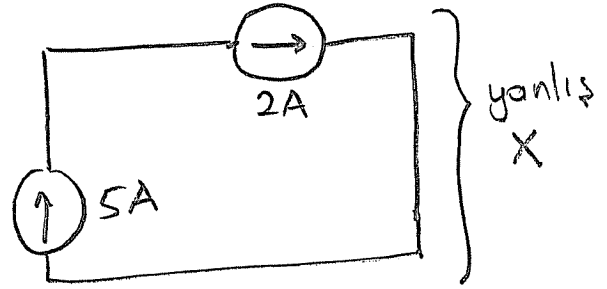
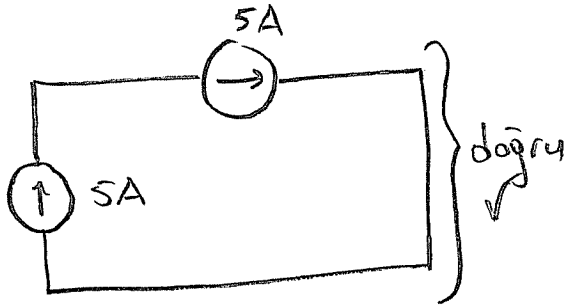
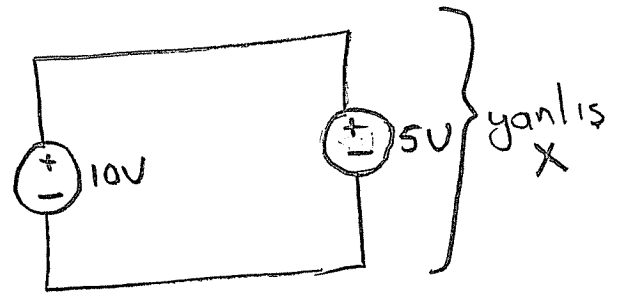
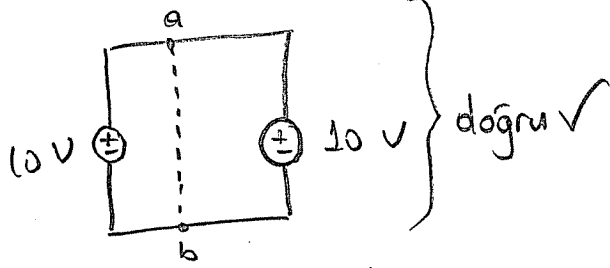


* Devrede herhangi bir kopukluk olmamalıdır.

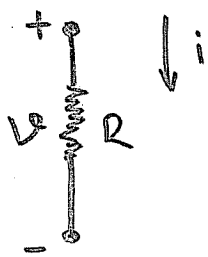
* Bir devrede her zaman giriş-cıkış olmalıdır.

① Paralel bağlı devrelerde voltaj eşit olacağı için sağ-sol voltaj eşit olmalıdır. (Devre kapalı olacak) (Seri devrelerde ise akım aynı olmalı)

Örnekler:



OHM KANUNU:



$$V = iR$$

$$R = \Omega \text{ (ohm)}$$

$$G = \frac{1}{R} \text{ S (siemens)}$$

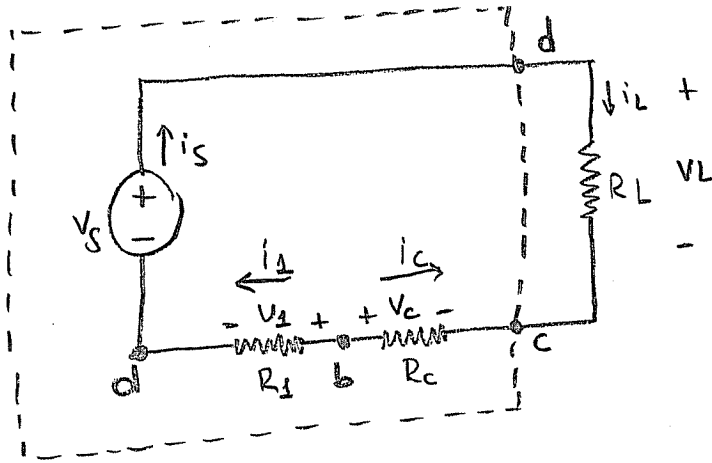
$$P = iV = i(i \cdot R) = i^2 R$$

$$= \frac{V}{R} \cdot V = \frac{V^2}{R}$$

KIRCHHOFF KANUNU:

- KCL (akım kanunu)
- KVL (voltage kanunu)

⊗ K. Akım Kanunu (KCL):



* * *
→ girenler (-)
* * *
→ çıkanlar (+)
* * *

- Her direncin üzerindeki voltaj bulunur ve akımın yönü gösterilir.
- Bir düğüme girenler (-), çıkanlar (+) dir.
- Önce düğümler işaretlenir. İki düğüm arasındaki akım aynı olmalıdır. (Örneğin d ve a arasındaki akım i_s dir.)

KCL'den;

$$a: -i_1 + i_s = 0$$

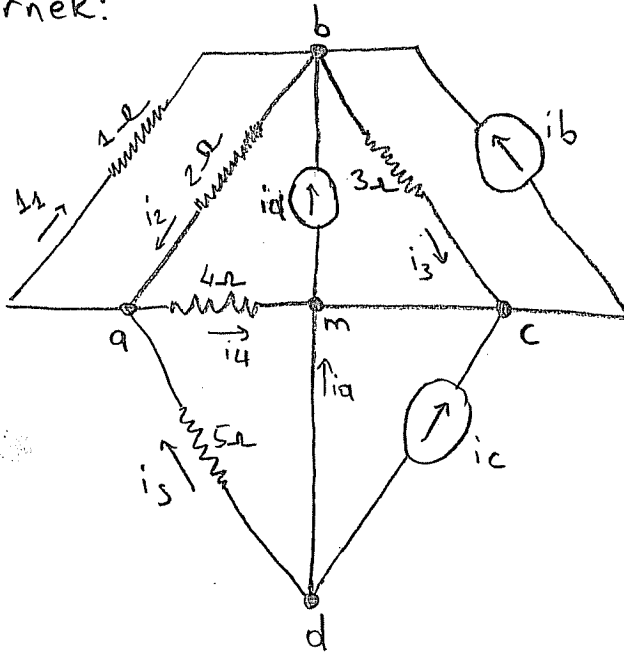
↳ çıktığı için (+)
↳ girdiği için (-)

$$b: i_1 + i_c = 0$$

$$c: -i_c - i_L = 0$$

$$d: i_L - i_s = 0$$

Örnek:



KCL ile göz. girenler (-)
çıkanlar(+)

Gözüm:

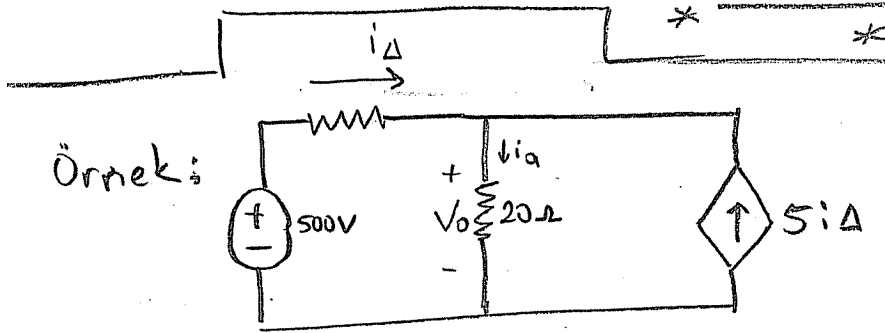
$$a: i_1 - i_2 + i_4 - i_5 = 0$$

$$b: -i_1 + i_2 - i_b + i_3 - i_a = 0$$

$$c: +i_b - i_3 - i_c - i_4 = 0$$

$$d: +i_a + i_c + i_5 = 0$$

* Not: Ortadaki m noktasını ben uy-
* clurdum. Sanki devrede o nokta
* hiç yokmuşcasına hareket edilmiş.
Dikkat!!! * * * *



Örnek:

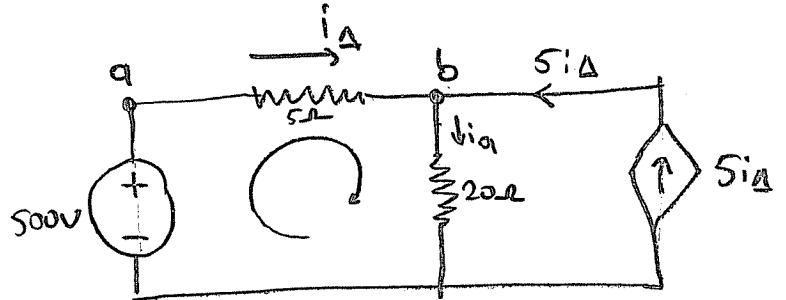
$V_0 = ?$

Gözüm:

→ KVL: (çevre)

$$-500 + 5i_{\Delta} + 20i_a = 0$$

* (Not: Voltaj olmadığı için
* sağ taraf uygulanamaz.) Dikkat!!! *
* * *



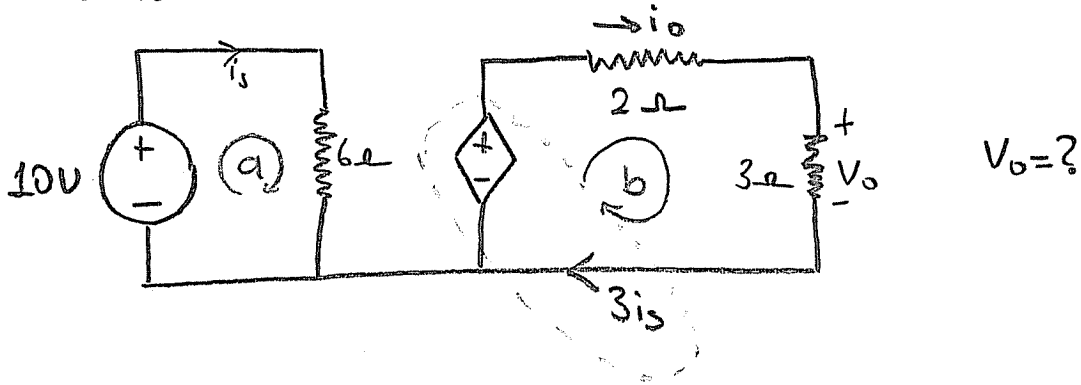
→ KCL: (düğüm) (girenler (-), çıkanlar (+))

$$b: -i_{\Delta} + i_a - 5i_{\Delta} = 0 \Rightarrow i_a = 6i_{\Delta}$$

→ i_a 'yı KVL'de yerine koyarız.

$$-500 + 5i_{\Delta} + 20(6i_{\Delta}) = 0 \Rightarrow i_{\Delta} = 4A \quad ; \quad i_a = 24A \quad ; \quad V_0 = 480V$$

Örnek:



Gözüm: $V=IR$

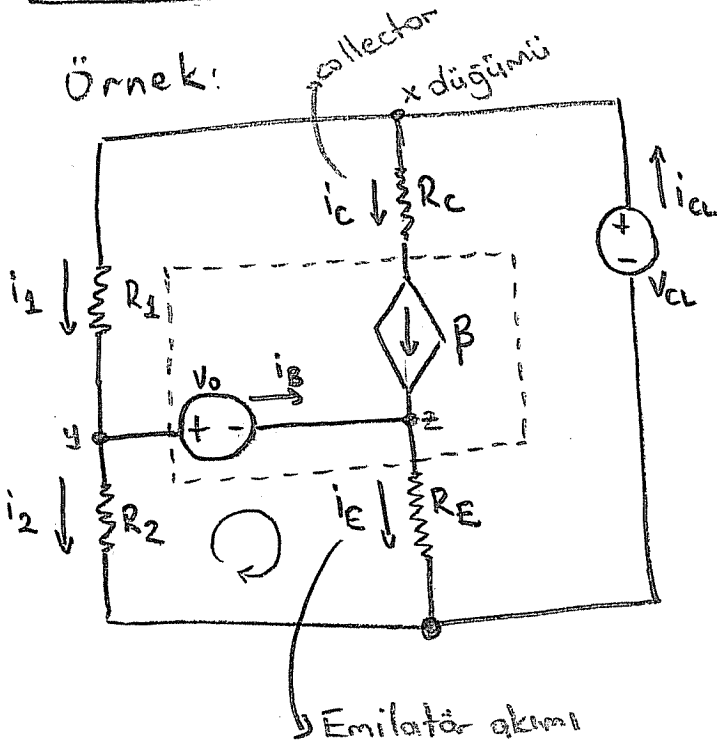
(a) KVL: $-10V + 6i_s = 0 \rightarrow i_s$ 'yi çekip b çevresine koyarız.

(b) KVL: $-3i_s + 2i_o + \underbrace{3i_o}_{V_o} = 0$

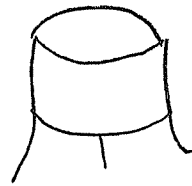
$$i_s = 1,67 \text{ A} \quad i_o = 1 \text{ A} \quad \underline{\underline{V_o = 3V}}$$

(Not: i_s ile voltaj aynı yönde olduğundan i_s (+)'dir)

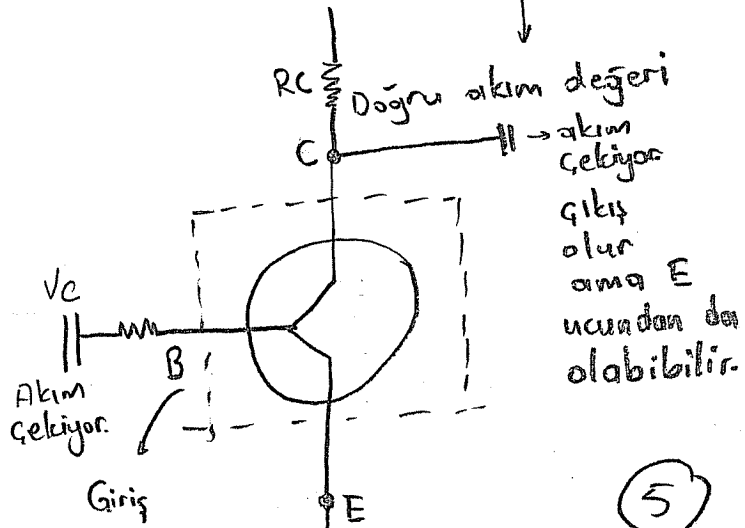
Örnek:



* Transistör girişte uygulanan akımı yükseltir.



