

BİR ENERJİ DEPOLAMA ELEMANLI SABİT BAĞIMSIZ KAYNAKLI DEVRELERİN ANALİZİ

ADIM ADIM YAKLAŞIM

BU YAKLAŞIM ÇÖZÜMÜN BİLİNER FORMUNA DAYANIR, ANCAK TEMEL DEVRE ANALİZ ARAÇLARI KULLANILARAK K_1, K_2, τ SABİTLERİ BULUNUR.

$$x(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$$

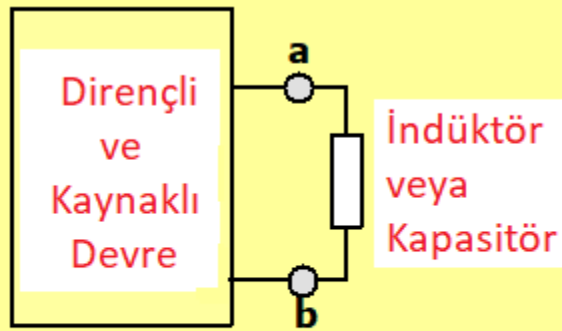
K_1 : ilgili degiskenin kalici durum degeridir ve devre kalici durumda analiz edilerek bulunabilir

$x(0+)$: baslangic sartidir ve K_1, K_2 sabitlerini hesaplamak icin ikinci denklemini saglar

τ : zaman sabitidir ve depolama elemani uclarina göre Thevenin esdegerinden belirlenebilir

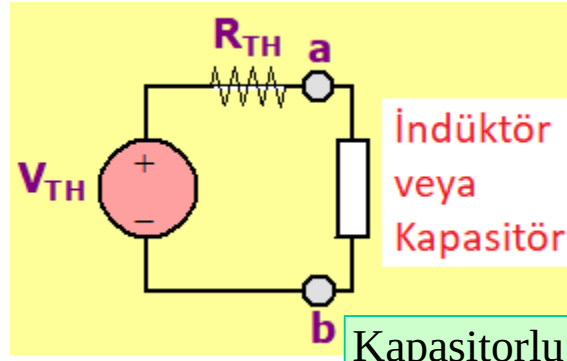
TEK DEPOLAMA ELEMANLI DEVRE

Zaman sabitinin elde edilmesi: Genel Yaklaşım



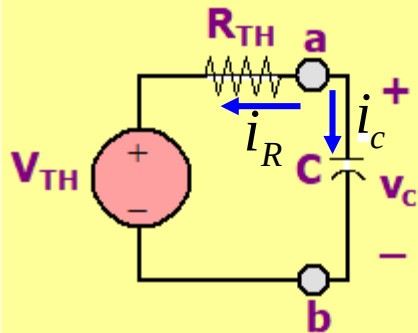
Tek depolama elemanlı devrenin temsili

→ Thevenin



Kapasitorlu Devre $\tau = R_{TH} C$

İndüktör Devre $\tau = \frac{L}{R_{TH}}$



Durum 1.1

Kapasitör uçlarındaki gerilim

Düğüm a'ya KAK

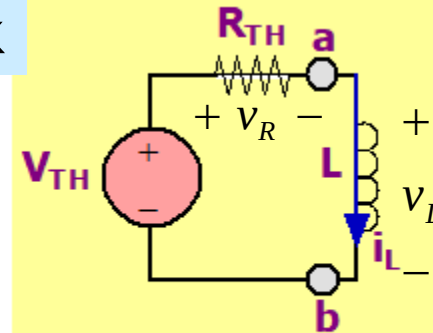
$$i_C + i_R = 0$$

$$i_C = C \frac{dv_C}{dt}$$

$$i_R = \frac{v_C - v_{TH}}{R_{TH}}$$

$$C \frac{dv_C}{dt} + \frac{v_C - v_{TH}}{R_{TH}} = 0$$

$$R_{TH} C \frac{dv_C}{dt} + v_C = v_{TH}$$



Durum 1.2

İndüktörden geçen akım

KGK KULLAN

$$v_R + v_L = v_{TH}$$

$$v_R = R_{TH} i_L$$

$$v_L = L \frac{di_L}{dt}$$

$$L \frac{di_L}{dt} + R_{TH} i_L = v_{TH}$$

$$\left(\frac{L}{R_{TH}} \right) \frac{di_L}{dt} + i_L = \frac{v_{TH}}{R_{TH}} = i_{SC}$$

ADIMLAR

ADIM 1. ÇÖZÜMÜN BİÇİMİ

$$x(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$$

$$K_1 = x(\infty); K_1 + K_2 = x(0+)$$

$x(0+)$ 'i belirleyin

ADIM 2: ANAHTARLAMADAN ÖNCE KALICI DURUMDA DEVREYİ ÇİZİN VE KAPASİTÖR GERİLİMİNİ VEYA İNDÜKTÖR AKIMINI BELİRLEYİN.

ADIM 3: DEVREYİ $t=(0+)$ 'DA ÇİZİN, KAPASİTÖR BİR GERİLİM KAYNAĞI OLARAK, İNDÜKTÖR BİR AKIM KAYNAĞI OLARAK DAVRANIR. $t = (0+)$ 'DA İLGİLİ DEĞİŞKEN DEĞERİNİ BELİRLEYİN.

$x(\infty)$ 'i belirleyin

ADIM 4: ANAHTARLAMADAN SONRA DEVREYİ KALICI DURUMDA ÇİZİN VE İLGİLİ DEĞİŞKENİ KALICI DURUMDA BELİRLEYİN

ADIM 5: ZAMAN SABİTİNİ BELİRLEYİN.

$$\tau = R_{TH} C \quad \text{tek kapasitörlü devre}$$

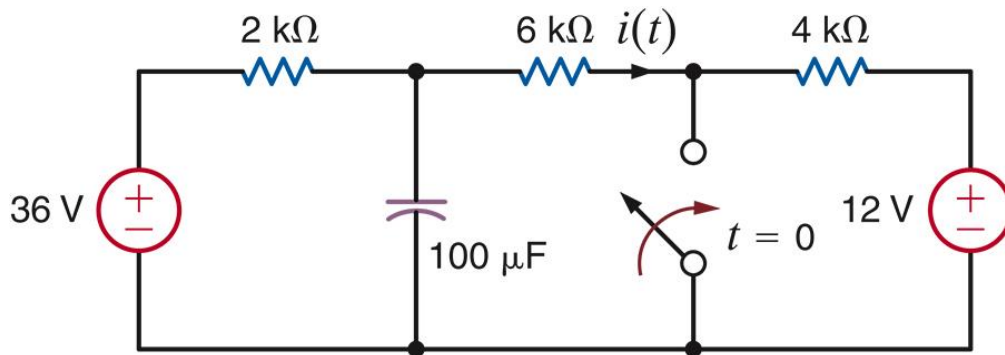
$$\tau = \frac{L}{R_{TH}} \quad \text{tek indüktörlü devre}$$

ADIM 6: K_1 , K_2 SABİTLERİNİ BELİRLEYİN

$$K_1 = x(\infty), K_1 + K_2 = x(0+)$$

ÖRNEK

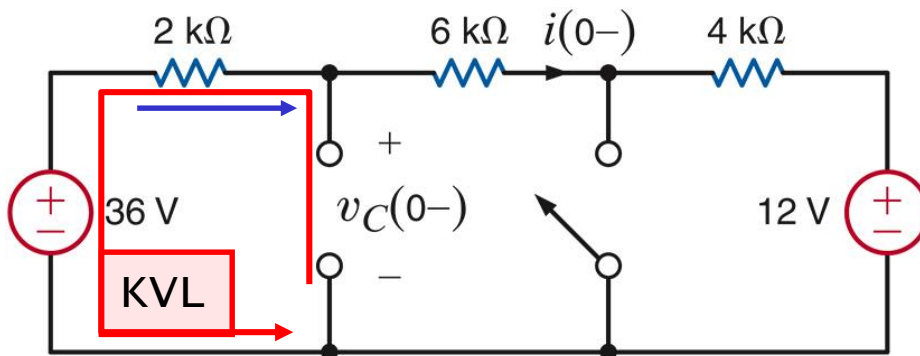
$t > 0$ için $i(t)$ 'yi bulun



ADIM 1: $i(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

ADIM 2 : Kapasitör uçlarındaki başlangıç gerilimi

ANAHTARLAMADAN ÖNCE DEVREYİ
KALICI DURUMDA KULLANIN



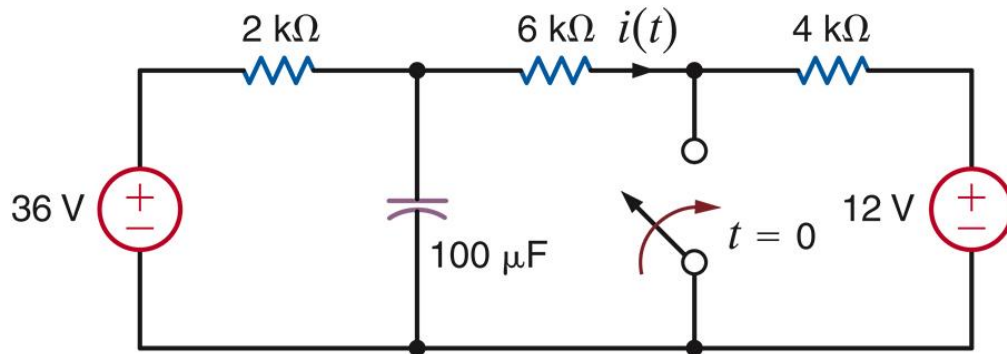
$$i = \frac{36 - 12}{(2 + 6 + 4)k\Omega} = \frac{24V}{12k\Omega} = 2mA = i(0-)$$