BJT → Besleme voltajları DC'dir.



Gözüm:

Not: Akım geçen kondansatör ya da direnç kullanabiliriz.

$$x: i_1 - i_{CL} + i_L = 0 \quad (KCL)$$

$$y: -i_1 + i_2 + i_B = 0 \quad (KCL)$$

$$z: -i_C - i_B + i_E \quad (KCL)$$

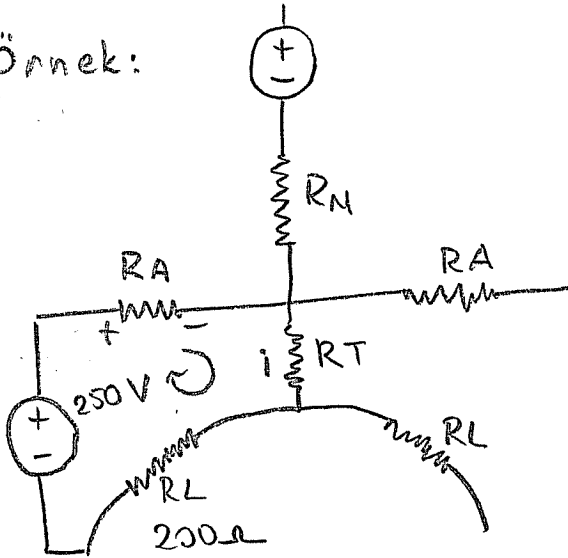
$$P: V_0 + i_E R_E - i_2 \cdot R_2 = 0 \quad (KVL)$$

↳ i_g gerçeğe

$$R: V_{CC} - i_2 R_2 - i_1 R_1 = 0 \quad (KVL)$$

↳ d_g gerçeğe

Örnek:

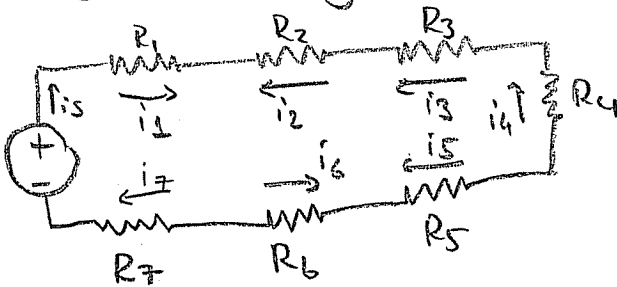


$$-250 + 400i + 50i + 200i = 0$$

$$i = \frac{250}{650} = 38,5 \text{ mA}$$

③ DIRENÇLİ DEVRELER

① Seri Bağlı Devreler:



Devredeki akım eğer i_s ise;

$$i_s = i_1 = -i_2 = -i_3 = -i_4 = i_5 = -i_6 = i_7$$

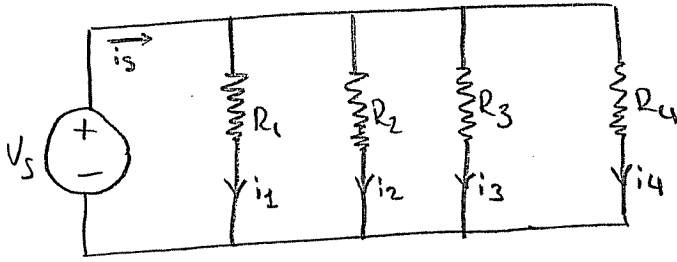
* Akımın yönünü istediğimiz gibi belirleyebiliriz.

* Seri bağlı devrelerde akımlar eşittir.

$$* R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5 + R_6 + R_7$$

$$= \sum_{n=1}^N R_N$$

⑥ Paralel Bağlı Devreler:



* Paralel bağlı devrelerde
ise voltajlar aynı, akımlar farklıdır.

$$\Rightarrow V_s = i_1 \cdot R_1 = i_2 R_2 = i_3 R_3 = i_4 R_4$$

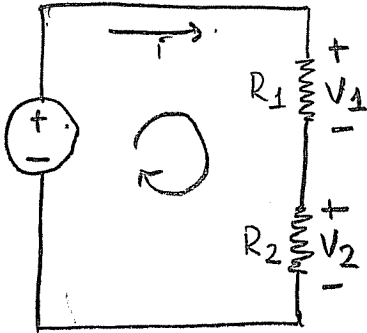
$$i_s = i_1 + i_2 + i_3 + i_4$$

$$i_s = V_s \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \right) = V_s \cdot \frac{1}{R_{eq}}$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

iletkenlik $\leftarrow G = G_1 + G_2 + G_3 + G_4 \rightarrow$ eş iletkenlik.

VOLTAJ BÖLÜCÜ DEVRE:



$$-V_s + iR_1 + iR_2 = 0$$

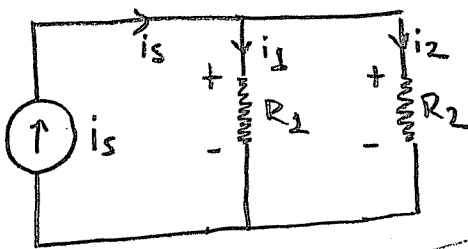
$$V_s = i(R_1 + R_2)$$

$$i = \frac{V_s}{R_1 + R_2}$$

$$V_1 = i \cdot R_1 = \frac{V_s \cdot R_1}{R_1 + R_2}$$

$$V_2 = i \cdot R_2 = \frac{V_s \cdot R_2}{R_1 + R_2}$$

AKIM BÖLÜCÜ DEVRE:



$$i_s = i_1 + i_2$$

$$V = i_1 R_1 = i_2 R_2$$

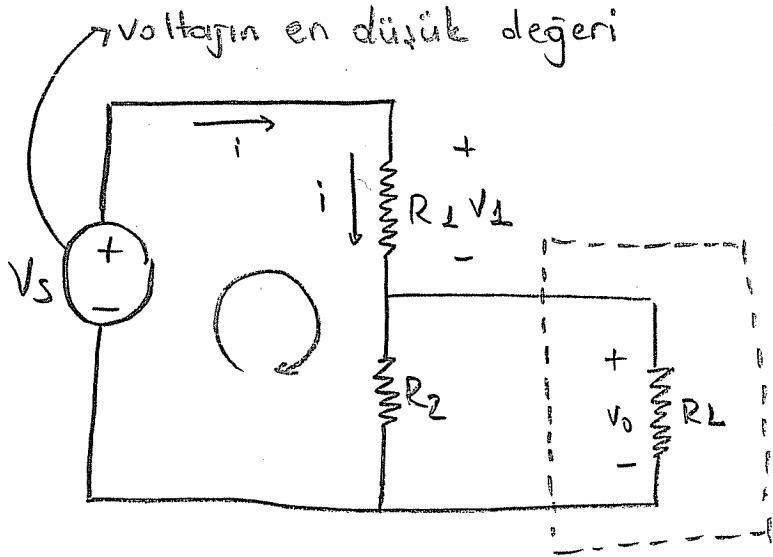
$$= \frac{R_1 \cdot R_2}{R_1 + R_2} \cdot i_s$$

Not: Devrenin girişinde voltaj ya da akım kaynağı varsa, dirençler aracılığıyla bunları istediğimiz gibi çekebiliriz.

$$\Rightarrow i_1 R_1 = \frac{R_1 \cdot R_2}{R_1 + R_2} \cdot i_s$$

$$i_1 = \frac{i_s \cdot R_2}{R_1 + R_2} \Rightarrow i_2 = \frac{i_s \cdot R_1}{R_1 + R_2}$$

Örnek:



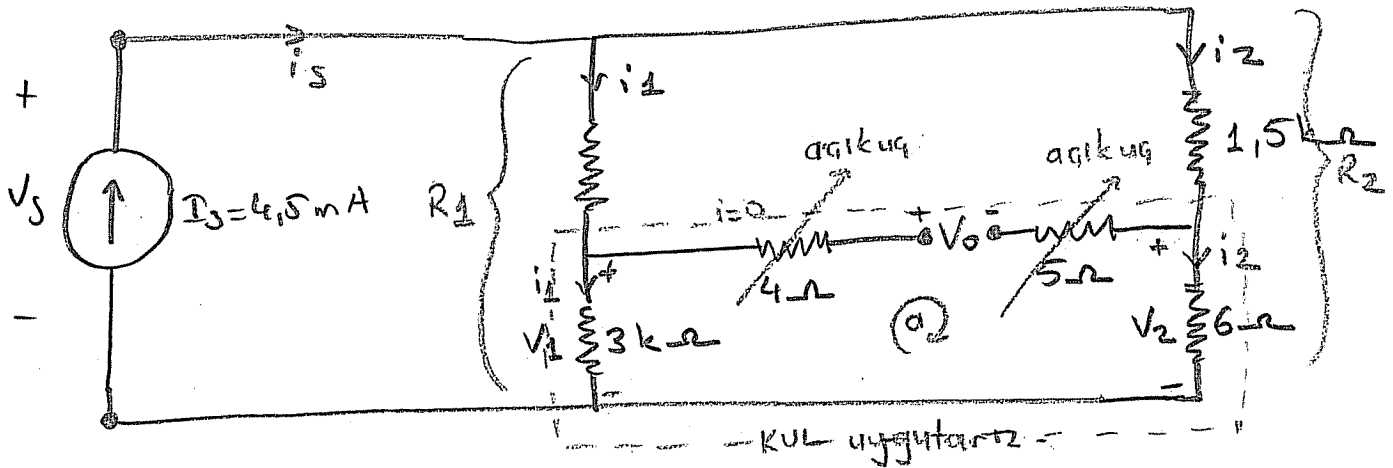
$$R_{eq} = R_2 // R_L = \frac{R_2 \cdot R_L}{R_2 + R_L}$$

$$-V_s + i \cdot R_1 + i \cdot R_{eq} = 0$$

$$i = V_s / (R_1 + R_{eq})$$

$$V_0 = i \cdot R_{eq}$$

Örnek: $V_0 = ?$



* Akım kullanırsan Kircsof kullanamazsın.

* Kaynaktan başla.

* Bağımsız akım kaynağındaki ok akımın yönü gösterir.

* V_s akımın kaynağıdır, iki nokta arasındaki voltajdır.

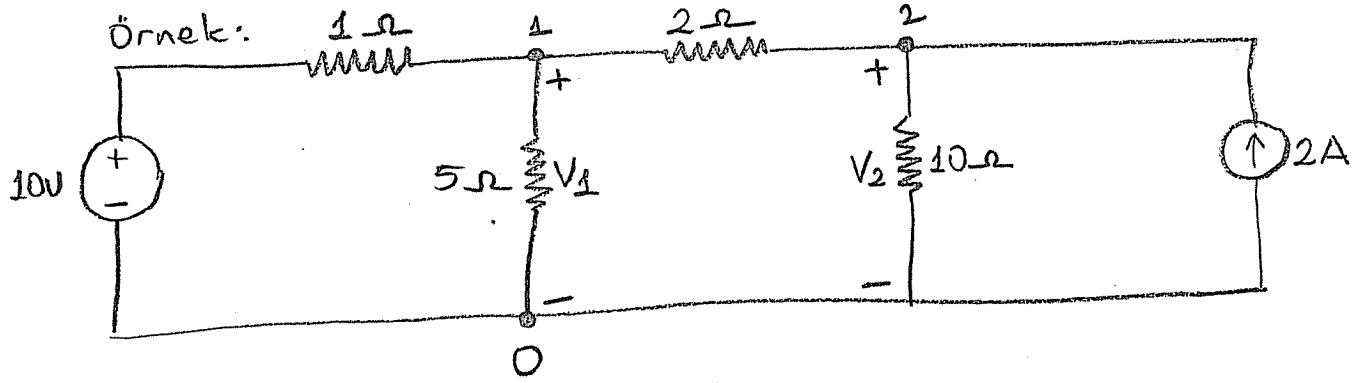
$$a) -V_1 + V_0 + V_2 = 0 \quad \rightarrow \quad R_1 = 5k\Omega, R_2 = 7.5k\Omega$$

$$V_0 = V_1 - V_2 \quad \rightarrow \quad i_1 = \left(\frac{R_2}{R_1 + R_2} \right) i_s = 2.7mA$$

$$V_1 = i_1 \cdot R_1 = 8.1V$$

$$V_2 = 1.8 \cdot 6 \quad \rightarrow \quad V_0 = 8.1 - 10.8 = -2.7V$$

DÜĞÜM VOLTAJ METODU:



$$1 \text{ için; } \frac{V_1 - 0}{5} + \frac{V_1 - V_2}{2} + \frac{V_1 - 10}{1} = 0$$

$$2 \text{ için; } \frac{V_2 - 0}{10} + \frac{V_2 - V_1}{2} - 2 = 0$$

* Dirençler her zaman güç harcar.

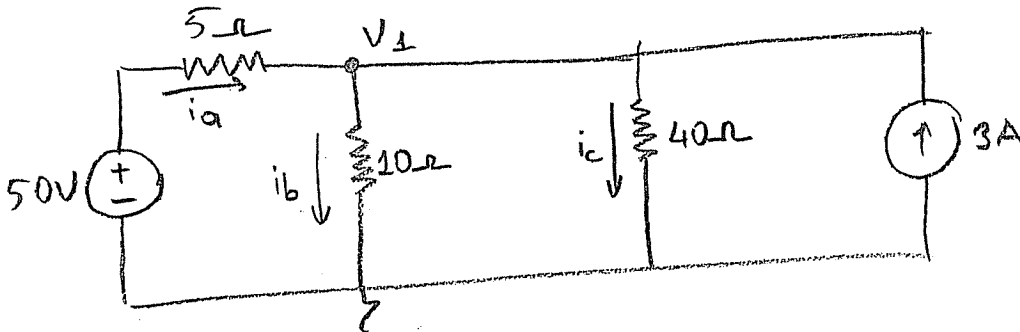
* Voltajlar ya da akımlar?