$$v_C(0-) = 36V - (2mA)(2k) = 32[V]$$

$$v_C(0+) = v_C(0-)$$

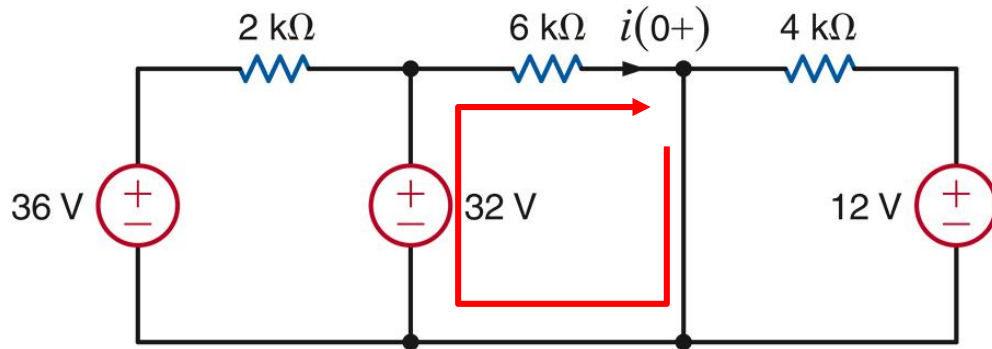
ÖRNEK - devam

$t > 0$ için $i(t)$ 'yi bulun



ADIM 3: $i(0+)$ 'yi belirleyin

$t=(0+)$ 'DA GEÇERLİ DEVREYİ KULLANIN.
KAPASİTÖR KAYNAK OLARAK DAVRANIR



$$i(0+) = \frac{32V}{6k} = \frac{16}{3} mA$$

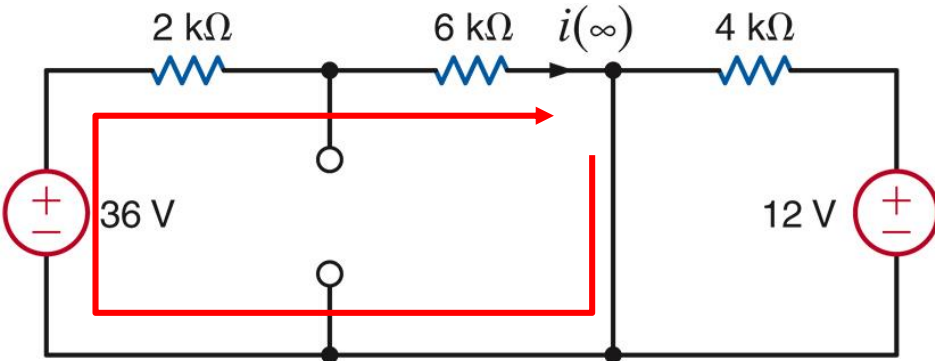
İNDÜKTİF DEVRELER İÇİN NOTLAR

(1) ADIM 2'DE İNDÜKTÖR BAŞLANGIÇ AKIMINI BELİRLEYİN

(2) $t=(0+)$ 'DAKİ DEVREDE, İNDÜKTÖRÜ BİR AKIM KAYNAĞI İLE DEĞİŞTİRİN

ADIM 4: $i(\infty)$ 'yi belirleyin

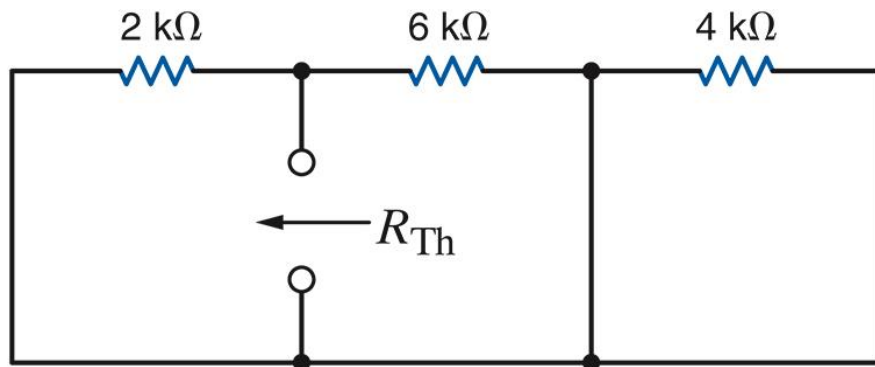
ANAHTARLAMADAN SONRA DEVREYİ
KALICI DURUMDA KULLANIN



$$i(\infty) = \frac{36}{2k + 6k} = \frac{36}{8k} = \frac{9}{2} \text{ mA}$$

ADIM 5: Zaman sabitini belirleyin

Kapazitif devre: $\tau = R_{TH} C$



$$R_{TH} = 2k \parallel 6k = 1.5k\Omega$$

$$C = 100\mu F$$

$$\tau = (1.5 \times 10^3 \Omega)(100 \times 10^{-6} F) = 0.15s$$

ADIM 6: K_1, K_2 'yi belirleyin

$$(ADIM 1) \quad i(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$$

$$(ADIM 3) \quad i(0+) = \frac{16}{3} \text{ mA} = K_1 + K_2$$

$$(ADIM 4) \quad i(\infty) = \frac{9}{2} \text{ mA} = K_1$$

$$\therefore K_2 = \frac{16}{3} - \frac{9}{2} = \frac{5}{6}$$

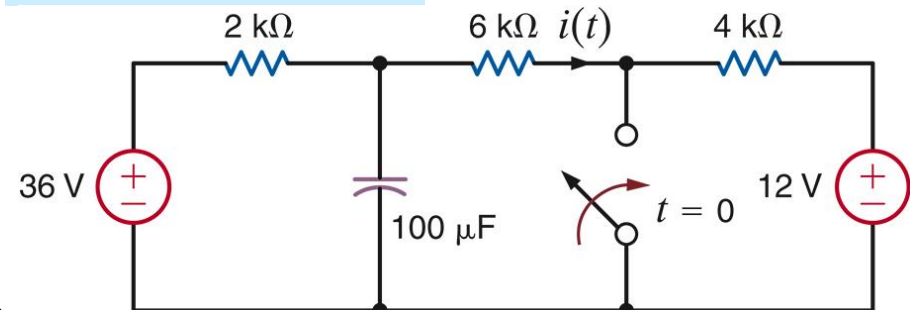
SON CEVAP

$$i(t) = \frac{9}{2} + \frac{5}{6} e^{-\frac{t}{0.15}}, t > 0$$

NOT: İNDÜKTİF DEVRE İÇİN

$$\tau = \frac{L}{R_{TH}}$$

ORJİNAL DEVRE



SON CEVABI GÖSTERMEK İÇİN MATLAB KULLANIMI

Doğrusal aralıklı dizileri tanımlamak için kullanılan komut

$$i(t) = \begin{cases} 2mA & t \leq 0 \\ \frac{9}{2} + \frac{5}{6}e^{-\frac{t}{0.15}}, & t > 0 \end{cases}$$

» help linspace

Linspace Linearly spaced vector.

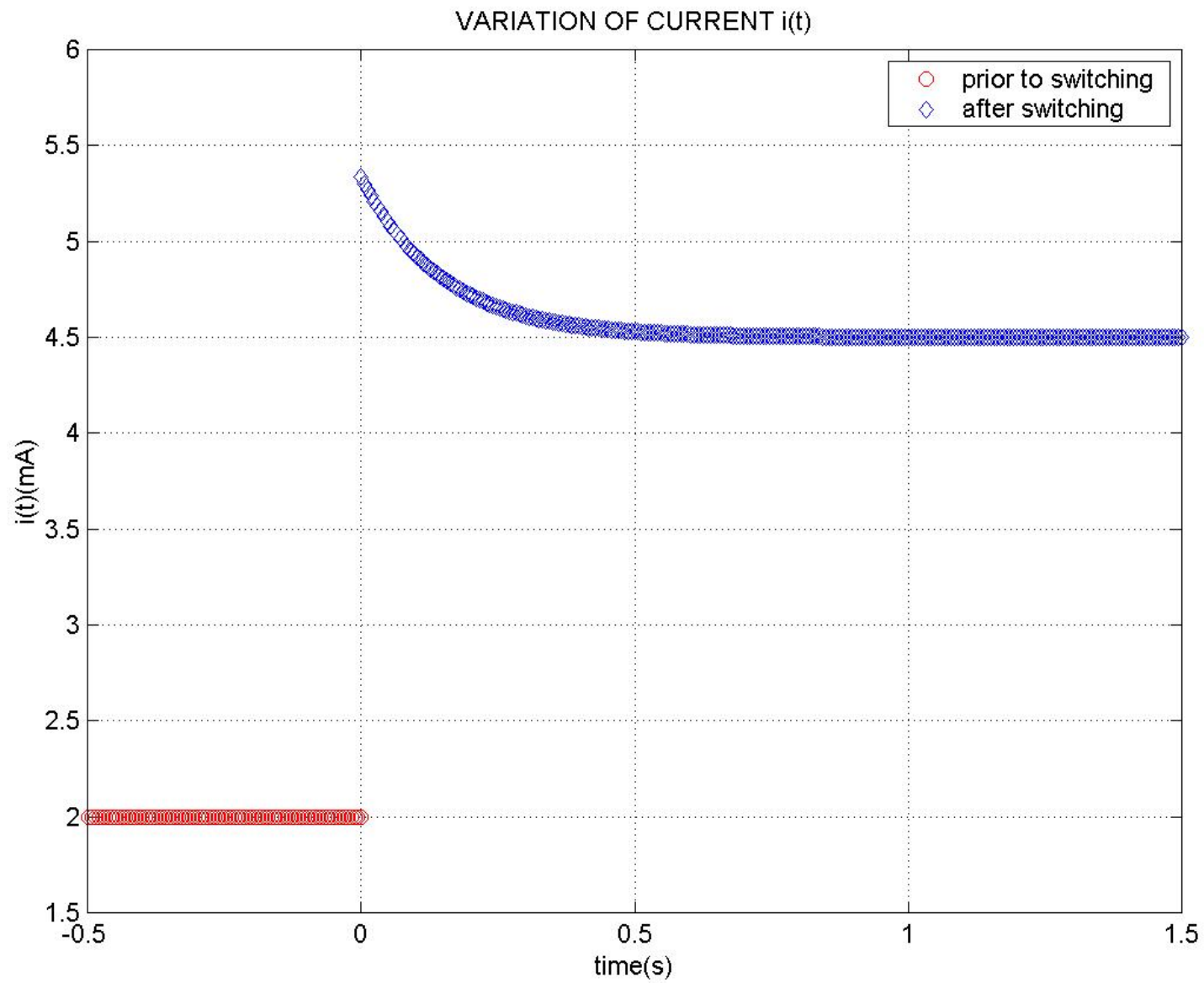
Linspace(x1, x2) generates a row vector of 100 linearly equally spaced points between x1 and x2.

Linspace(x1, x2, N) generates N points between x1 and x2.

See also LOGSPACE, :.

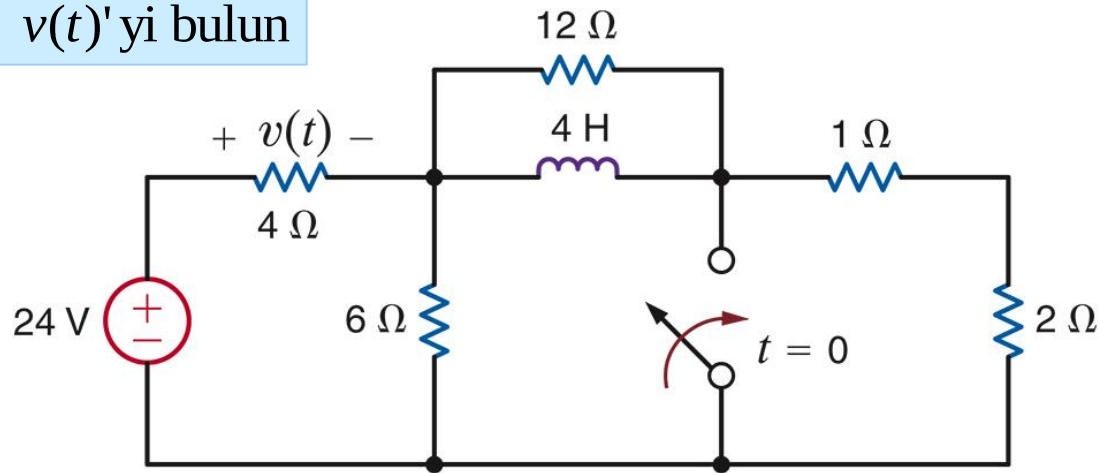
Kullanılan komutları içeren komut dosyası (m-dosyası). MATLAB Editörüyle Hazırlanmıştır

```
%example6p3.m
%commands used to display funtion i(t)
%this is an example of MATLAB script or M-file
%must be stored in a text file with extension ".m"
%the commands are executed when the name of the M-file is typed at the
%MATLAB prompt (without the extension)
tau=0.15; %define time constant
tini=-4*tau; %select left starting point
tend=10*tau; %define right end point
tminus=linspace(tini,0,100); %use 100 points for t<=0
tplus=linspace(0,tend, 250); % and 250 for t>=0
iminus=2*ones(size(tminus)); %define i for t<=0
iplus=9/2+5/6*exp(-tplus/tau); %define i for t>=0
plot(tminus,iminus,'ro',tplus,iplus,'bd'), grid; %basic plot command specifying
                                                %color and marker
title('VARIATION OF CURRENT i(t)'), xlabel('time(s)'), ylabel('i(t) (mA)')
legend('prior to switching', 'after switching')
axis([-0.5,1.5,1.5,6]);%define scales for axis [xmin,xmax,ymin,ymax]
```