→ Pozitifse güç harcar.

→ Negatifse güç alır.

* Akım iki düğüm arasında akar.

Örnek:



$$i_a, i_b, i_c = ?$$

$$P_{50V} = ?$$

$$P_{3A} = ?$$

Gözüm:

$$\frac{V_1 - 50}{5} + \frac{V_1}{10} + \frac{V_1}{40} \overset{\text{Girdiği için}}{\ominus} 3 = 0 \Rightarrow \boxed{V_1 = 40 \text{ V}}$$

$$i_a = \frac{50 - V_1}{5} = 2 \text{ A} , \quad i_b = \frac{V_1}{10} = 4 \text{ A} , \quad i_c = \frac{V_1}{40} = 1 \text{ A}$$

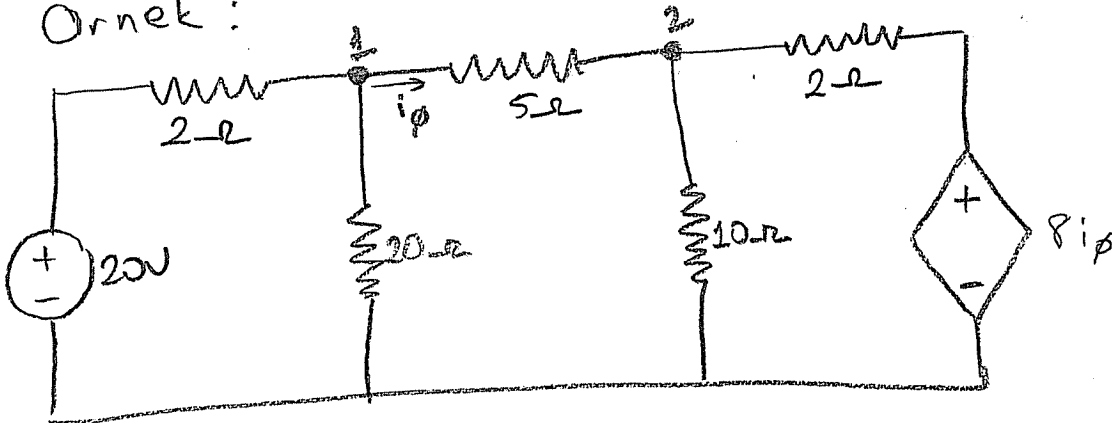
$$P_{50V} = -50 \cdot 2 = -100 \text{ W}$$

$$P_{3A} = -3 \cdot V_1 = -3 \cdot 40 = -120 \text{ W}$$

(Devreye güç verin.)

Not: Güç negatif (-) çıktığı için devreye güç verin.

Örnek:



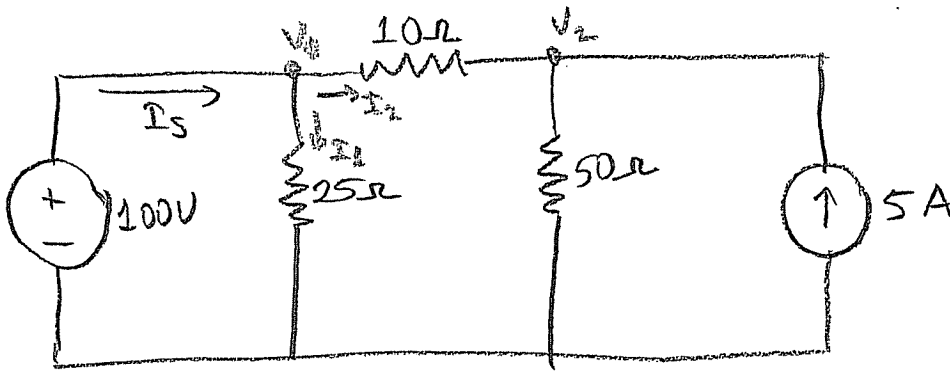
$$1. \text{ düğüm: } \frac{V_1 - 20}{2} + \frac{V_1 - V_2}{5} + \frac{V_1}{20} = 0$$

$$2. \text{ düğüm: } \frac{V_2 - V_1}{5} + \frac{V_2}{10} + \frac{V_2 - 8i_\phi}{2} = 0$$

$$V_1 = 16 \text{ V} \quad V_2 = 10 \text{ V} \quad i_\phi = 1,2 \text{ A}$$

$$P_{5\Omega} = i_\phi^2 \times 5 = (1,2)^2 \times 5 = 7,2 \text{ W}$$

Örnek:



* $V_1 = 100 \text{ V}$ (Çünkü arada eleman yok)

$$V_2 \Rightarrow \frac{V_2 - V_1}{10} + \frac{V_2}{50} - 5 = 0 \quad \text{girdiği için.}$$

$$V_1 = 100 \text{ V}$$

$$V_2 = 125 \text{ V}$$

$$I_1 = \frac{V_1}{25} = \frac{100}{25} = 4 \text{ A}$$

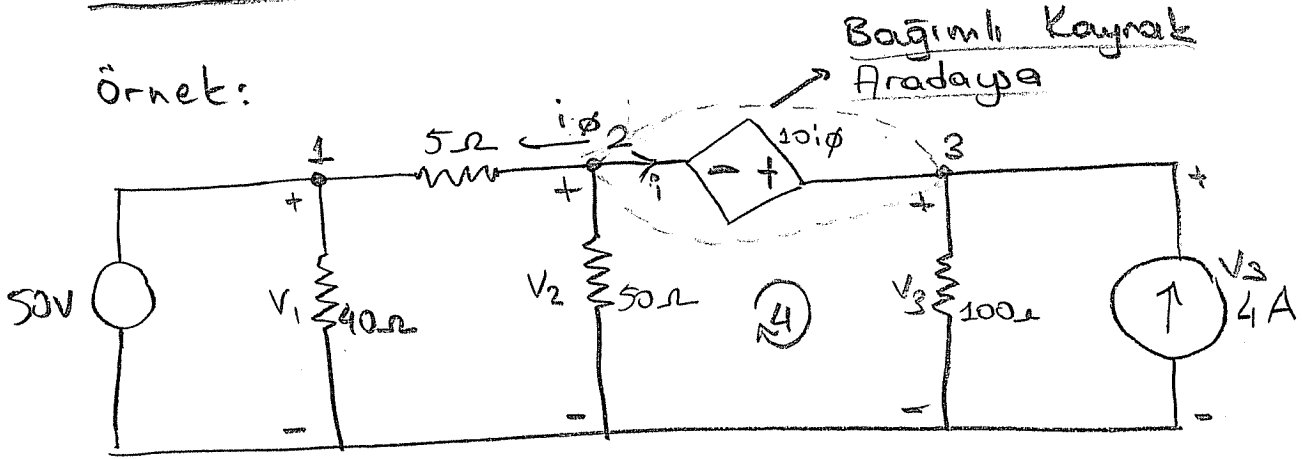
$$I_2 = \frac{V_1 - V_2}{10} = -2,5 \text{ A}$$

V_1 düğümünden;

$$-I_s + I_1 + I_2 = 0 \Rightarrow I_s = 1,5 \text{ A}$$

SÜPER DÜĞÜM

Örnek:



$V_1, V_2, V_3 = ?$

$i_\phi = ?$

$$V_1 = 50 \text{ V}$$

$$2: \frac{V_2 - V_1}{5} + \frac{V_2}{50} + i = 0 \quad \text{bilinmeyen akım/voltage tanımlanır.}$$

$$3: \frac{V_3}{100} - 4 - i = 0$$

+

$$\frac{V_2 - V_1}{5} + \frac{V_2}{50} + i - i - 4 + \frac{V_3}{100} = 0$$

Süper düğüm:

$$\frac{V_2 - V_1}{5} + \frac{V_2}{50} + \frac{V_3}{100} - 4 = 0$$

$$i_\phi = \frac{V_2 - V_1}{5} \quad V_1 = 50 \text{ V}$$

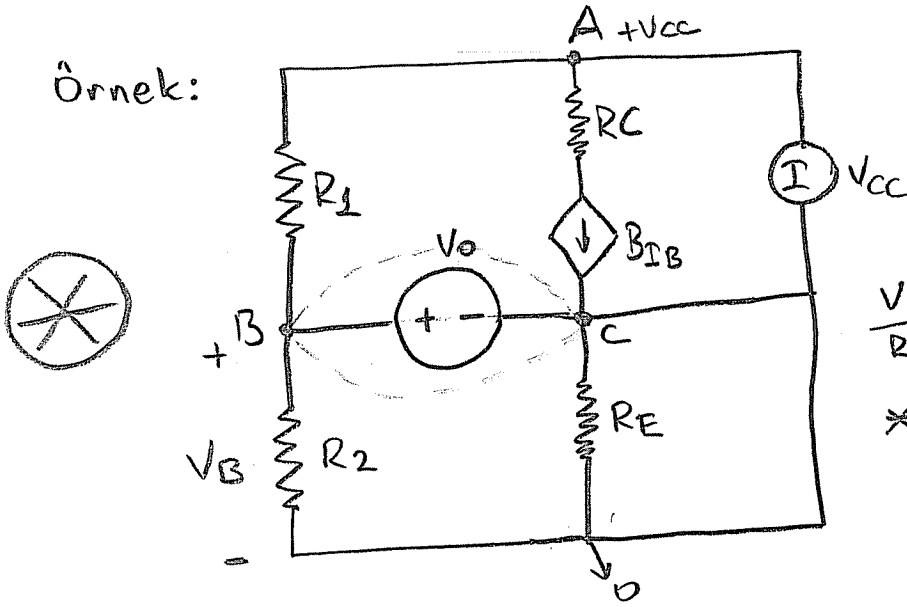
$$4: -V_2 - 10i_\phi + V_3 = 0$$

$$V_2 = 60 \text{ V}$$

$$V_3 = 80 \text{ V}$$

$$i_\phi = 2 \text{ A}$$

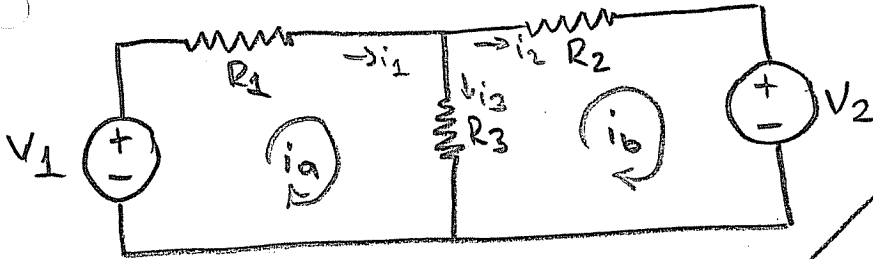
Örnek:



$$\frac{V_B}{R_2} + \frac{V_C}{R_E} - \beta I_B + \frac{V_B - V_{CC}}{R_1} = 0$$

* Teller üzerindeki akımları topluyoruz.

AĞ AKIMLARI



$$\begin{aligned} (KCL) : -i_1 + i_3 + i_2 &= 0 \\ (KVL) : -V_1 + R_1 i_1 + R_3 i_3 &= 0 \\ (KVL) : -i_3 R_3 + i_2 R_2 + V_2 &= 0 \end{aligned}$$

i_a ve i_b dahilinde ;

$$-V_1 + R_1 i_a + R_3 (i_a - i_b) = 0$$

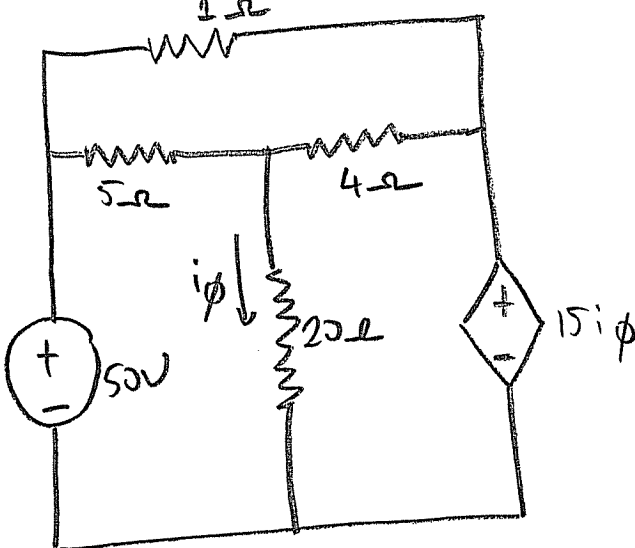
$$R_3 (i_b - i_a) + R_2 i_b + V_2 = 0$$

$$i_a = i_1$$

$$i_b = i_2$$

$$i_3 = i_a - i_b$$

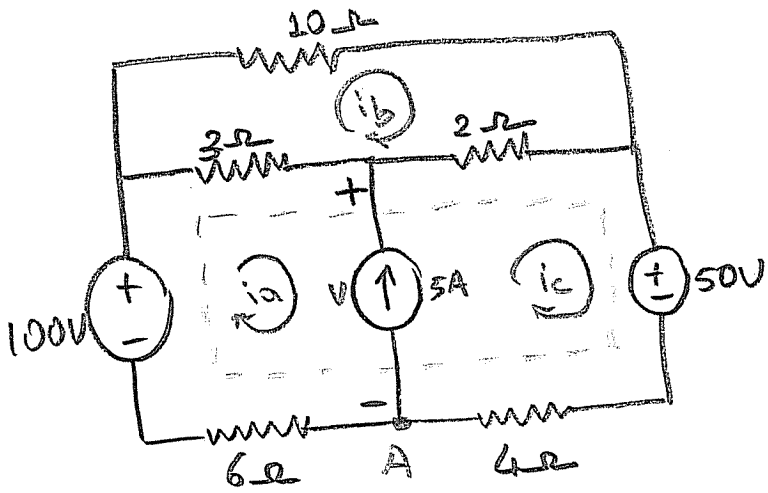
Örnek:



Çözüm.

$$P_{4\Omega} = ? \quad \underline{16W}$$

Örnek:



Görüm:

* 5A: Bağımsız akım kaynağı

$$-3i_a + 15i_b - 2i_c = 0 ; i_b$$

$$9i_a - 3i_b + V = +100 ; i_a$$

$$-V - 2i_b + 6i_c = -50 ; i_c$$

$$(KCL) : 5 - i_c + i_a = 0$$

$$i_a = 1,75A$$

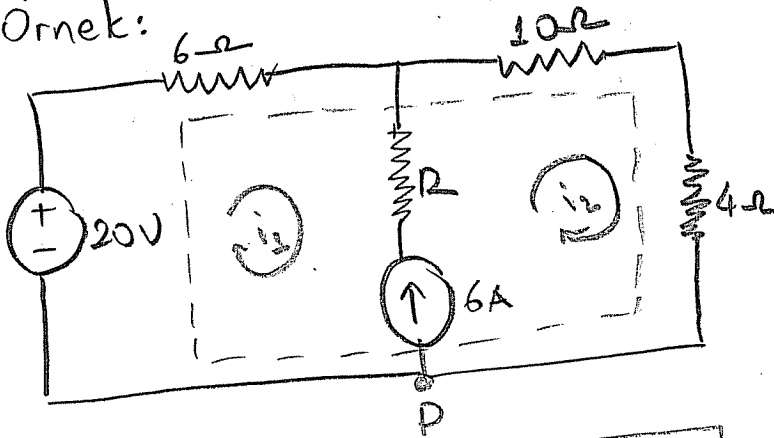
$$i_b = 1,25A$$

$$i_c = 6,75A$$

* Süper Ağ: Nerede hesaplamak istemediği-
miz bir ağ varsa onu devre dışı bırakınız.

$$9i_a - 5i_b + 6i_c = +50$$

Örnek:



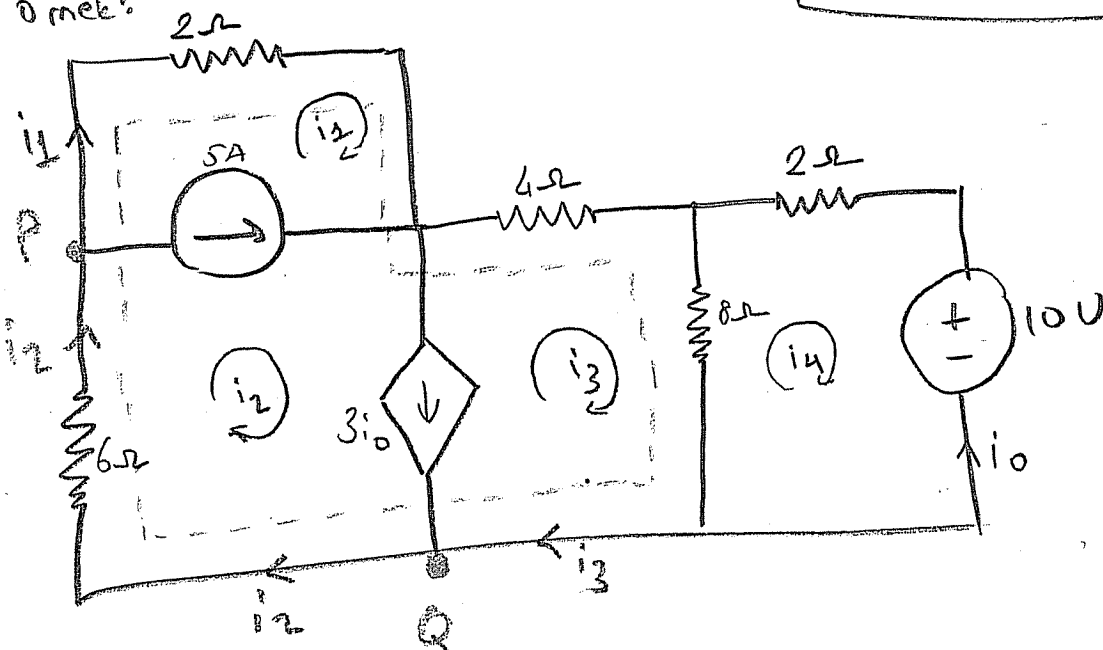
Ortada KVL'yi yazamıyoruz, çünkü R'yi bilmiyoruz. Süper ağdan yapmalıyız.

$$-20V + 6i_1 + 10i_2 + 4i_2 = 0$$

$$P(KCL) = 6 + i_1 + (-i_2) = 0$$

$$i_1 = -3,2 A ; i_2 = 2,8 A$$

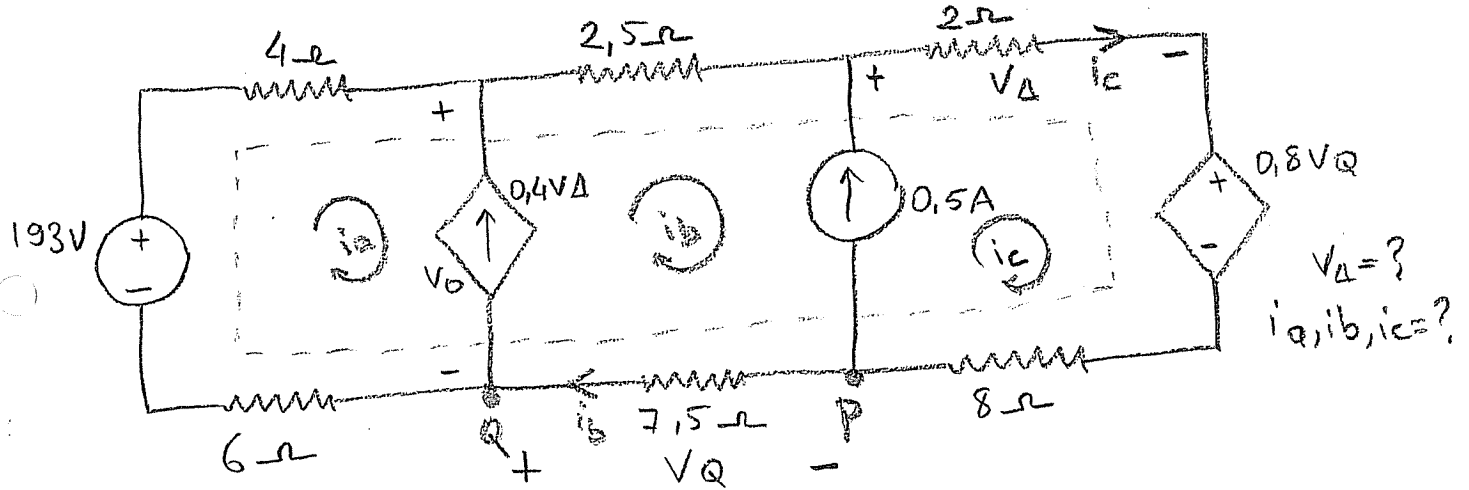
Örnek:



* Bilinmeyen sayısı kadar denklem yazarız.

$$\begin{aligned}
 \text{S.p.} : 2i_1 + 6i_2 + 12i_3 - 8i_4 &= 0 \\
 i_4 : 10i_4 - 8i_3 + 10 &= 0 \\
 \text{Q (KCL)} : -i_3 + i_2 - 3i_0 &= 0 \\
 \text{P (KCL)} : -i_2 + i_1 + 5 &= 0
 \end{aligned}
 \left. \vphantom{\begin{aligned} \text{S.p.} : 2i_1 + 6i_2 + 12i_3 - 8i_4 &= 0 \\ i_4 : 10i_4 - 8i_3 + 10 &= 0 \\ \text{Q (KCL)} : -i_3 + i_2 - 3i_0 &= 0 \\ \text{P (KCL)} : -i_2 + i_1 + 5 &= 0 \end{aligned}} \right\}
 \begin{aligned}
 i_1 &= -7,5 \text{ A} \\
 i_2 &= -2,5 \text{ A} \\
 i_3 &= 3,93 \text{ A} \\
 i_4 &= 2,143 \text{ A} \\
 i_0 &= -2,143 \text{ A}
 \end{aligned}$$

Örnek:



Çözüm:

$$V_{\Delta} = 2i_c$$

$$V_Q = -7,5i_b$$

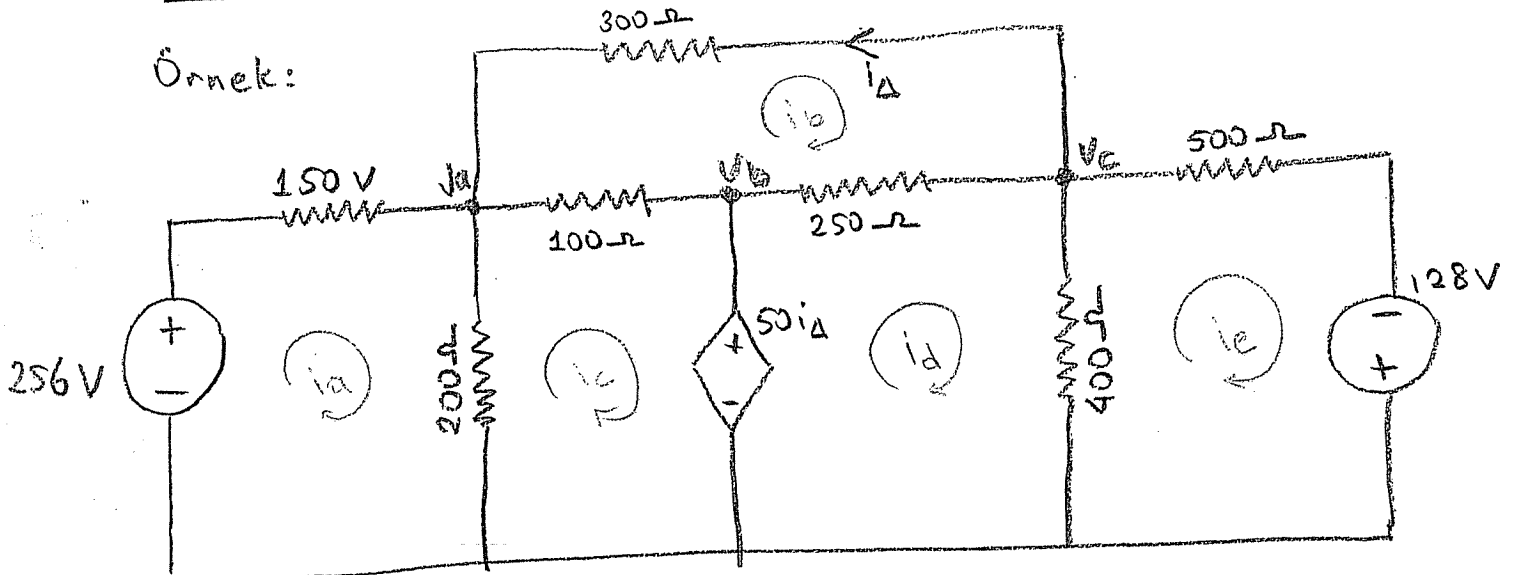
$$\text{S.p.} : -193V + 10i_a + 10i_b + 10i_c + 0,8V_Q = 0$$

$$\text{P (KCL)} : -i_c + i_b + 0,5 = 0$$

$$\text{Q (KCL)} : -i_b + i_a + 0,4V_{\Delta} = 0$$

$i_a = 2A \rightarrow i_a$ 'nın bulunduğu gerçeğe KVL uyguluyoruz:
 $-193 + 10i_a + V_0 = 0 \Rightarrow V_0 = 173V$

Örnek:



$$i_a: -256V + 350i_a - 200i_c = 0$$

$$i_b: +650i_b - 250i_d - 100i_c = 0$$

$$i_c: +300i_c - 100i_b + 50i_d = 0$$

$$i_d: -50i_d + 650i_d - 250i_b - 400i_e = 0$$

$$i_e: +900i_e - 128 - 400i_d = 0$$

$$i_d = -i_b$$

$$P_{300} = i_d^2 \times 300$$

*Ters yönlü KCL'ye gerek yok, 6 tane denklem var.

Düğüm Voltaj Metodu ile çözüm:

Bu noktada hangi düğüme sıfır deneceği önemlidir.

$$\frac{V_a - 256}{150} + \frac{V_a}{200} + \frac{V_a - V_b}{100} + \frac{V_a - V_c}{300} = 0$$

$$V_b = 50i_d$$

$$\frac{V_c - V_a}{300} + \frac{V_c - V_b}{250} + \frac{V_c - (-128)}{500} + \frac{V_c}{400} = 0$$

T. Quize kadar.

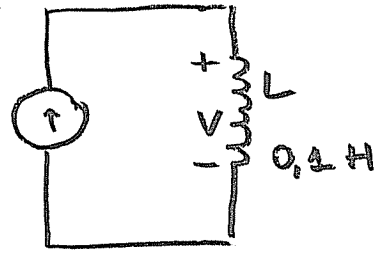
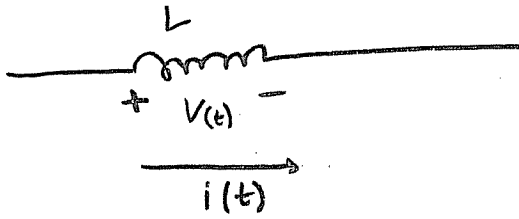
dönüşümlerine

kadar.

Kaynak

BOBIN-KONDANSATÖR TÜRLERİ:

$L \rightarrow$ bobinin büyüklüğü:



* Bu bölümde akım ve voltajın zamana bağlı olduğunu göstereceğiz.

* Akım ve voltajı zamanın fonksiyonu olarak kabul edeceğiz.

* $V(t) = L \cdot \frac{di(t)}{dt}$ Birimi Henry olarak kabul edeceğiz.