ÖRNEK

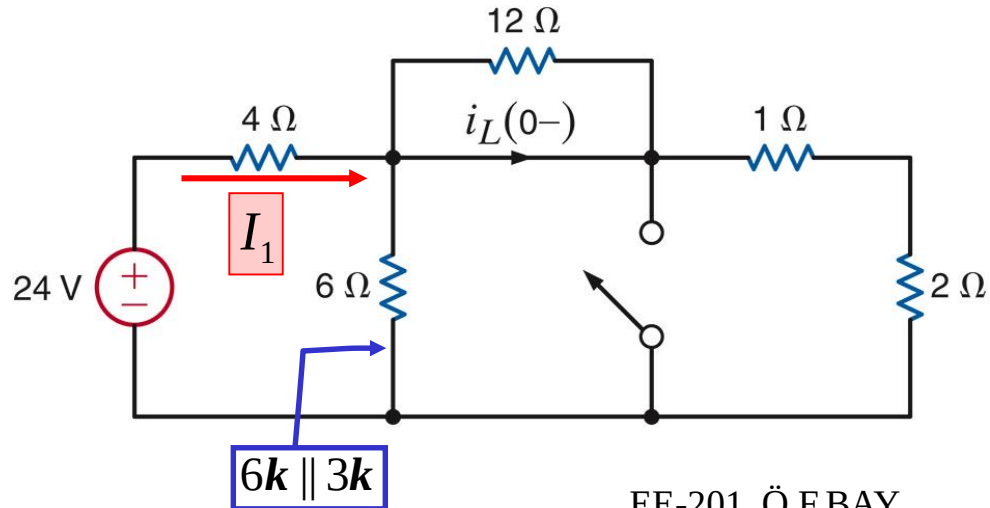
$t > 0$ için $v(t)$ 'yi bulun



ADIM 1: $v(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

ADIM 2: İndüktör başlangıç akımı

Anahtarlamadan önce kalıcı durumdaki devreyi kullanın

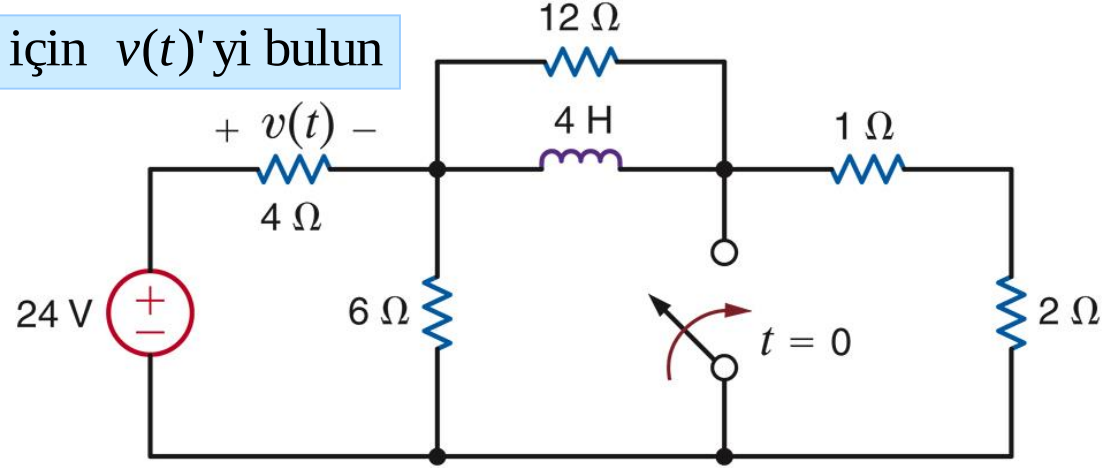


$$I_1 = \frac{24}{6} = 4mA$$

$$i_L(0-) = \frac{6}{6+3} I_1 \quad \text{Akım bölücü ile}$$

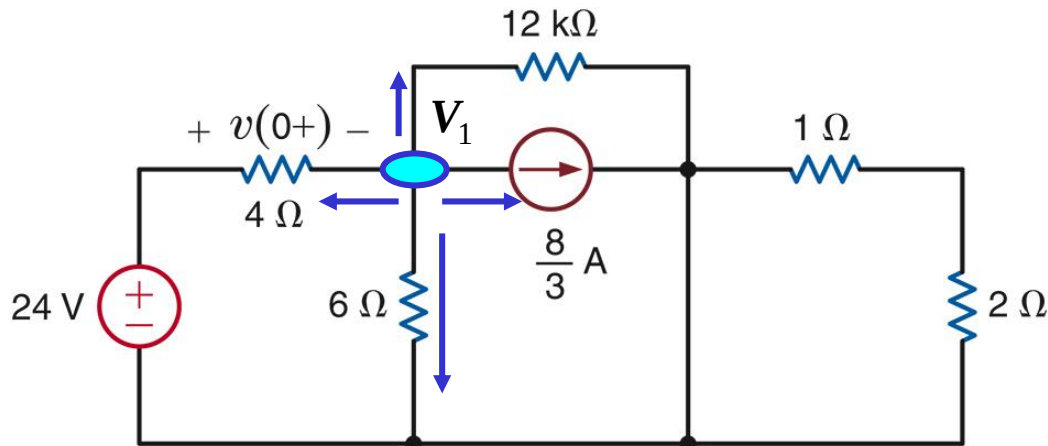
$$i_L(0-) = \frac{8}{3} mA$$

ÖRNEK - devam $t > 0$ için $v(t)$ 'yi bulun



ADIM 3: $v(0+)$ 'yi belirleyin

$t=0+$ 'daki devreyi kullanın.
İndüktör akım kaynağı ile değiştirilir



$$\frac{V_1 - 24}{4} + \frac{V_1}{6} + \frac{V_1}{12} + \frac{8}{3} = 0$$

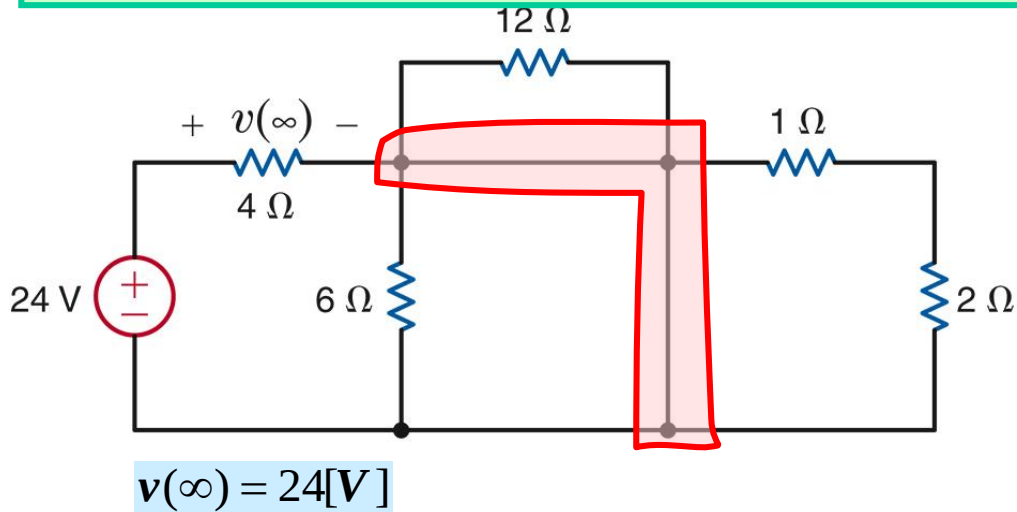
$$V_1 = \frac{20}{3} [V]$$

$$v(0+) = 24[V] - V_1 = \frac{52}{3} [V]$$

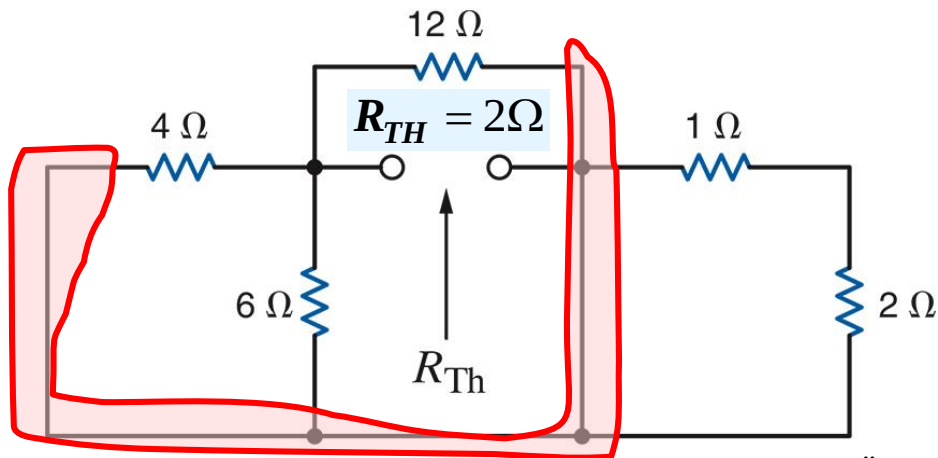
ÖRNEK - devam $t > 0$ için $v(t)$ 'yi bulun

ADIM 4: $v(\infty)$ 'yi belirleyin

ANAHTARLAMADAN SONRA KALICI DURUMDAKİ DEVREYİ KULLANIN



ADIM 5: Zaman Sabitini belirleyin



İndüktif Devre: $\tau = \frac{L}{R_{TH}}$

$R_{TH} = 4 \parallel 6 \parallel 12 = 2\Omega$

$\tau = \frac{4H}{2\Omega} = 2s$

ÖRNEK - devam $t > 0$ için $v(t)$ 'yi bulun

ADIM 6: K_1 , K_2 'yi belirleyin

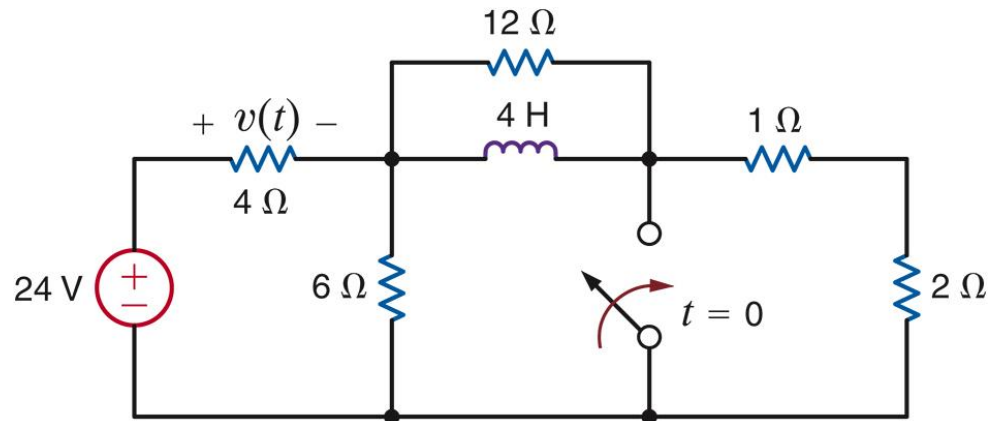
$$K_1 = v(\infty) = 24[V] \text{ (adım 4)}$$

$$v(0+) = \frac{52}{3} = K_1 + K_2 \text{ (adım 3)}$$

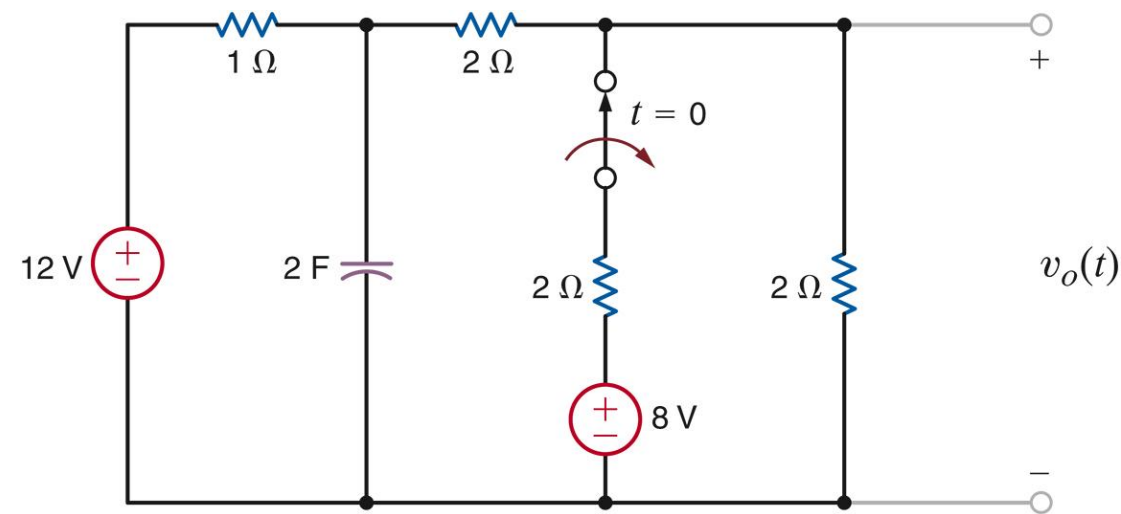
$$K_2 = \frac{52}{3} - 24 = -\frac{20}{3}[V]$$

$$\text{CEVAP: } v(t) = 24 - \frac{20}{3}e^{-\frac{t}{2}}, t > 0$$

ORJİNAL DEVRE

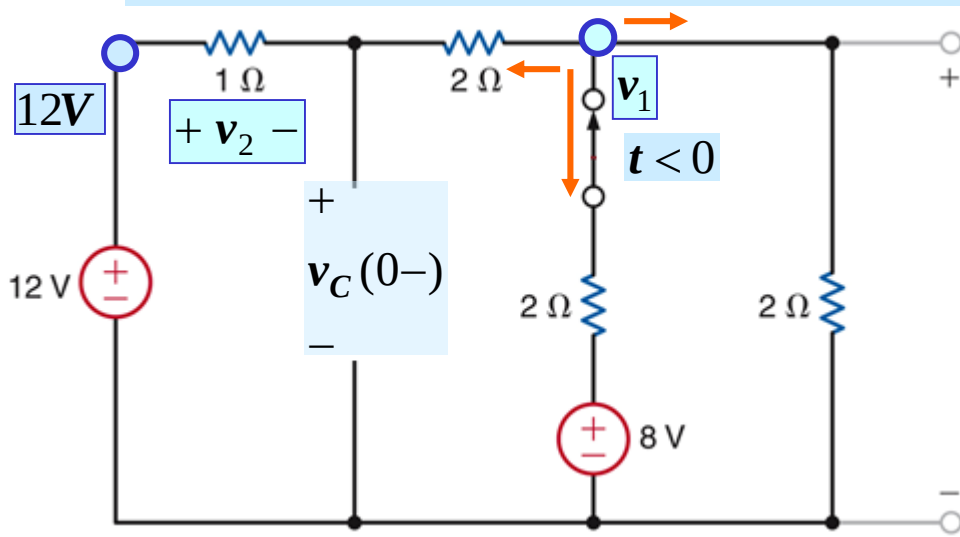


ÖRNEK $t > 0$ için $v_o(t)$ 'yi bulun



ADIM 1: $v_o(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

ADIM 2: Kapasitör başlangıç gerilimi



$$\text{KAK @ } v_1: \frac{v_1 - 12}{3} + \frac{v_1 - 8}{2} + \frac{v_1}{2} = 0 \quad */6$$

$$8v_1 - 48 = 0 \Rightarrow v_1 = 6[V]$$

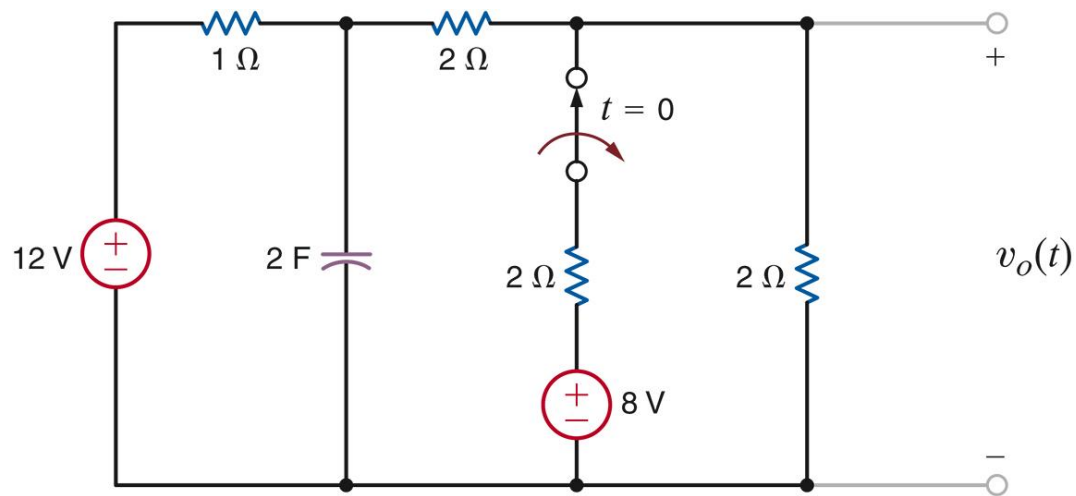
$$v_2 = \frac{1}{3}(12 - v_1) = 2[V]$$

$$v_C(0-) = 12 - v_2$$

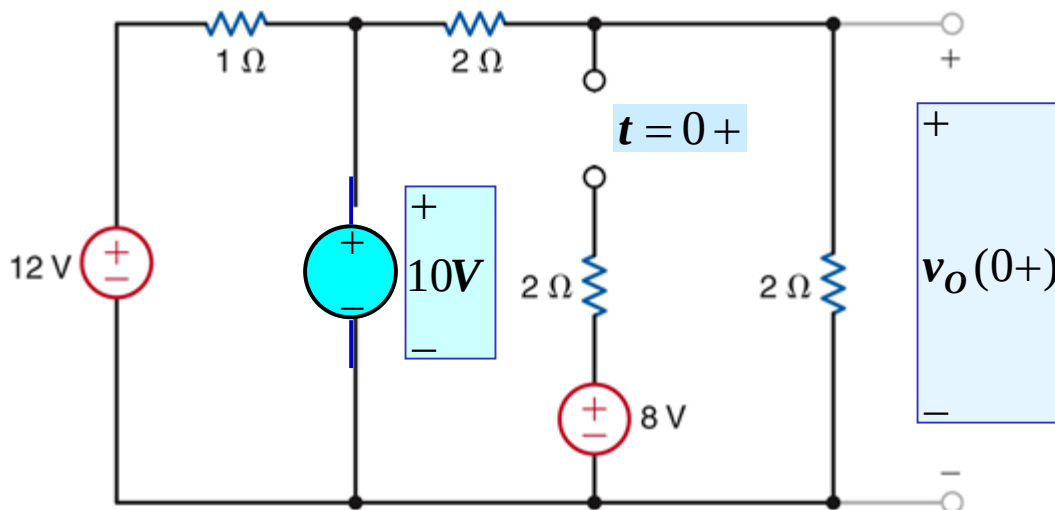
$$v_2 = 2[V] \Rightarrow v_C(0-) = v_C(0+) = 10[V]$$

ÖRNEK - devam

$t > 0$ için $v_o(t)$ 'yi bulun



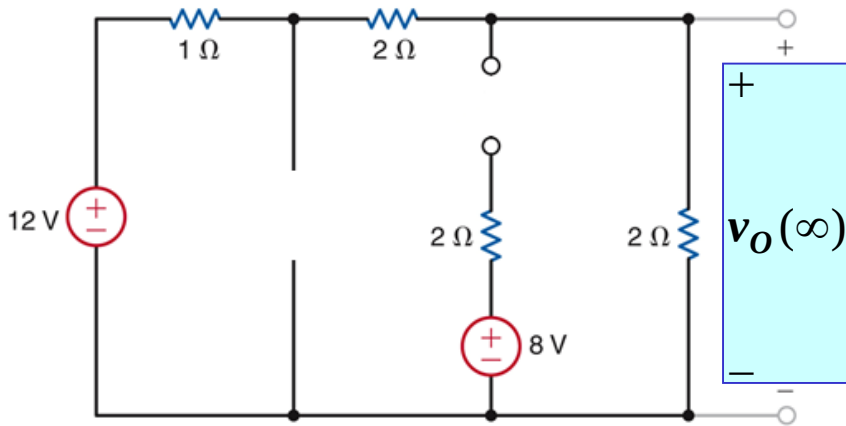
ADIM 3: $v_o(0+)$ 'yi belirleyin



$$v_o(0+) = \frac{2}{2+2}(10) = 5[V]$$

ÖRNEK - devam $t > 0$ için $v_o(t)$ 'yi bulun

ADIM 4: $v_o(\infty)$ 'i belirleyin



$$v_o(\infty) = \frac{2}{(1+2+2)}(12) = \frac{24}{5}[\text{V}]$$

ADIM 6: K_1, K_2 'yi belirleyin

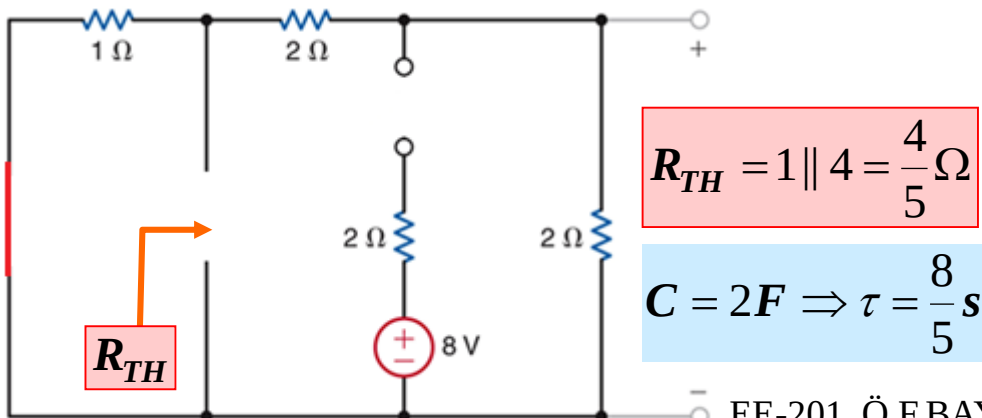
$$K_1 = v_o(\infty) = \frac{24}{5}[\text{V}]$$

$$v_o(0+) = 5[\text{V}] = K_1 + K_2 \Rightarrow K_2 = \frac{1}{5}[\text{V}]$$

CEVAP: $v_o(t) = \frac{24}{5} + \frac{1}{5}e^{-\frac{t}{8/5}}[\text{V}]; t > 0$

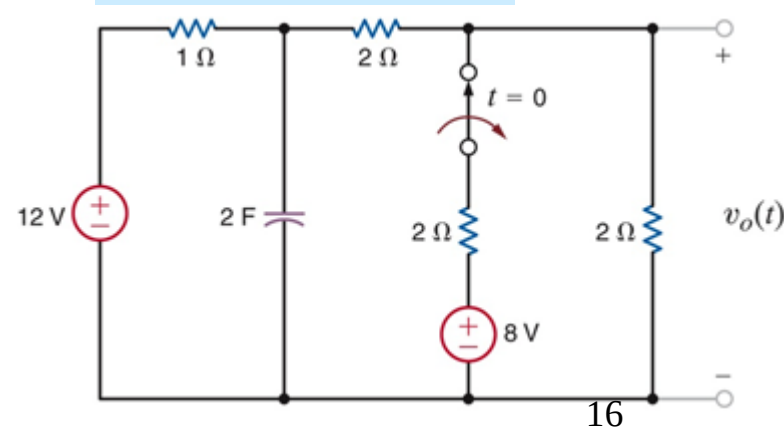
ADIM 5: Zaman Sabitini belirleyin

Kapasitif devre: $\tau = R_{TH}C$



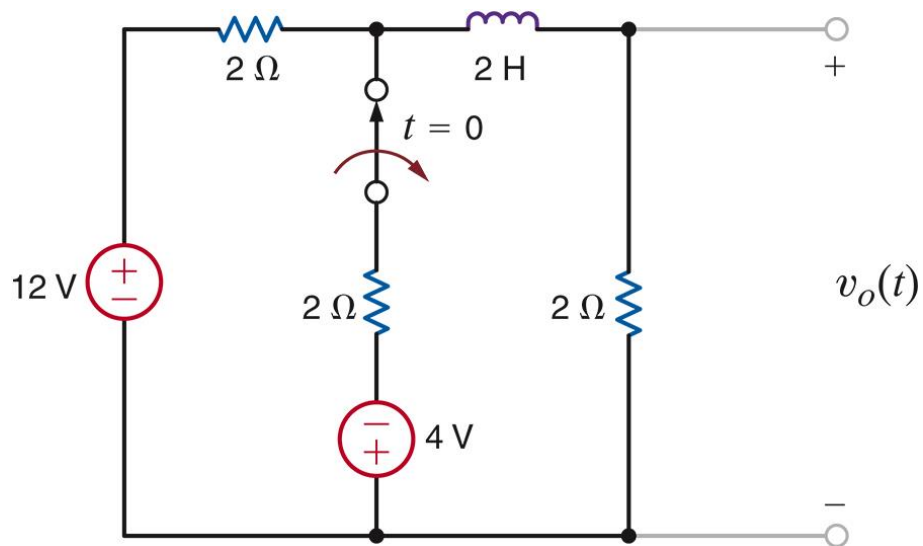
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ORJİNAL DEVRE



ÖRNEK

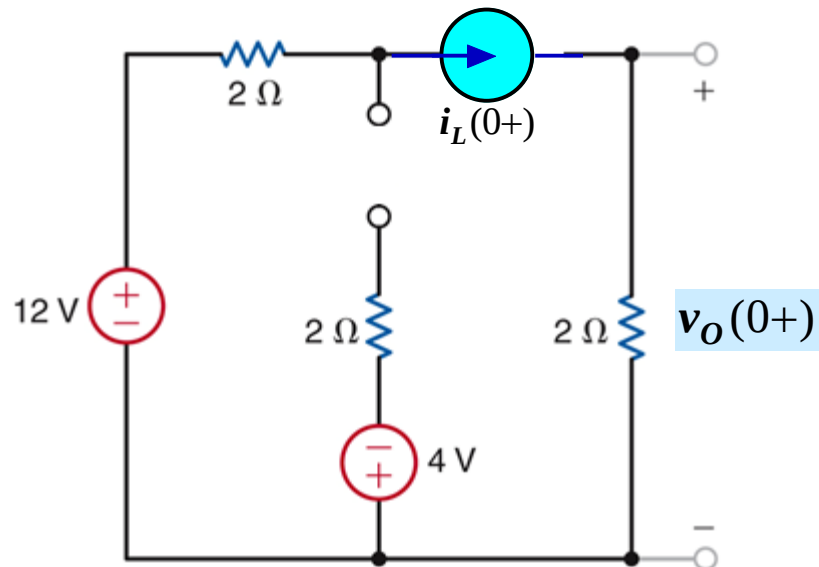
$t > 0$ için $v_o(t)$ 'yi bulun



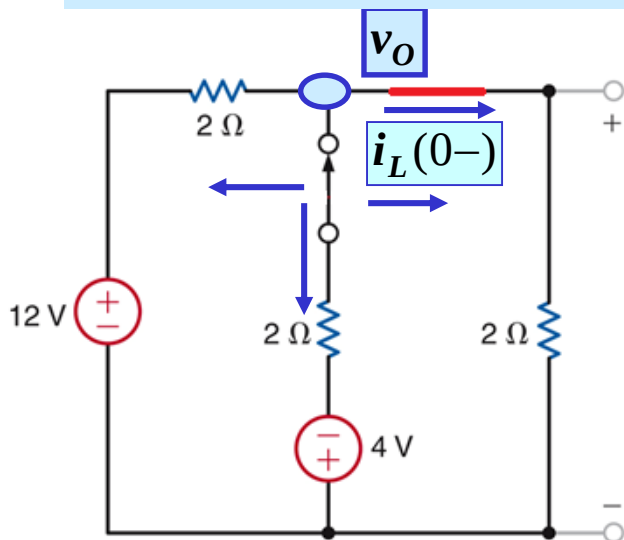
ADIM 1: $v_o(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