$i(t) = 10t \cdot e^{-5t} \rightarrow$ Türevini alarak voltajı hesaplıyoruz.

$$\begin{aligned} V(t) &= L [10e^{-5t} + (10t) \cdot (-5e^{-5t})] \\ &= L \cdot 10e^{-5t} [1 - 5t] \rightarrow L = 0,1 \\ &= 0,1 \times 10e^{-5t} (1 - 5t) \\ &= e^{-5t} (1 - 5t) \end{aligned}$$

$$V(t) dt = L di(t)$$

$$\int_{i(t_0)}^{i(t)} di(t) = \frac{1}{L} \int_{t_0}^t V(t) dt$$

① Başlangıç değeri

② Tepedeki

③ Sonsuzdaki

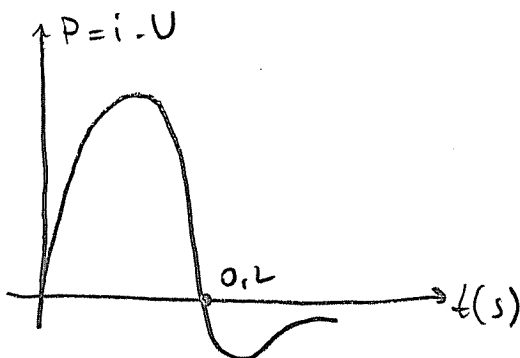
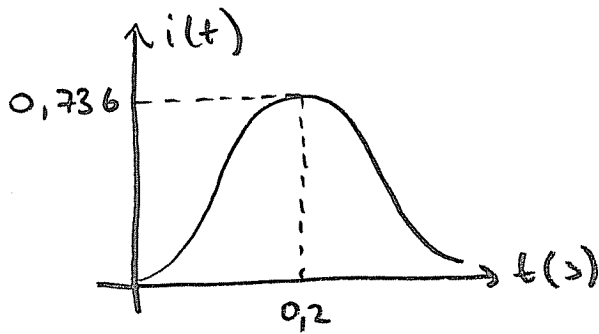
$$i(t) = \frac{1}{L} \int_{t_0}^t V(t) dt + i(t_0)$$

* $i(t)$, bobinin üzerinde depolanan akımdır.

* Kondansatörde depoladığı maximum voltaja bakacağız.

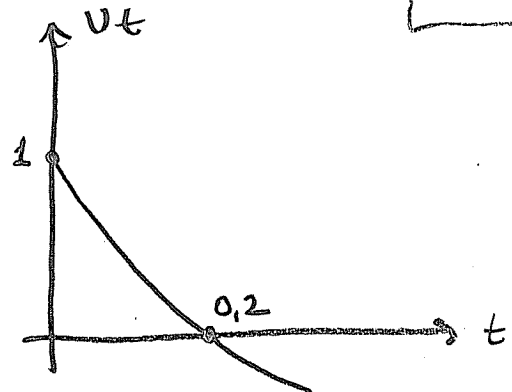
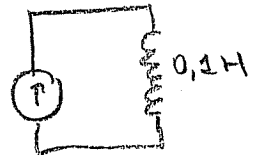
$$** \frac{di(t)}{dt} = 10 e^{-\frac{1}{0,2}t} (1 - 5t) \quad t = 0,2 \text{ s verelim.}$$

↳ Her sistem için verilen akım kaynağı farklıdır.
Bu yüzden grafik farkı çıkar.



(grafiklerin çözümü
güs ve enerjide.)

* Bir $t=0$ anına bir de $t=\max$ ve $t=\infty$ anındaki durumları inceleyeceğiz.



GÜÇ VE ENERJİ:

* Bir önceki formülden yola çıkılarak, bundan böyle zamanın fonksiyonu

$$P = V \cdot i = \left[L \cdot \frac{di(t)}{dt} \right] i(t) \rightarrow \text{önceki formüle gidiyoruz.}$$

$$= V(t) \left[\frac{1}{L} \int_{t_0}^t V(t) dt + i(t_0) \right]$$

$$P = \frac{dW}{dt} = L \cdot i(t) \cdot \frac{di(t)}{dt}$$

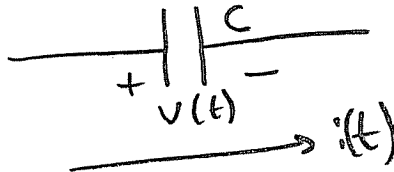
↓ gücü biliyorsak oradan enerjiyi hesaplayabiliriz.

$$\int_0^W dW = L \int_0^I i(t) di(t) \Rightarrow \boxed{W = \frac{1}{2} L I^2}$$

(Sayfa 2'deki grafikleri incele)

KONDANSATÖR

* Akımın ve Voltajın yönünü belirteceğiz.

$$i(t) = C \frac{dV(t)}{dt}$$


* Elektrik akımı, yüklerin yön değiştirmesi

$$C \cdot dV(t) = i(t) \cdot dt$$

$$\int_{V(t_0)}^{V(t)} V(t) = \frac{1}{C} \int_{t_0}^t i(t) \cdot dt \Rightarrow V(t) = \frac{1}{C} \int_{t_0}^t i(t) dt + V(t_0)$$

Güç ve Enerji:

$$P = i \cdot V = i(t) \left[\frac{1}{C} \cdot \int_{t_0}^t i(t) \cdot dt \right]$$

$$= \left[C \cdot \frac{dV(t)}{dt} \right] \cdot V(t)$$

$$P(t) = \frac{dw}{dt} = V \left(C \cdot \frac{dV}{dt} \right)$$

$$\int_0^w dw = C \int_0^V V \cdot dV \Rightarrow \boxed{w = \frac{1}{2} C V^2}$$

* Her seferinde bir akım kaynağı olacak.

Örnek:

$V(t) = 0$	$t < 0$
$V(t) = 4t$	$0 \leq t \leq 1$
$V(t) = 4 \cdot e^{-(t-1)}$	$1 \leq t < \infty$

$$C = 0,5 \mu F$$

$$i'(t) = C \cdot \frac{dV}{dt}$$

$$C = 0,5 \times 10^{-6} F$$

$$i(t) = (0,5 \times 10^{-6}) \cdot 0 = 0 \rightarrow t < 0 \text{ aralığında.}$$

$$i(t) = (0,5 \times 10^{-6}) \cdot 4 = 2 \mu A \rightarrow 0 \leq t \leq 1 \text{ aralığında.}$$

(Zamana göre türevini alıyoruz.)

$$i(t) = (0,5 \times 10^{-6}) \cdot (1 - 4 \cdot e^{-(t-1)}) = -2e^{-(t-1)}$$

türev alıyoruz.

Güç için; $P = V \cdot i$

1. Aralık $\rightarrow P = V \cdot i = 0$

2. " $\rightarrow P = (4t) \times 2 = 8t$

3. " $\rightarrow P = (4e^{-(t-1)}) \cdot (-2e^{-(t-1)})$
 $= -8e^{-2(t-1)}$

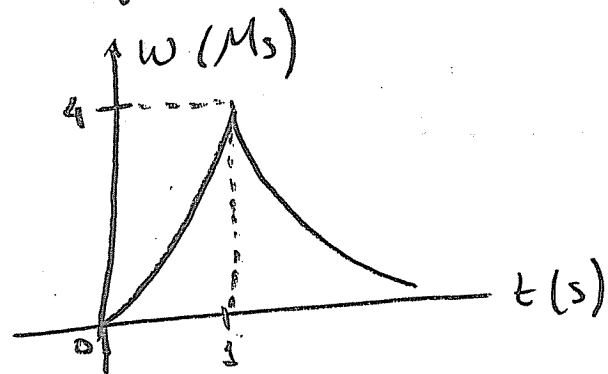
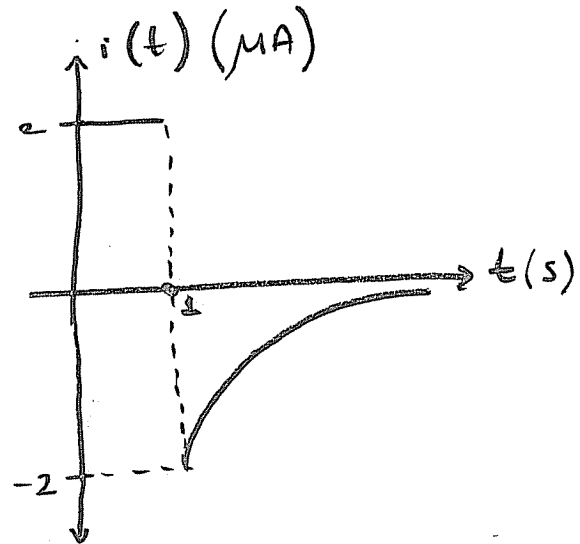
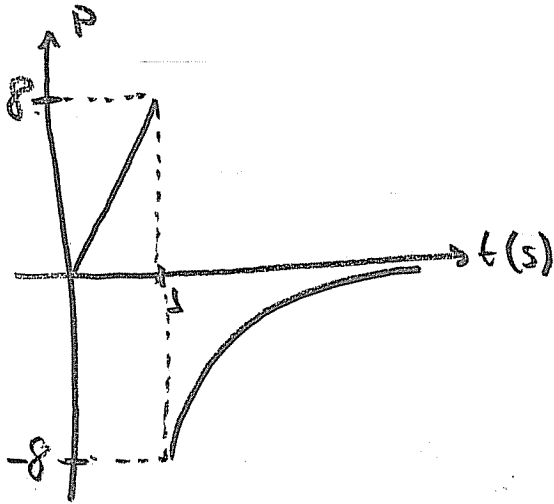
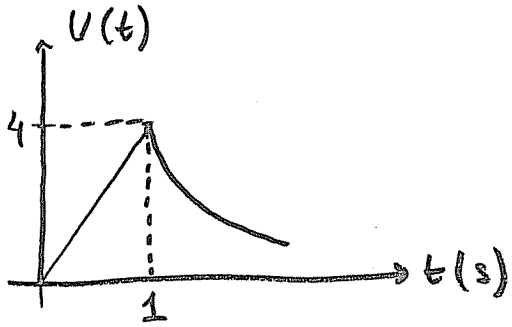
Enerji için $w = \frac{1}{2} C V^2$

1. Aralık $\rightarrow w = 0$

2. Aralık $= \frac{1}{2} \cdot (0,5 \times 10^{-6}) (4t)^2 = 4t^2 \mu J$

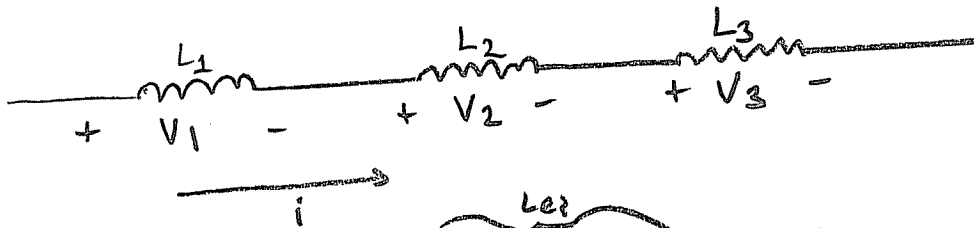
3. Aralık $= \frac{1}{2} (0,5 \times 10^{-6}) (4 \cdot e^{-(t-1)})^2$
 $= 4e^{-2(t-1)} \mu J$

Grafikler:

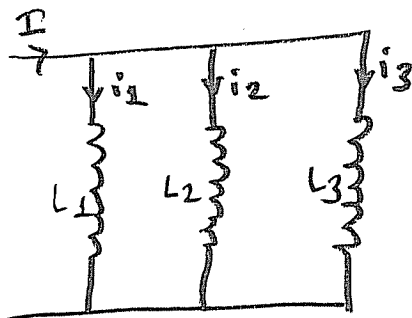


Seri Bağlı ve Paralel Bağlı Birimler:

$$V_1 = L_1 \frac{di}{dt} \quad V_2 = L_2 \frac{di}{dt} \quad V_3 = L_3 \frac{di}{dt}$$



$$V = V_1 + V_2 + V_3 = \frac{di}{dt} (L_1 + L_2 + L_3) \Rightarrow L_{eq} = L_1 + L_2 + L_3$$



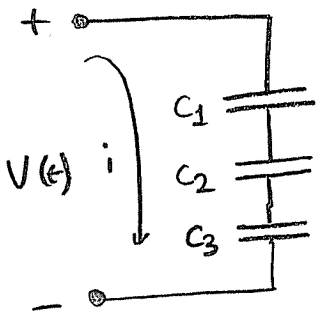
$$i = i_1 + i_2 + i_3$$

$$= \frac{1}{L_1} \int V(t) dt + \frac{1}{L_2} \int V(t) dt + \frac{1}{L_3} \int V(t) dt$$

$$\Rightarrow \frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

6

Seri Bağlı Kondansatörler:



$$V_1(t) = \frac{1}{C_1} \int i(t) dt + V_1(t_0)$$

$$V_2(t) = \frac{1}{C_2} \int i(t) dt + V_2(t_0)$$

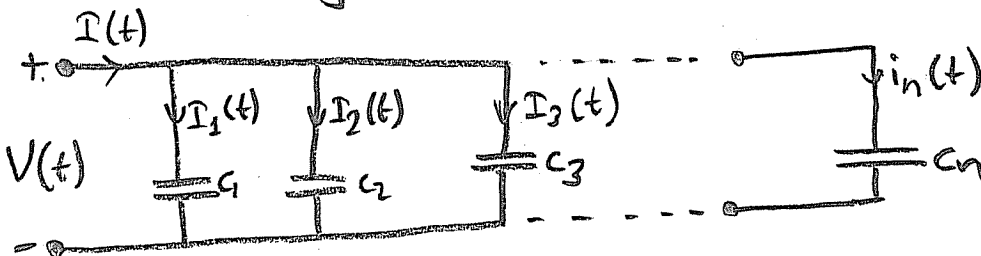
$$V_3(t) = \frac{1}{C_3} \int i(t) dt + V_3(t_0)$$

$$V(t) = V_1(t) + V_2(t) + V_3(t) + \dots + V_n(t)$$

$$\Rightarrow V(t) = \left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_2} + \dots + \frac{1}{C_n} \right] \int_0^t i(t) dt + \underbrace{(V_1(t_0) + V_2(t_0) + \dots + V_n(t_0))}_{V(t_0)}$$

$$\Rightarrow \frac{1}{C_{es}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}$$

Paralel Bağlı Kondansatör:



$$i(t) = i_1(t) + i_2(t) + i_3(t) + \dots + i_n(t)$$

$$i_1(t) = C_1 \cdot \frac{dV(t)}{dt} + i_1(t_0)$$

$$i_2(t) = C_2 \cdot \frac{dV(t)}{dt} + i_2(t_0)$$

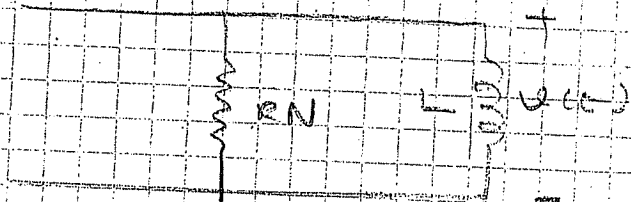
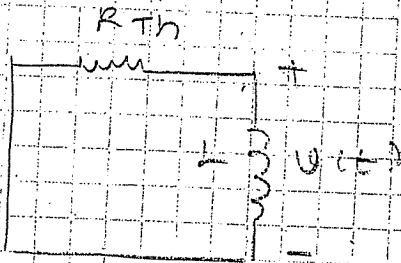
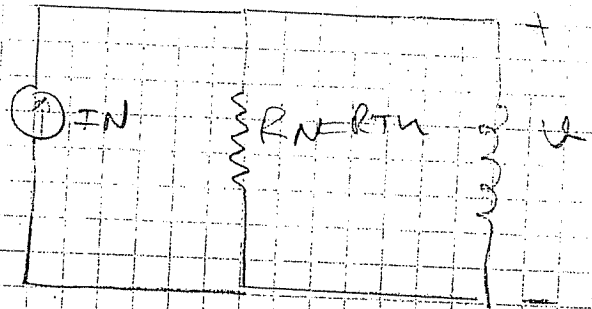
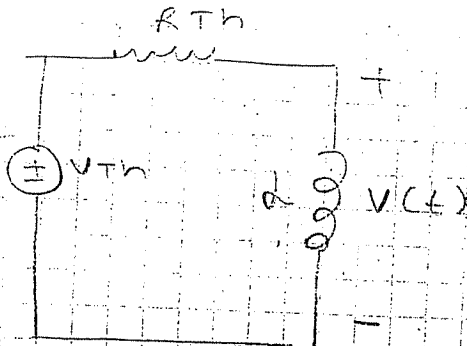
$$i_n(t) = C_n \cdot \frac{dV(t)}{dt} + i_n(t_0)$$

$$i(t) = i_1(t) + i_2(t) + i_3(t) + \dots + i_n(t)$$

$$= (C_1 + C_2 + C_3 + \dots + C_n) \frac{dV(t)}{dt} + \underbrace{(i_1(t_0) + i_2(t_0) + \dots + i_n(t_0))}_{i(t_0)}$$

$$C_{es} = C_1 + C_2 + C_3 + \dots + C_n$$

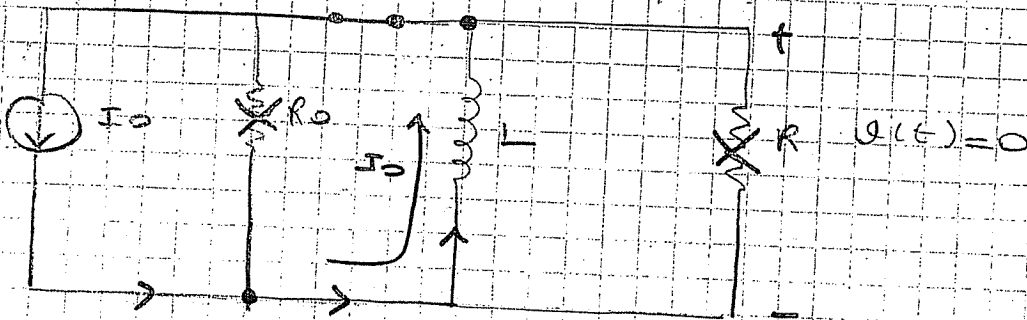
* One Thevenin $\Rightarrow$ diğer devreyi besliyor. V_E



* Anahtar kapalıken;

* Anahtar açıkken;

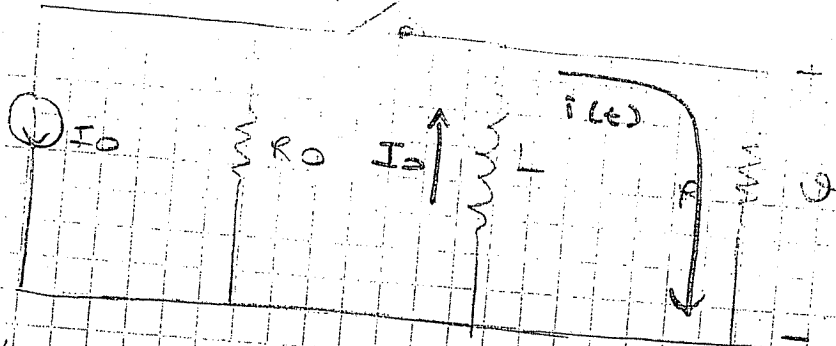
$\rightarrow$ Analizi 3'e indiririz
(Anahtar kapalı)



$t < 0$ anahtar kapalı

Akım dirençin küçük olduğu yerden yeni bölüme geçer)

$t=0$ anahtar açılır



*Kısaca: Akım o anda gelge bobinin üzerinden
akım kollar, o da R'na üzerinden dolaşarak
Zamanla azalır (isi enerjisi ısıya dönüşür)
bu nedenle)

$t < 0$

$$L \frac{di(t)}{dt} + Ri(t) = 0$$

$i(t)$

$$\int_{I(0)}^i \frac{di(t)}{i(t)} = - \frac{R}{L} \int_0^t dt \quad (\text{Akım zamanla azalır})$$

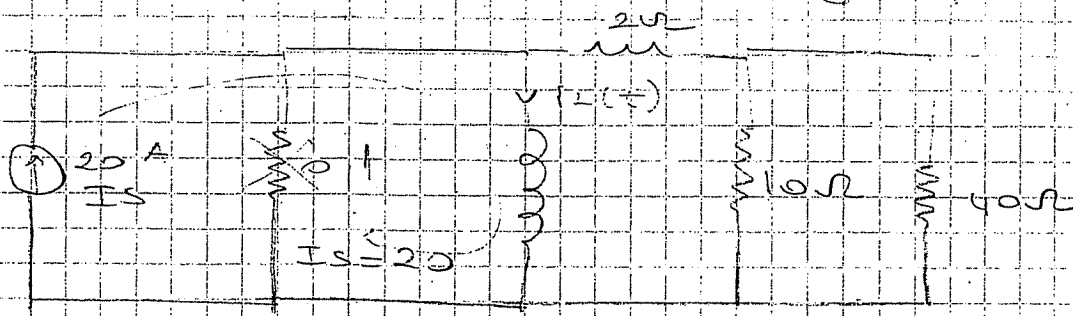
$$\ln \frac{i(t)}{i(0)} = - \frac{R}{L} t$$

$$\frac{i(t)}{i(0)} = e^{-\frac{R}{L} t}$$

$$i(t) = i(0) \cdot e^{-\frac{R}{L} t}$$

7.5k

* Analyse schaltung für $i_L(t)$?



$$I_L(0^-) = I_s = 20A$$

$$R_{eq} = 2 + 10 // 40 = 10\Omega$$

$$\tau = \frac{L}{R_{eq}} = \frac{2}{10} = 0.2s$$

$$I_L(t) = I_s \cdot e^{-\frac{t}{\tau}} = 20 \cdot e^{-5t}$$

a.) $i_o(t) = ?$ $i_o(t) = \frac{10}{10+40} [-i_L(t)] = -4e^{-5t}$

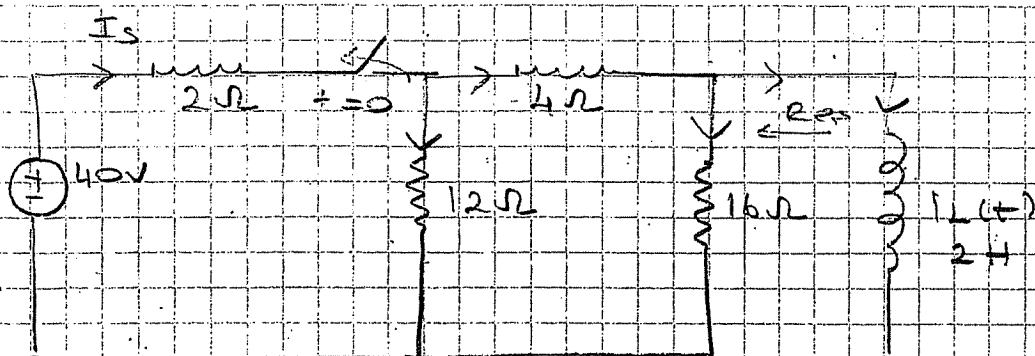
b.) $i_L(t) = 40$ $i_o(t) = -160e^{-5t}$

c.) $P_{10\Omega} = \frac{10i_o^2(t)}{10} = \frac{(-160 \cdot e^{-5t})^2}{2} = 2560e^{-10t} W$

d.) $W_{10\Omega} = \int_0^\infty P_{10\Omega} dt = \int_0^\infty 2560e^{-10t} dt = 256J$

$$W(0) = \frac{1}{2} i_L(0)^2 = 400J$$

$$\frac{256}{400} \times 100 = 64\%$$



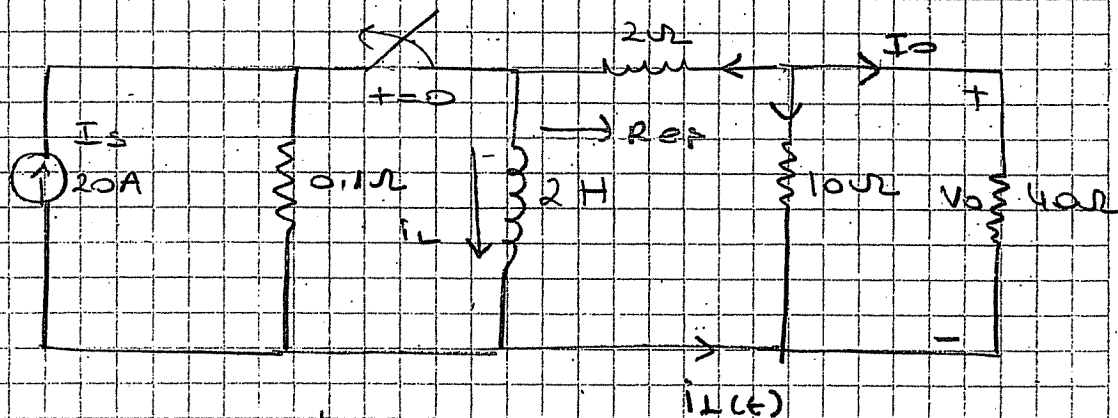
$t \geq 0$

$$\tau = \frac{L_{eq}}{R_{eq}} = \frac{2}{8} = \frac{1}{4} \text{ s}$$

$$R_{eq} = (4 + 12) // 16 = 8 \Omega$$

$$i_L(t) = i_L(0) e^{-t/\tau} = 6 e^{-4t}$$

break:



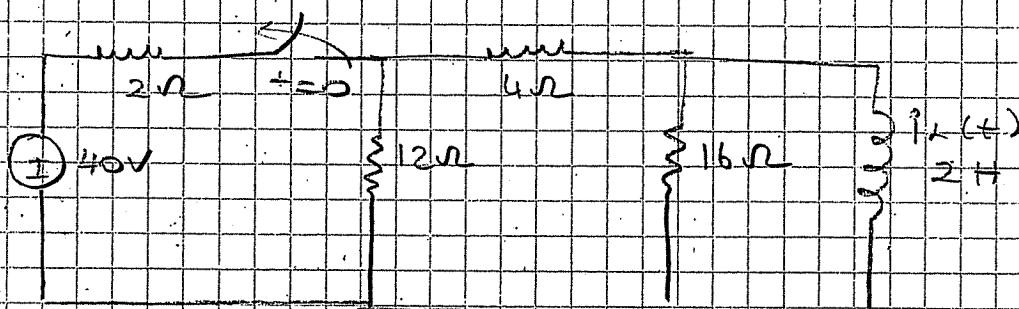
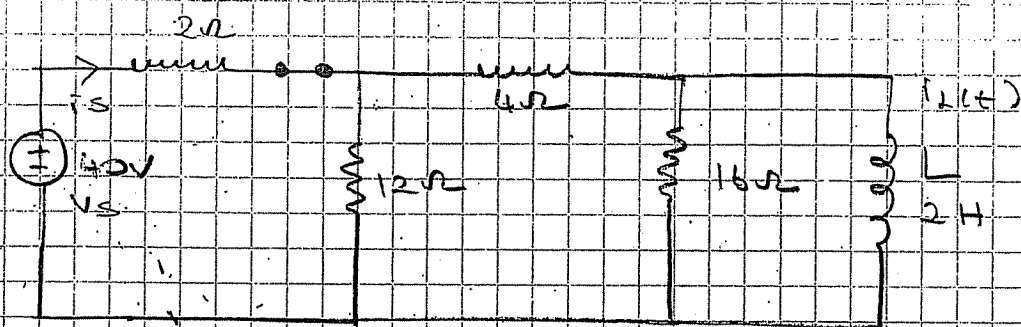
For $t < 0$, $i_L = 0$, $t \geq 0$, $i_L = ?$