ADIM 2: İndüktör başlangıç akımı

ADIM 3: $v_o(0+)$ 'yi belirleyin



$$v_o(0+) = 2i_L(0+) = \frac{8}{3}[\text{V}]$$



$$\frac{v_o - 12}{2} + \frac{v_o - (-4)}{2} + \frac{v_o}{2} = 0$$

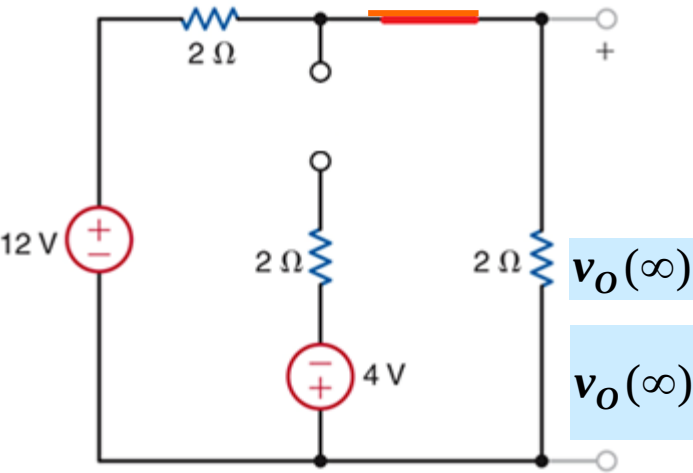
$$v_o = \frac{8}{3}[\text{V}]$$

$$i_L(0-) = i_L(0+) = \frac{4}{3}[\text{A}]$$

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ÖRNEK - devam $t > 0$ için $v_o(t)$ 'yi bulun

ADIM 4: $v_o(\infty)$ 'i belirleyin



$$v_o(\infty) = \frac{2}{2+2}(12) = 6[V]$$

ADIM 6: K_1, K_2 'yi belirleyin

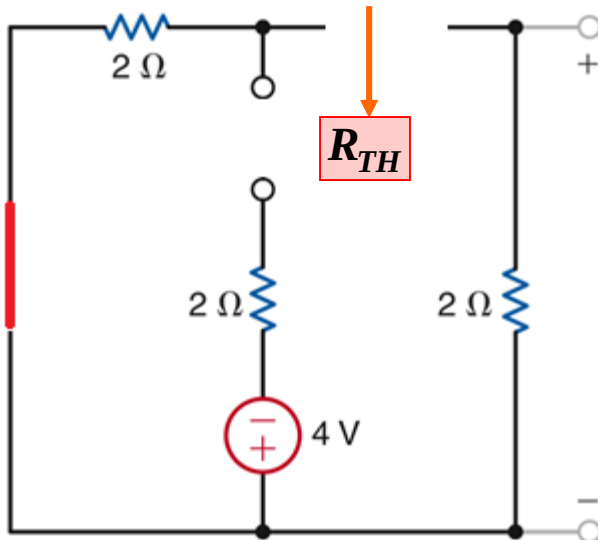
$$K_1 = v_o(\infty) = 6[V] \quad (\text{adım 4})$$

$$v_o(+)=\frac{8}{3}=K_1+K_2 \quad (\text{adım 3})$$

$$K_2 = \frac{8}{3} - 6 = -\frac{10}{3}[V]$$

$$\text{CEVAP: } v_o(t) = 6 - \frac{10}{3}e^{-\frac{t}{0.5}}, t > 0$$

ADIM 5: Zaman Sabitini belirleyin



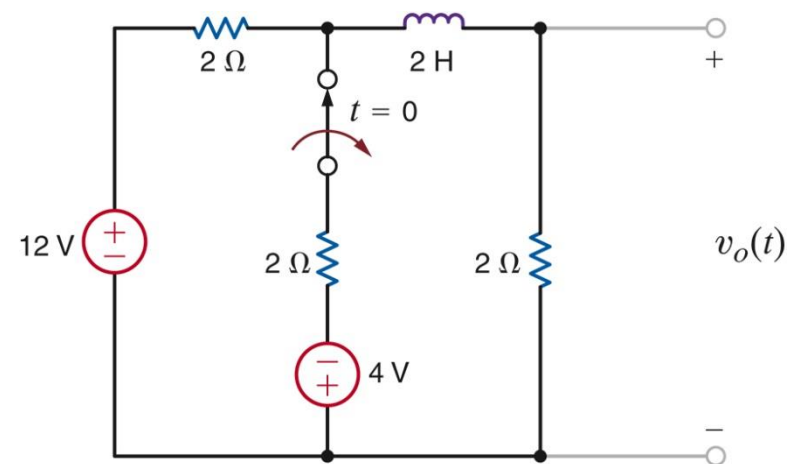
Enduktif Devre

$$\tau = \frac{L}{R_{TH}}$$

$$R_{TH} = 4\Omega$$

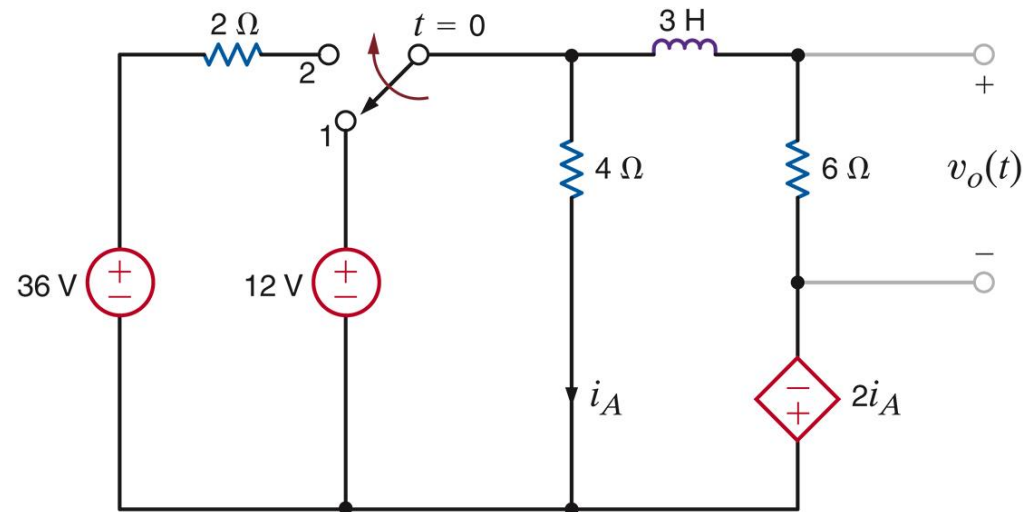
$$\tau = \frac{2}{4} = 0.5s$$

ORJİNAL DEVRE



ÖRNEK

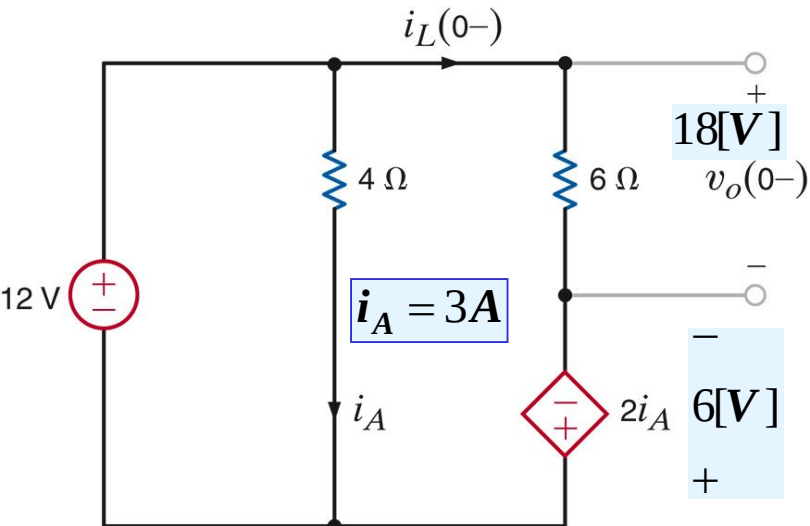
$t > 0$ için $v_o(t)$ 'yi bulun



ADIM 1: $v_o(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

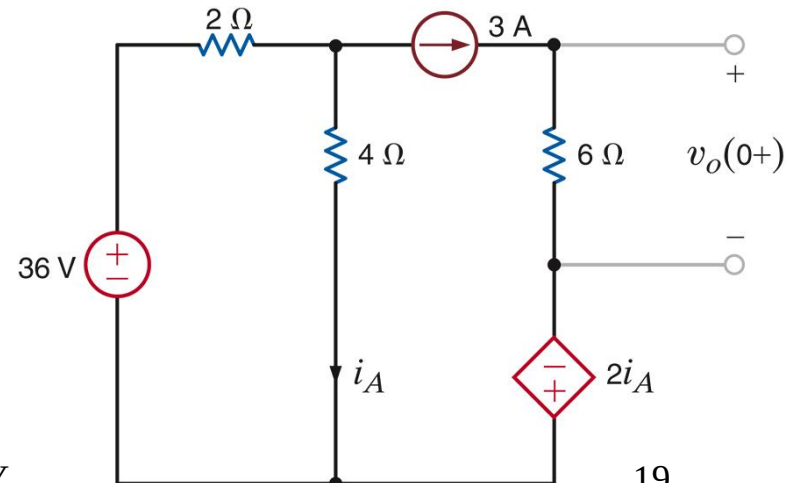
ADIM 2: $i_L(0+)$ 'yi belirleyin

$i_L(0-) = i_L(0+) = 3[A]$



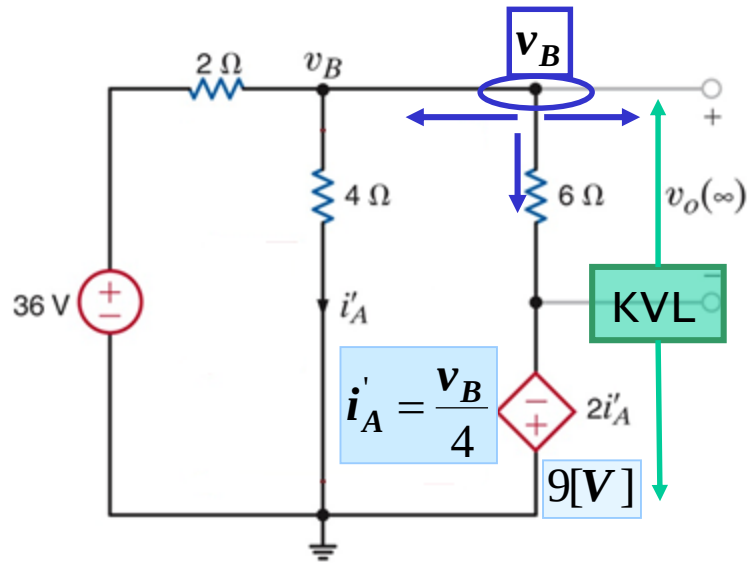
ADIM 3: $v_o(0+)$ 'yi belirleyin

$v_o(0+) = 3 * 6 = 18[V]$



ÖRNEK - devam $t > 0$ için $v_o(t)$ 'yi bulun

ADIM 4: $v_o(\infty)$ 'i belirleyin



$$\frac{v_B - 36}{2} + \frac{v_B}{4} + \frac{v_B - (-2i'_A)}{6} = 0 \quad */12$$

$$11v_B + 4i'_A = 36 \times 6$$

$$v_B = 18[V], i'_A = 4.5[A]$$

$$v_o(\infty) = v_B + 2i_A$$

$$= 18 + 2 \times 4.5 = 27[V]$$

$$v_o(\infty) = 27[V]$$

ADIM 5: Zaman Sabitini belirleyin

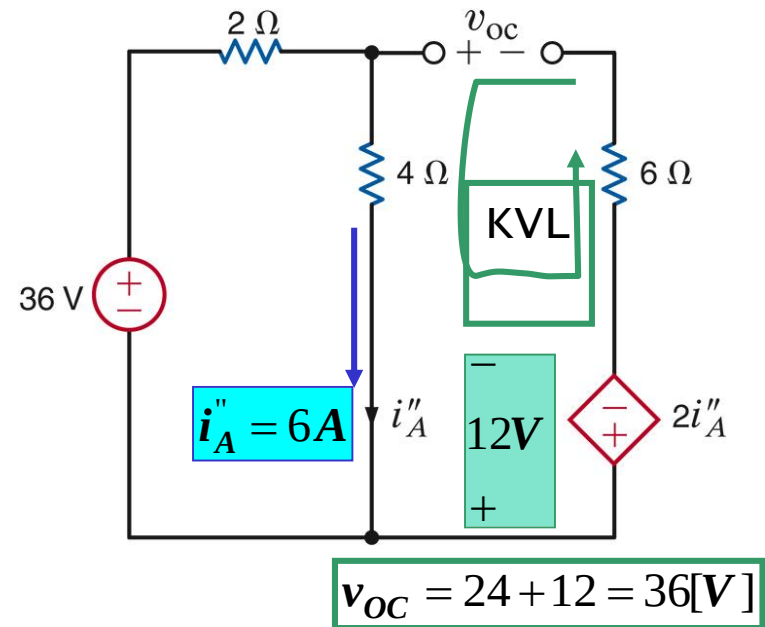
indüktif devre

$$\tau = \frac{L}{R_{TH}}$$

Bağımlı kaynaklı devre

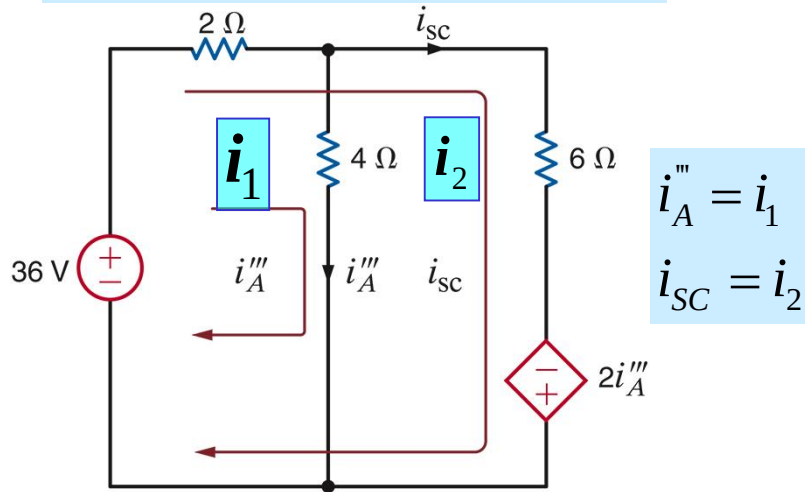
$$R_{TH} = \frac{v_{OC}}{i_{SC}}$$

Açık devre gerilimi v_{OC}



$$v_{OC} = 24 + 12 = 36[V]$$

Kısa devre akımı I_{SC}



Not: indüktif durumda, kısa devre akımını hesaplamak için kullanılan devre, $v_o(\infty)$ 'ı belirlemek için aynı şekilde kullanılır.