$$t \geq 0 \quad i_L(t) = ? \quad V_o(t) = ? \quad P_{10\Omega} = ?$$

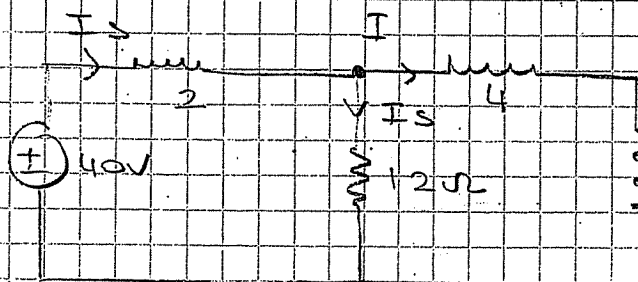
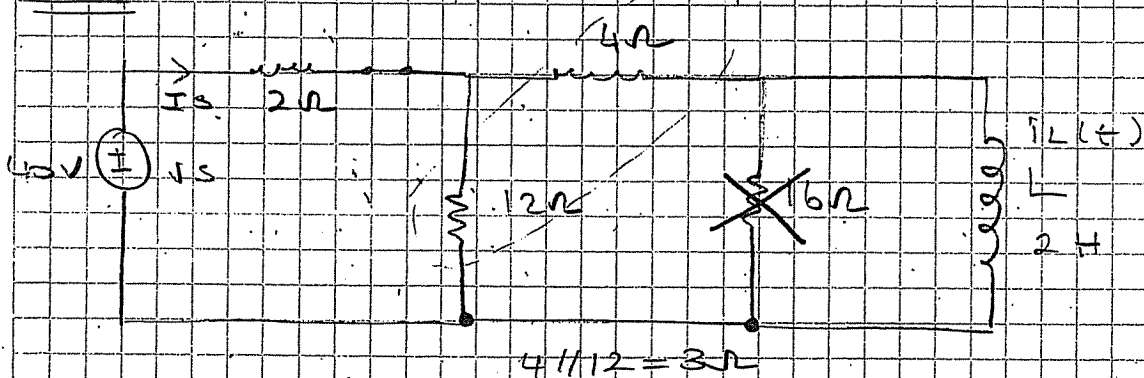
Zaman Sabitli:

$$\tau = \frac{L_{eq}}{R_{eq}} \quad i(t) = I_0 e^{-\left(\frac{R}{L}\right)t} = I_0 e^{-\frac{t}{\tau}}$$

$t < 0$

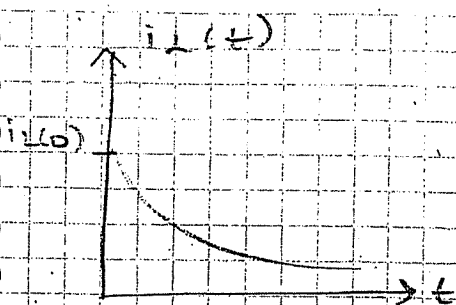


$t > 0$



$$I_S = \frac{40}{2+3} = 8$$

$$i_L(0) = \frac{12(8)}{12+4} = 6$$



$t \geq 0$

$$v(0^+) = I_0 \cdot R$$

$$v(t) = \left(i_L(0) \cdot e^{-R/L \cdot t} \right) \cdot R$$

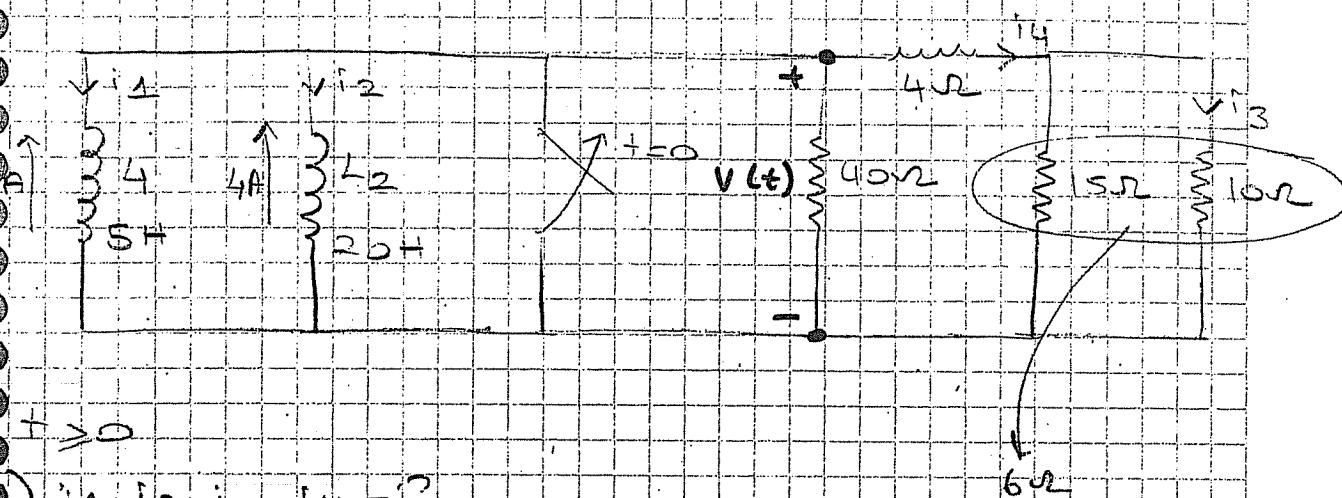
$\underbrace{\hspace{10em}}_{i_L(t)}$

$$= I_0 R e^{-\frac{R}{L} t}$$

$$P(t) = \frac{[v(t)]^2}{R} = \frac{I_0^2 R^2}{R} e^{-\frac{2R}{L} t}$$

$$P(t) = I_0^2 R e^{-\frac{2R}{L} t}$$

$$W = \int_0^t P(t) dt = \frac{1}{2} L I_0^2 \left(1 - e^{-2 \left(\frac{R}{L} \right) t} \right)$$



$t \geq 0$

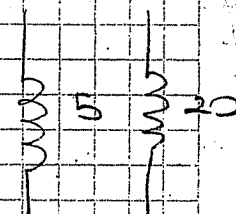
a) $i_1, i_2, i_3, i_4 = ?$

b) $i_L(0^+) = ?$
 L_1, L_2

c) $i_L(\infty) = ?$
 L_1, L_2

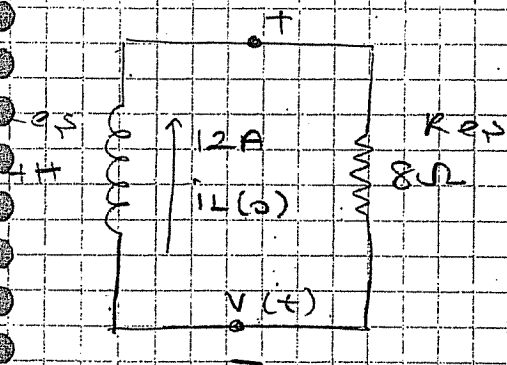
$$L = \frac{L_{eq}}{R_{eq}} = L_{eq} = \frac{5 \times 20}{5 + 20} = \frac{4}{1} \text{ H}$$

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}$$



$$R_{eq} = 40 \parallel (4 + (15 \parallel 10)) = 8 \Omega$$

$$\tau = \frac{L}{R} = \frac{4}{8} = \frac{1}{2} = 0.5 \text{ s}$$



(Es d'après cours)

$$i(t) = 12 \cdot e^{-t/\tau}$$

$$= 12 \cdot e^{-2t}$$

$$V(t) = 8 i(t)$$

$$= 8 \times 12 \cdot e^{-2t} = 96 e^{-2t}$$

$$a) i_1(t) = \frac{1}{L_1} \int_0^t v(t) dt + i_1(0)$$

$$= \frac{1}{5} \int_0^t 96 e^{-2t} dt + (-8)$$

$$= 1.6 - 9.6 e^{-2t}$$

$$i_2(t) = \frac{1}{L_2} \int_0^t 96 e^{-2t} dt + (-4)$$

$$= -1.6 - 2.4 e^{-2t}$$

$$i_3(t) = \frac{15 \times i_4(t)}{(15+10)}$$

$$i_4(t) = \frac{96 e^{-2t}}{4 + (15/10)}$$

$$= 9.6 e^{-2t}$$

$$= \frac{15}{25} \cdot 9.6 e^{-2t}$$

$$= 5.76 e^{-2t}$$

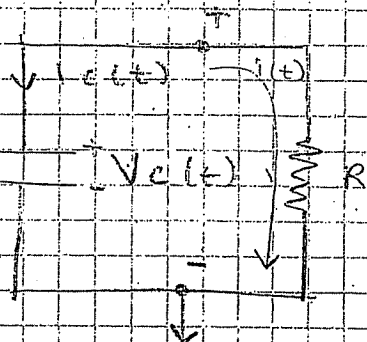
$$b) w(0^+) = \frac{1}{2} L_1 i_1(0)^2 + \frac{1}{2} L_2 i_2(0)^2$$

$$= \frac{1}{2} 5 \times (8)^2 + \frac{1}{2} 20 \cdot (4)^2 = 320 \text{ J}$$

$$c) w(\infty) = \frac{1}{2} 5 \cdot (1.6)^2 + \frac{1}{2} 20 \cdot (-1.6)^2 = 320 \text{ J}$$

Değerleri:

$C = R \cdot C \cdot C_0$



$$i_C = C \frac{dV_C(t)}{dt}$$

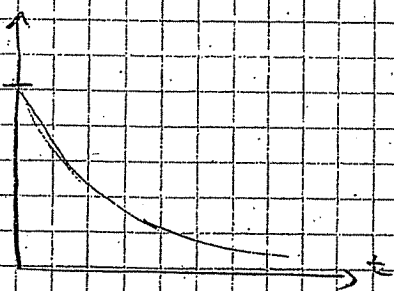
$$C \frac{dV_C(t)}{dt} + \frac{V_C(t)}{R} = 0$$

$$\frac{dV_C(t)}{dt} = -\frac{V_C(t)}{R \cdot C}$$

$$\int_{V(0)}^{V(t)} \frac{dV_C(t)}{V_C(t)} = -\frac{1}{R \cdot C} \int_0^t dt$$

$$\ln \left(\frac{V_C(t)}{V_C(0)} \right) = -\frac{1}{R \cdot C} t$$

$$\frac{V_C(t)}{V_C(0)} = e^{-\frac{t}{R \cdot C}} \quad (V_C(t) = V_C(0) e^{-\frac{t}{R \cdot C}})$$



$$i(t) = \frac{V(t)}{R} = \frac{V(0)}{R} e^{-\frac{t}{R \cdot C}}$$

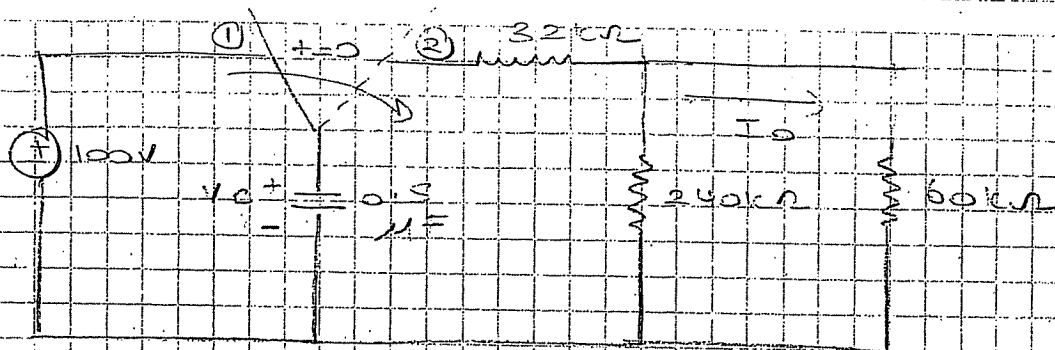
$$= \frac{V(0)}{R} e^{-\frac{t}{\tau}}$$

$$P = i \cdot V$$

$$= \left(\frac{V(0)}{R} \right) \cdot \left(\frac{V(0)}{R} e^{-\frac{t}{\tau}} \right)$$

$$W = \int_0^t P(t) \cdot dt$$

Örnek:



a.) $V_c(t) = ?$ b.) $V_o(t) = ?$ c.) $I_o(t) = ?$

$$V_c(t) = V_c(0) e^{-t/\tau}$$

$$R_{eq} = 32 + \underbrace{(240 // 60)}_{48} = 80k\Omega$$

$$\tau = R_{eq} \cdot C = (80k\Omega) (0.5\mu F) = 40ms$$

$$V_c(t) = 100 e^{-t/40ms} = 100 e^{-25t}$$

10^{-3}

$$\frac{-t}{4 \cdot 10^{-2}} = -\frac{t \cdot 100}{4}$$

? b.) $V_o(t) = \frac{48 \times V_c(t)}{32 + 48} = \frac{48 \times 100 e^{-25t}}{80k\Omega} = 60 e^{-25t}$

c.) $I_o(t) = \frac{V_o(t)}{60k\Omega} = \frac{60 e^{-25t}}{60k\Omega} = e^{-25t} \text{ mA}$