$$36 = 2(i_1 + i_2) + 4i_1$$

$$36 = 2(i_1 + i_2) + 6i_2 - 2i_A'''$$

$$i_2 = i_{SC} = \frac{36}{8} [A]$$

$$\left. \begin{array}{l} v_{OC} = 36[V] \\ i_{SC} = 36/8[A] \end{array} \right\} \Rightarrow R_{TH} = 8\Omega \quad L = 3H \Rightarrow \tau = \frac{3}{8}s$$

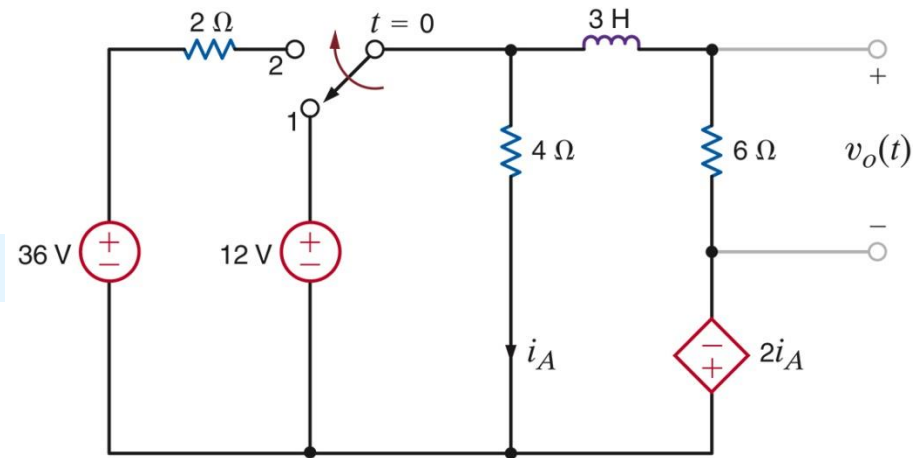
ADIM 6: K_1 , K_2 'yi belirleyin

$$v_o(\infty) = 27 = K_1 \quad (\text{adım 4})$$

$$v_o(0+) = 18 = K_1 + K_2 \Rightarrow K_2 = -9[V] \quad (\text{adım 3})$$

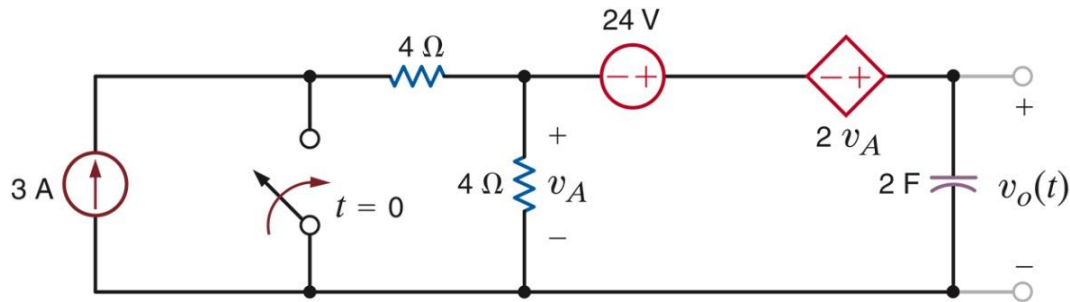
$$\text{CEVAP: } v_o(t) = 27 - 9e^{-\frac{t}{3/8}}, t > 0$$

ORJİNAL DEVRE



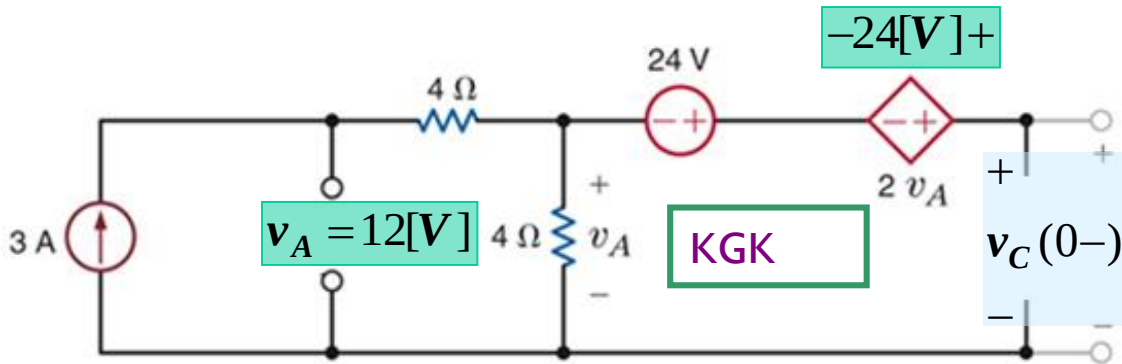
ÖRNEK

$t > 0$ için $v_o(t)$ 'yi bulun



ADIM 1: $v_o(t) = K_1 + K_2 e^{-\frac{t}{\tau}}, t > 0$

ADIM 2: $t = 0+$ 'daki kapasitör gerilimini belirleyin



$$v_C(0-) = 24 + 24 + 12 = 60[V]$$

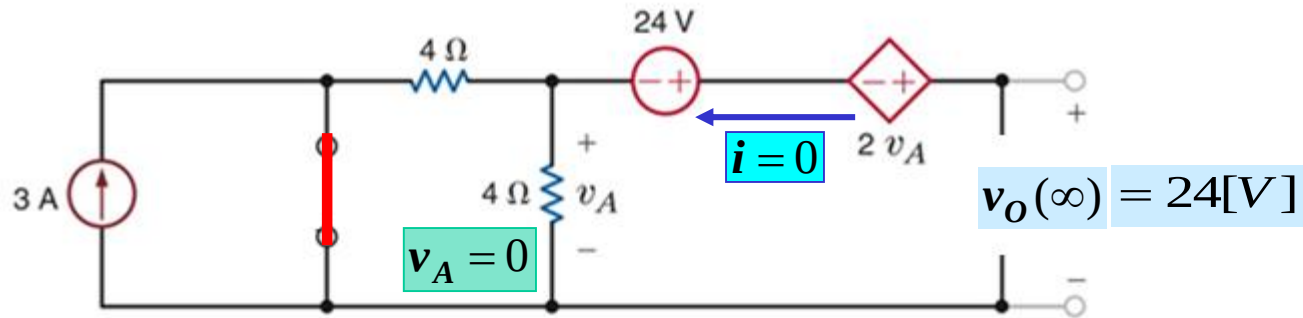
$$v_C(0+) = v_C(0-)$$

ADIM 3: $v_o(0+)$ 'yi belirleyin

$$v_o = v_C \Rightarrow v_o(0+) = 60[V]$$

ÖRNEK - devam $t > 0$ için $v_o(t)$ 'yi bulun

ADIM 4: $v_o(\infty)$ 'i belirleyin

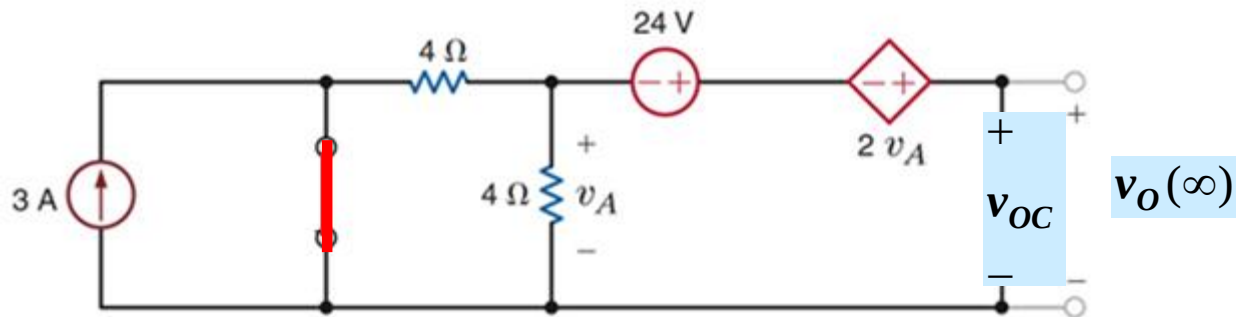


ADIM 5: Zaman Sabitini belirleyin

kapasitif devre $\Rightarrow \tau = R_{TH} C$

$$R_{TH} = \frac{v_{OC}}{i_{SC}}$$

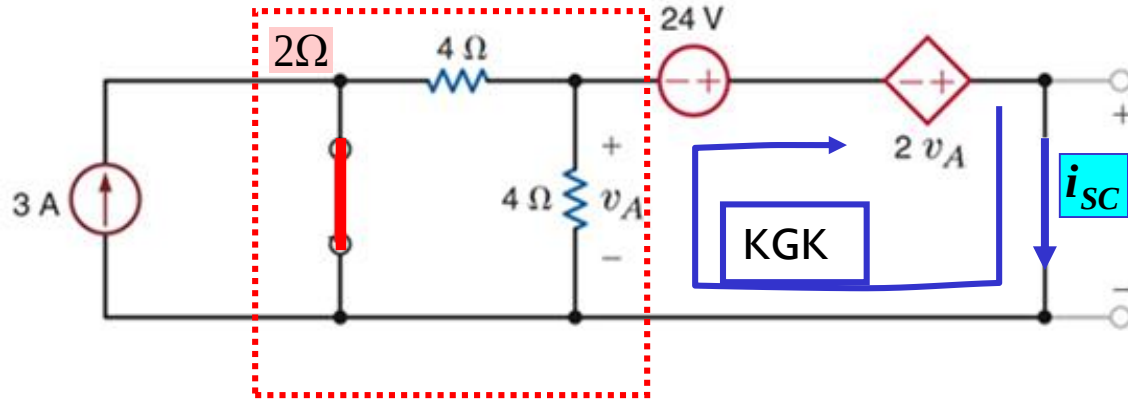
Açık devre gerilimi v_{OC}



$$v_{OC} = v_o(\infty) = 24[V]$$

ÖRNEK - devam $t > 0$ için $v_o(t)$ 'yi bulun

Kısa devre akımı I_{SC}



$$2i_{SC} - 24 - 2v_A = 0$$

$$v_A = -2i_{SC}$$

$$i_{SC} = 4[A]$$

$$R_{TH} = \frac{24}{4} = 6\Omega$$

$$\tau = 6\Omega \times 2F = 12s$$

ADIM 6: K_1 , K_2 'yi belirleyin

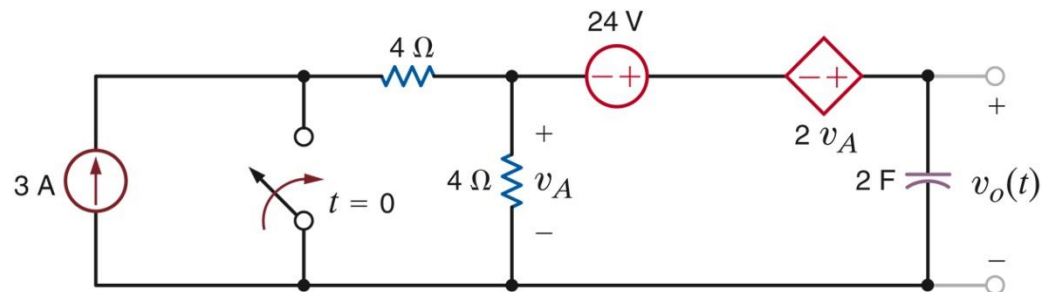
$$K_1 = v_o(\infty) = 24 \quad (\text{adım 4})$$

$$v_o(0+) = 60 = K_1 + K_2 \quad (\text{adım 3})$$

$$K_2 = 36[V]$$

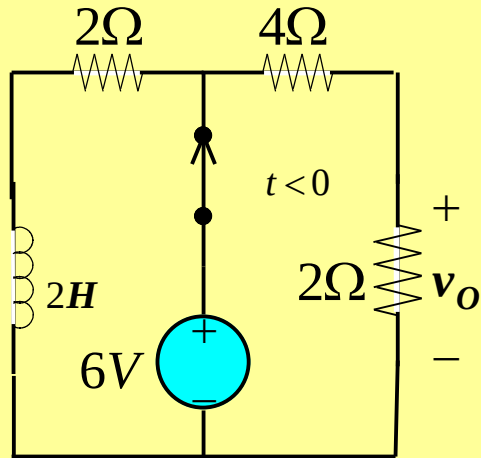
$$\text{CEVAP: } v_o(t) = 24 + 36e^{-\frac{t}{12}}, t > 0$$