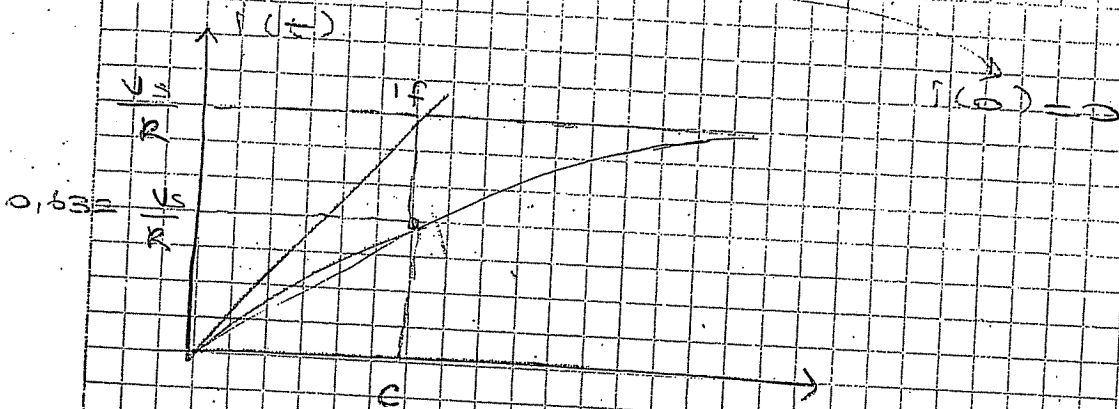
d.) $P_{60k\Omega} = I_o^2(t) \times 60k\Omega$

$$= (e^{-25t})^2 \cdot 60k\Omega = 60 \cdot e^{-50t} \text{ mW}$$

$$Kond: Z = R \times C$$

$$Robin: Z = R \parallel L$$

$$i_L(t) = i_f + [i(0) - i_f] e^{-\frac{t}{\tau}}$$



Formulas =

$$i_L(t) = \frac{V_s}{R} - \frac{V_s}{R} e^{-\frac{t}{\tau}}$$

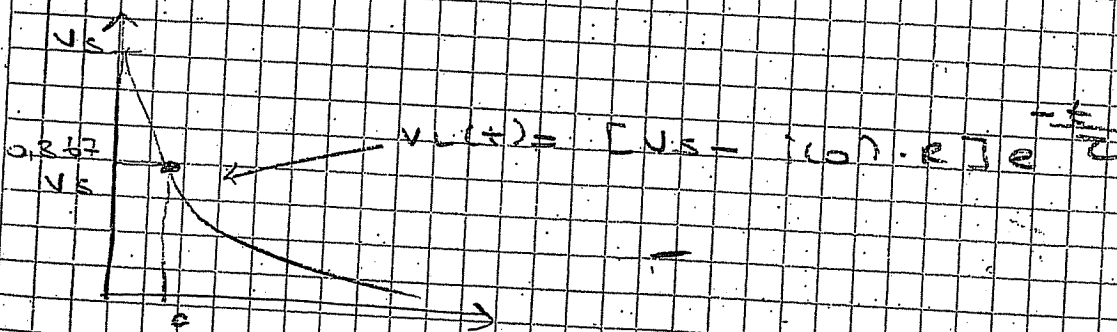
$$= 0.632 \frac{V_s}{R}$$

(t yeme τ logluk)

$$i(t) = \frac{V_s}{R} + [i(0) - \frac{V_s}{R}] e^{-\frac{t}{\tau}}$$

(t yeme τ logluk) τ dir t yeme τ logluk $(+ V_s$ göre t yeme τ)

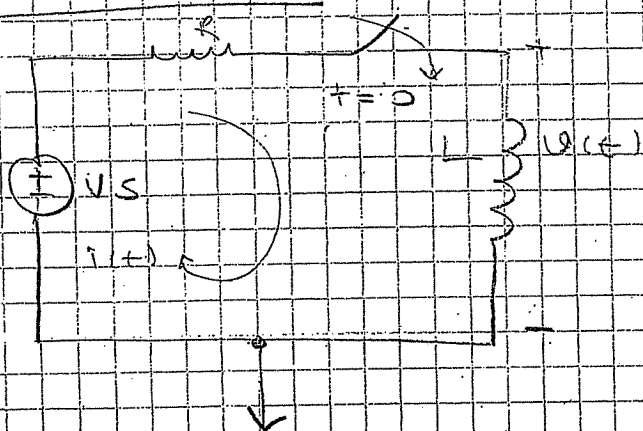
$$V_L(t) = L \frac{di(t)}{dt} = [V_s - i(0) \cdot R] e^{-\frac{t}{\tau}}$$



$$w_{60\mu s} = \int_0^{\infty} \frac{p(t)}{60\mu s} dt = \int_0^2 60 e^{-50t} dt$$

$$= 1.2 \text{ mJ}$$

STEP RESPONSE:



$$-V_S + R i(t) + L \frac{di(t)}{dt} = 0$$

$$\frac{di(t)}{dt} = \frac{V_S}{L} - \frac{R}{L} i(t)$$

$$= -\frac{R}{L} \left(i(t) - \frac{V_S}{R} \right)$$

$$\int_{i(0)}^{i(t)} \frac{di(t)}{\left[i(t) - \frac{V_S}{R} \right]} = -\frac{R}{L} \int_0^t dt$$

$$e^{\ln \left[i(t) - \frac{V_S}{R} \right]} = e^{-\frac{R}{L} t}$$

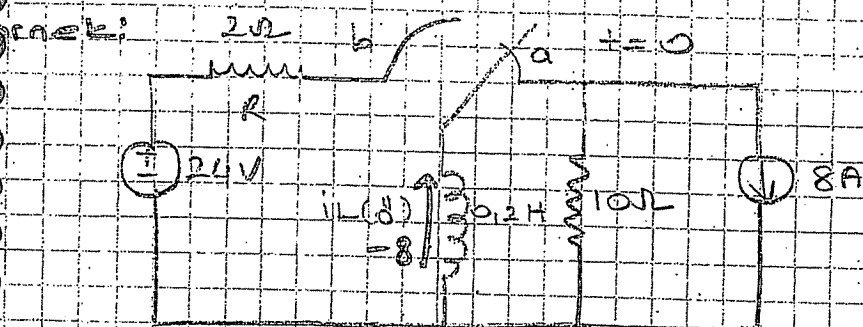
$$\left[i(t) - \frac{V_S}{R} \right] = \left[i(0) - \frac{V_S}{R} \right] e^{-\frac{R}{L} t}$$

$$\tau = L/R$$

$$\left[i(t) - \frac{V_S}{R} \right] = \left[i(0) - \frac{V_S}{R} \right] e^{-\frac{R}{L} t}$$

$$i(t) = \underbrace{\frac{V_S}{R}}_{i(\infty)} + \left[i(0) - \underbrace{\frac{V_S}{R}}_{i(\infty)} \right] e^{-\frac{t}{\tau}}$$

en son o baki ekimin üzeri



a) $i_L(t) = ?$ $t \geq 0$ $i_L(t) = i_f + [i(0) - i_f] e^{-t/\tau}$

Eğer $0.2H$ yerine direnci olsaydı Akım $10A$ den da geçirdi.

$$i_f = \frac{V_s}{R} = \frac{24}{2} = 12A \quad i_f: \text{son durum}$$

$$i_L(t) = 12 + [-8 - 12] e^{-\frac{(R)}{L}t}$$

$$= 12 - 20 e^{-\left(\frac{2}{0.2}\right)t} = 12 - 20 e^{-10t}$$

$$\tau = \frac{L_{es}}{R_{es}}$$

şimdi

* $11k$ b den a ya $R_{es} = 10$ olurdu.

* 2Ω b ya a göre $R_{es} = 2\Omega$

b) $V_L(t) = ?$

$$L \frac{di_L(t)}{dt} = (0.2) \cdot (-20) \cdot (-10 e^{-10t}) = 40 e^{-10t}$$

c) V ne zaman $24V$ olur?

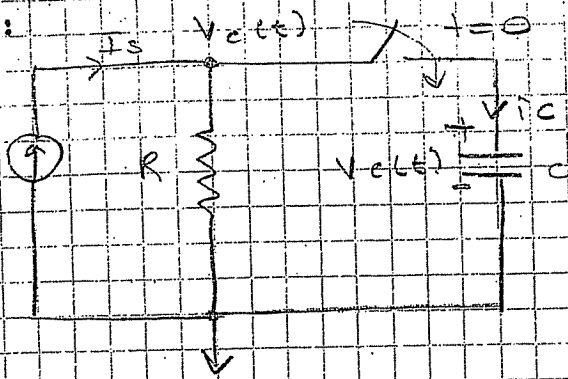
(Bobinin üstündeki akım ne zaman $24V$ olur)

$$V_L(t) = 40 e^{-10t} = 24$$

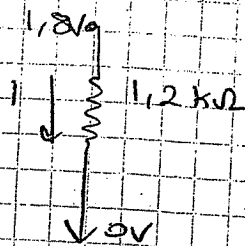
$$t = 51.08 \text{ ms}$$

$$V_L \frac{di}{dt}$$

Örnek:



* (Normalde bu devre herhangi bir devrenin norton
es örneği devresi)



$$I = \frac{U}{R} = \frac{1.8}{1.2 \text{ k}\Omega \times 10^3} = \underline{\underline{1.5 \text{ mA}}}$$

(ideal kabl etkisi)

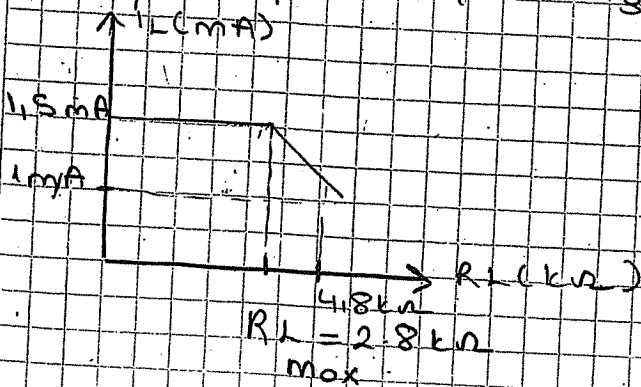
$$\frac{1.8 - 0}{1.2} = \underline{\underline{1.5 \text{ mA}}}$$

Sonuçları: 6V'den daha yukarı çıkamaz!
6V, -6V arası değişmesi.

$$U_0 = \underbrace{(1.2 + 1.8) \text{ k}\Omega}_{\underline{\underline{R_L}}} \times 1.5 = 4.5 \text{ V} < 6 \text{ V}$$

(değer tabiri ile)

b) $R_L \text{ max?}$ (Çıkışı 6V getirdiğimiz zaman $R_L \text{ max?}$)



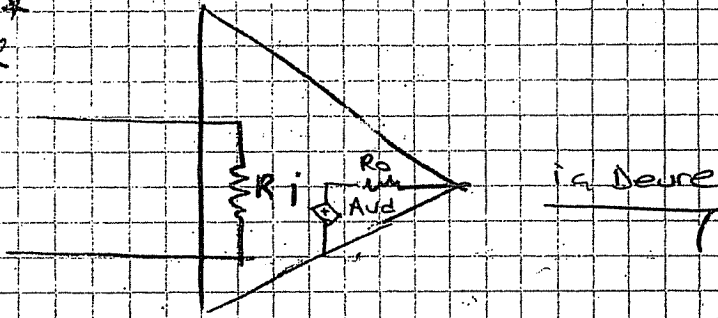
$$6 = (1.2 + R_L) \cdot 1.5$$

$$R_L \text{ max} = 2.8 \text{ k}\Omega$$

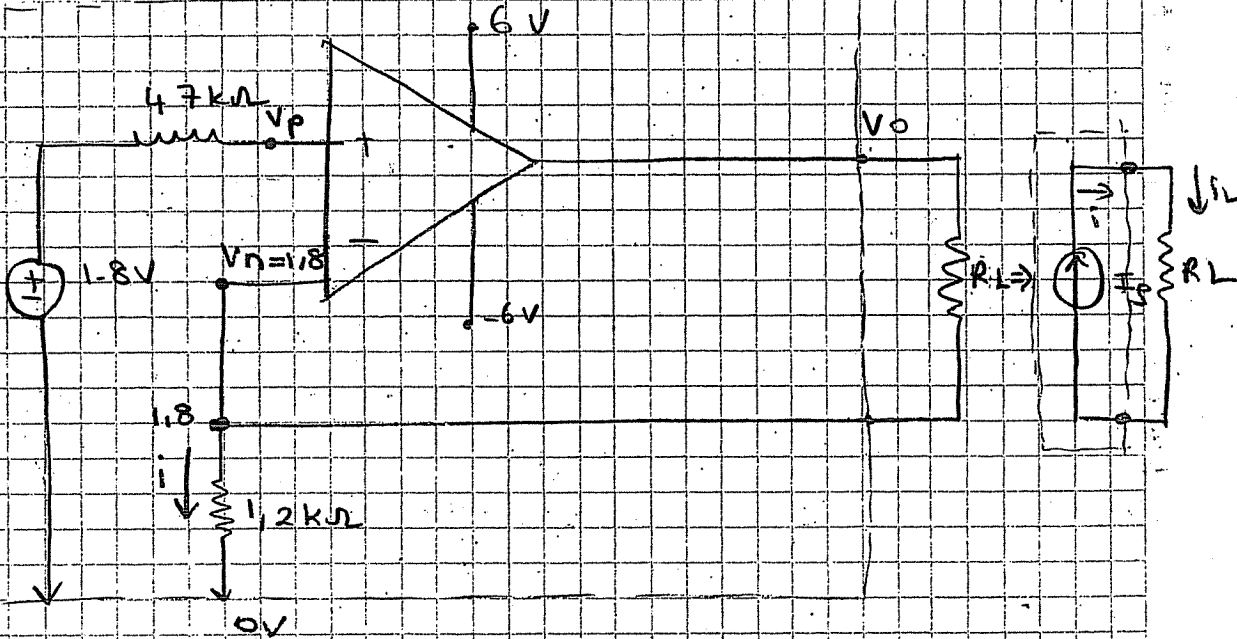
c) $R_L = 4.8 \text{ k}\Omega$ için $I_L = ?$

$$6 = (1.2 + 4.8) I_L \quad I_L = 1 \text{ mA}$$

$$V_1 = \frac{2 \times 2 - 3.9999398}{3} = 20.06667 \text{ mV}$$



örnek: Current source



$$R_L = 1.8 \text{ k}\Omega \text{ için } R_L = ?$$

$$i_p = 0 \quad i_n = 0 \quad \text{ideal}$$

R_L yok (R_L etkisini incelemek istiyorsanız önce

0 aldık yani R_L 'yi

etrip R_L 'nin i o kımını nasıl

etkiletiğini inceleyeceğiz)