ORJİNAL DEVRE



İndüktör örneği

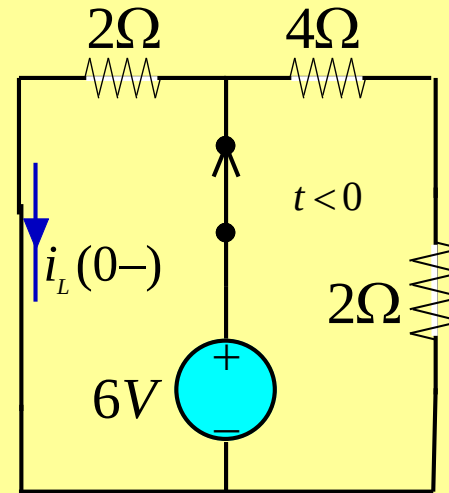
$t > 0$ için $v_o(t)$ 'yi bulun



ADIM 1: Çözüm formu

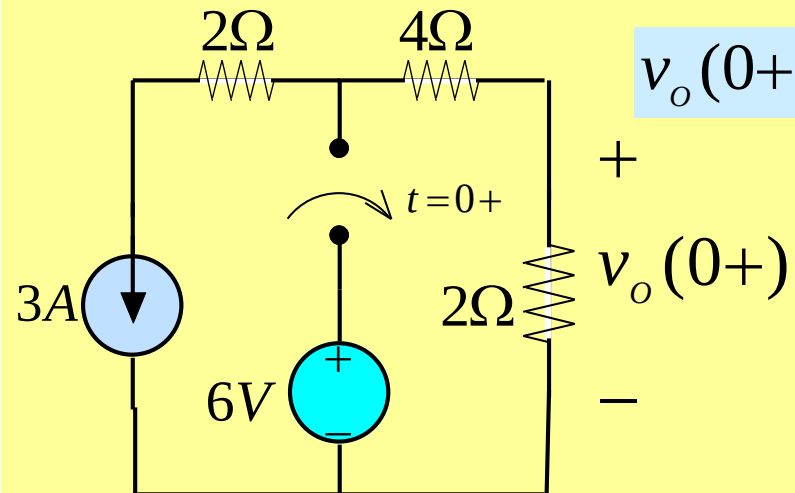
$$v_o(t) = K_1 + K_2 e^{-\frac{t}{\tau}}$$

ADIM 2: İndüktör başlangıç akımı



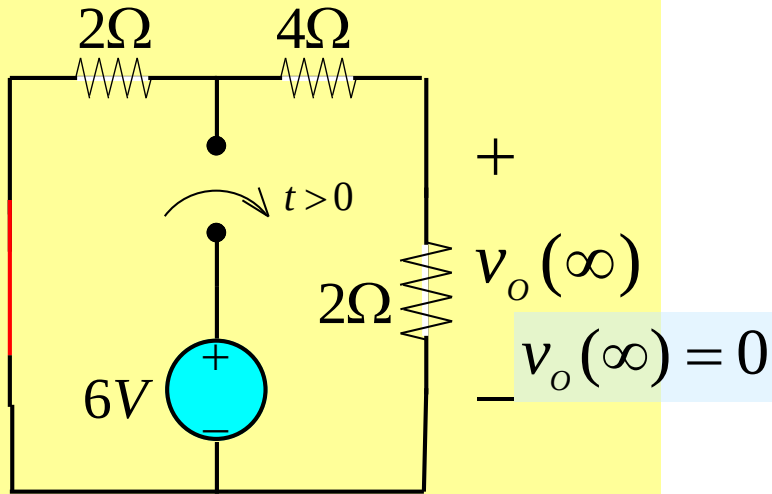
$$i_L(0-) = 3A$$

ADIM 3: $t=0+$ 'da çıkışı belirleyin (indüktör akımı sabit)

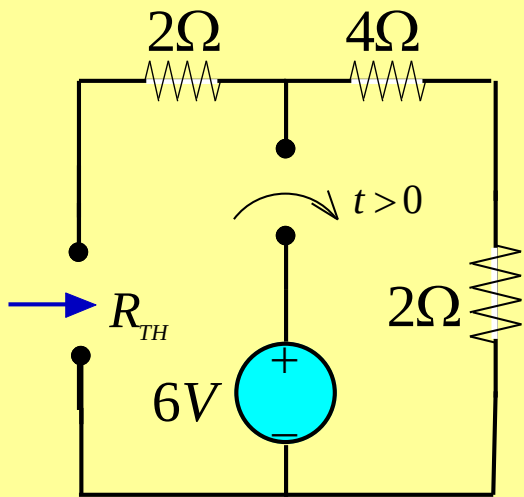


$$v_o(0+) = -6V$$

ADIM 4: Anahtarlamadan sonra kalıcı durumdayken çıkışı bulun



ADIM 5: Anahtarlamadan sonra zaman sabitini bulun



$$\tau = \frac{L}{R_{TH}}$$

$$R_{TH} = 8\Omega$$

$$\tau = \frac{2}{8} = 0.25 \text{ s}$$

EE-201, Ö.F.BAY

ADIM 6: Çözümü bulun

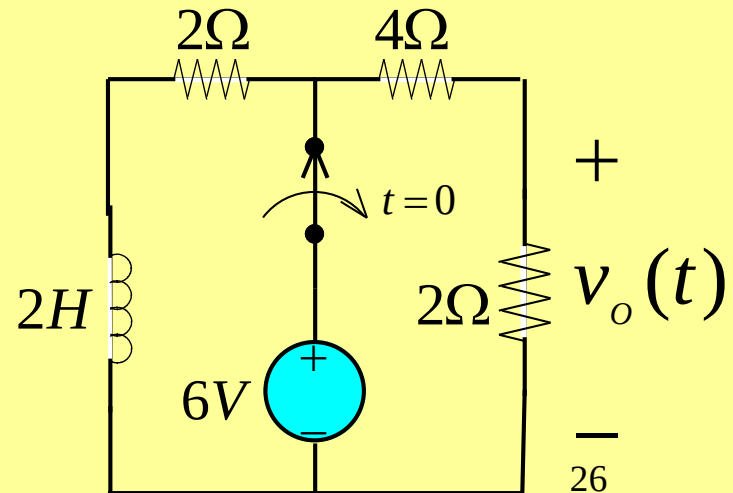
$$K_1 + K_2 = v_o(0+) = -6V$$

$$K_1 = v_o(\infty) = 0$$

$$v_o(t) = -6e^{-\frac{t}{0.25}}; t > 0$$

$$v_o(t) = -6e^{-4t}; t > 0$$

ORJİNAL DEVRE

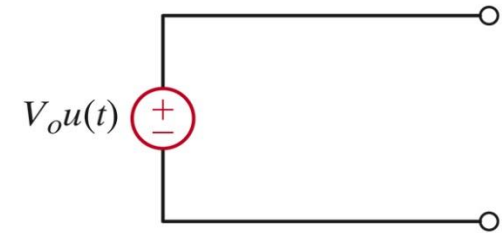
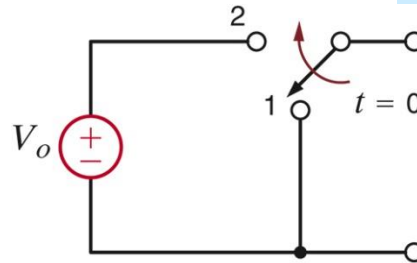
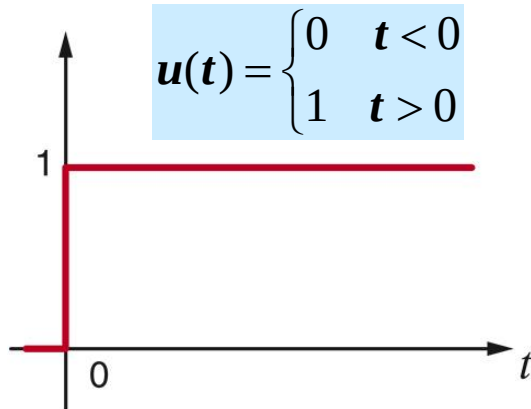


DARBE (PULSE) CEVABI

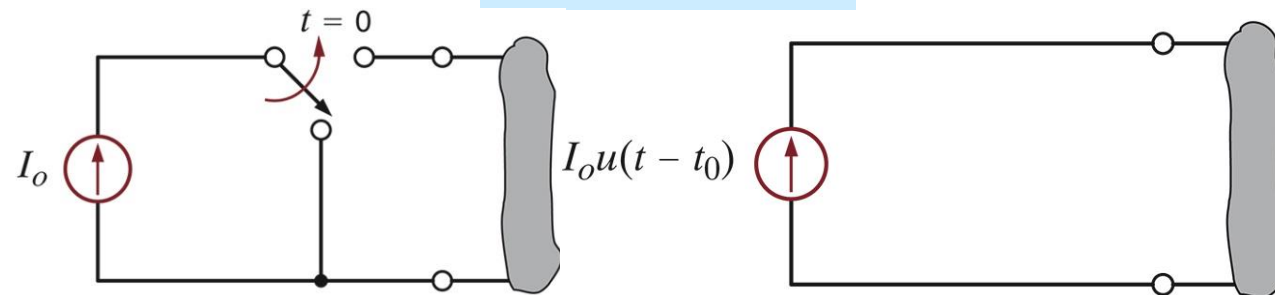
Devrelerin tekil fonksiyonların özel bir sınıfına olan tepkisini inceleyeceğiz.

Tekil Fonksiyonlar

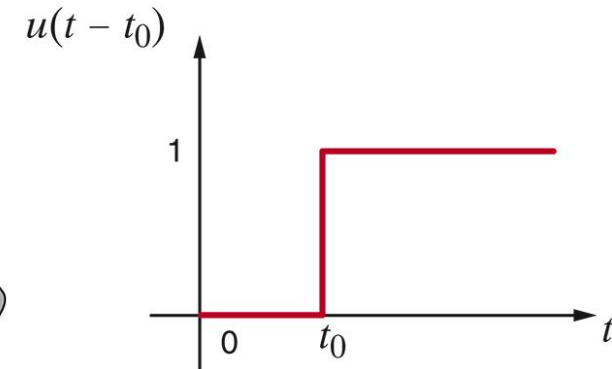
- Birinci dereceden devrelere bağlanan anlık bir kaynak sonucunda devrenin analizini yapmak için kullanılan fonksiyonlardır.
- Anahtarlama fonksiyonu olarak da bilinirler.



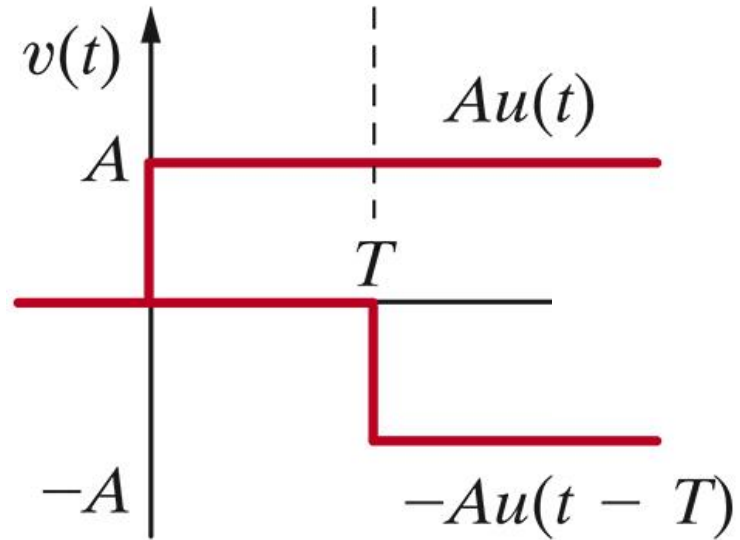
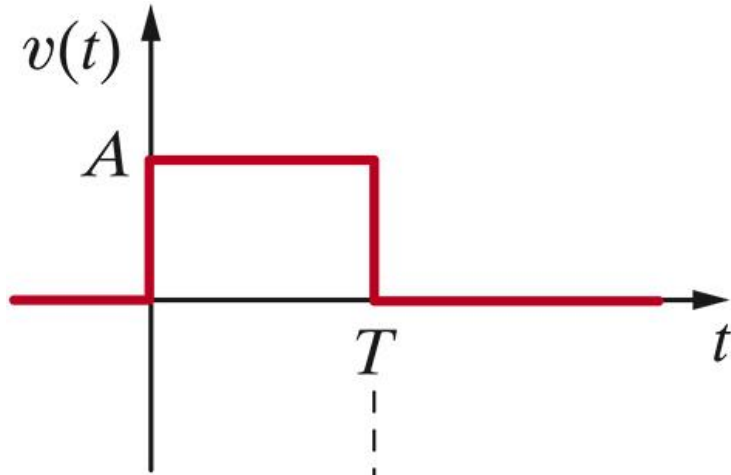
AKIM KADEMESİ



ZAMAN KAYDIRILMIŞ BASAMAK



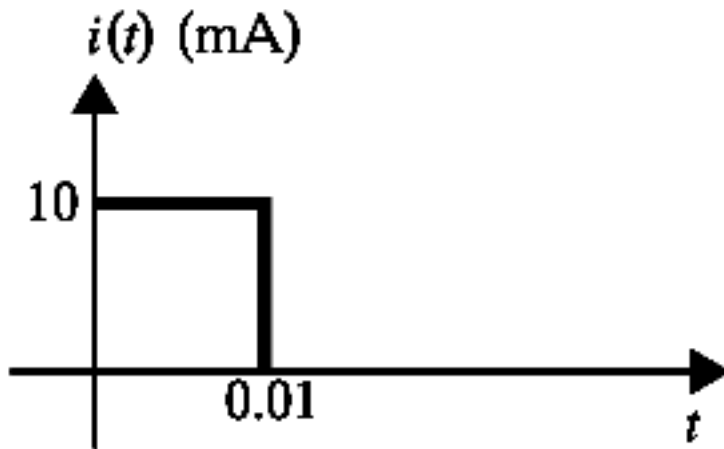
DARBE SİNYALİ



BASAMAK TOPLAMI OLARAK DARBE

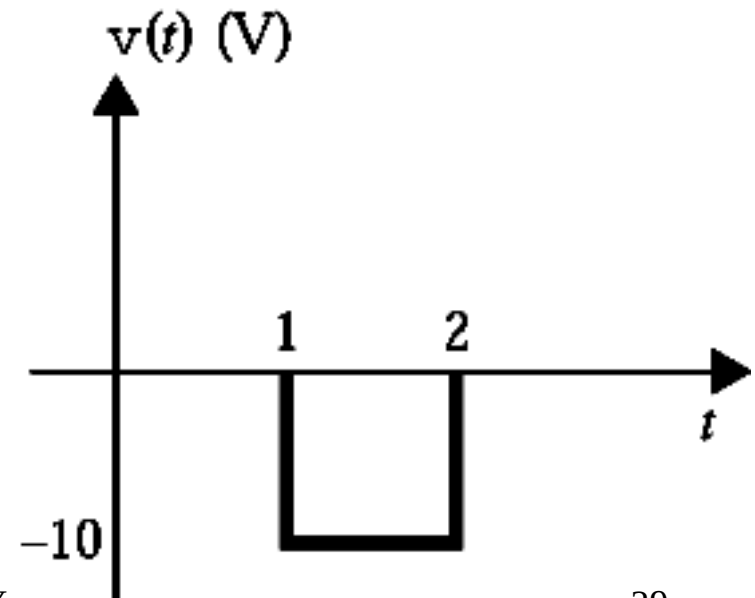
ÖRNEK

$$i(t) = 10[u(t) - u(t - 0.01)](\text{mA})$$



ÖRNEK

$$v(t) = -10[u(t - 1) - u(t - 2)](\text{V})$$



$$\tau \frac{dx}{dt} + x = f_{TH}; \quad x(t_0+) = x_0$$

$$x(t) = e^{-\frac{t-t_0}{\tau}} x(t_0) + \frac{1}{\tau} \int_{t_0}^t e^{-\frac{t-x}{\tau}} f_{TH}(x) dx$$

$$x(t) = K_1 + K_2 e^{-\frac{t-t_0}{\tau}}; \quad t \geq t_0$$

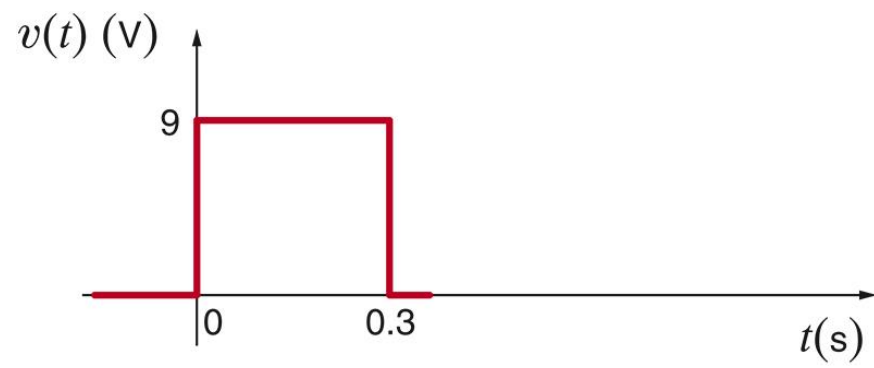
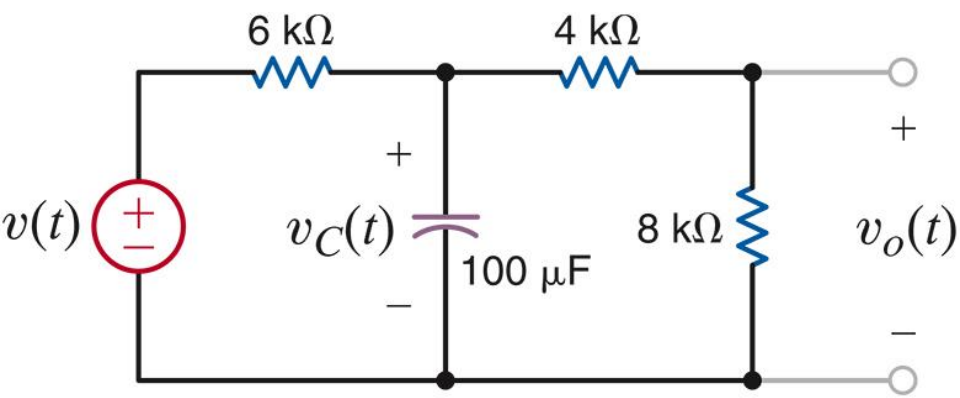
SABİT KAYNAKLAR İÇİN CEVAP

Bu ifade kaynakların sabit olduğu herhangi bir aralıkta gerçekleşecektir.
Sabitlerin değerleri farklı olabilir ve her aralık için değerlendirilmelidir.

Bir aralığın sonunda bulunan değerler bir sonraki aralık için başlangıç koşulları olarak kullanılır.

ÖRNEK

$t > 0$ için $v_o(t)$ çıkış gerilimini bulun



$$\tau = R_{TH}C = (6k \parallel 12k) \times 100\mu F = 0.4s$$

$$v_o(\infty) = \frac{8}{10+8}(9) = K'_1 = 4$$

$$v_o(0+) = K'_1 + K'_2 = 0$$

$$4 + K'_2 = 0 \Rightarrow K'_2 = -4$$

$$v_o(t) = 4 \left(1 - e^{-\frac{t}{0.4}} \right)$$

$$t < 0 \Rightarrow v(t) = 0 \Rightarrow v_o(t) = 0$$

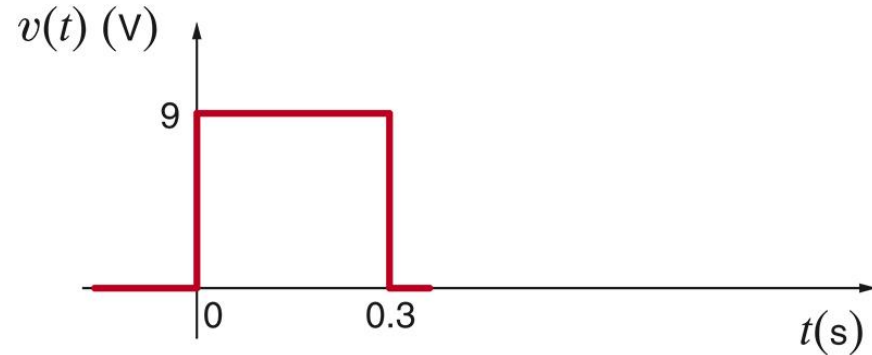
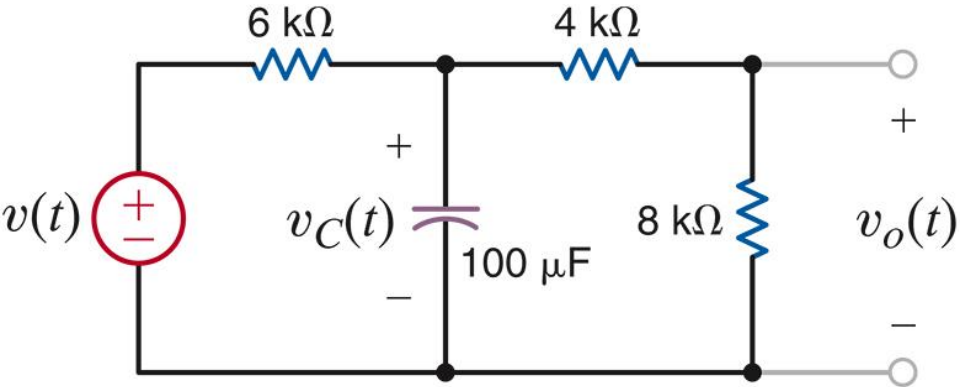
$$v_o(0+) = 0$$

$$t > 0 \Rightarrow v(t) = 9V$$

$$v_o(t) = K'_1 + K'_2 e^{-\frac{t}{\tau}}$$

ÖRNEK - devam

$t > 0$ için $v_o(t)$ çıkis gerilimini bulun



$$t > 0.3 \Rightarrow v(t) = 0 \quad t_o = 0.3$$

$$v_o(0.3+) = 4(1 - e^{-\frac{0.3}{0.4}})$$

$$v_o(t) = K_1'' + K_2'' e^{-\frac{(t-0.3)}{\tau'}} \quad \tau' = 0.4$$

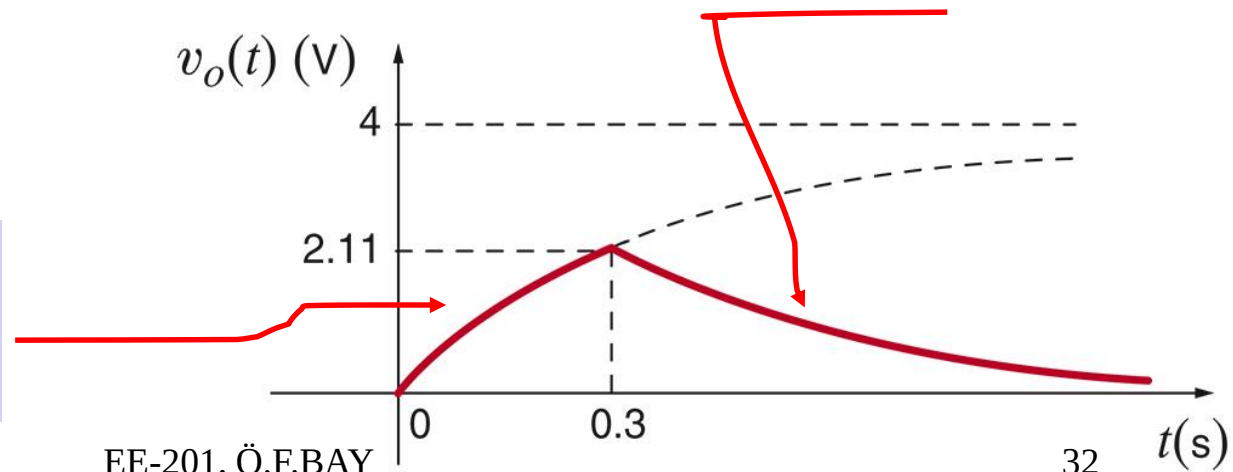
$$v_o(\infty) = 0 \Rightarrow K_1'' = 0$$

$$K_2'' = v_o(0.3+) = 2.11(\text{V})$$

$$v_o(t) = 2.11 e^{-\frac{t-0.3}{0.4}} ; t > 0.3$$

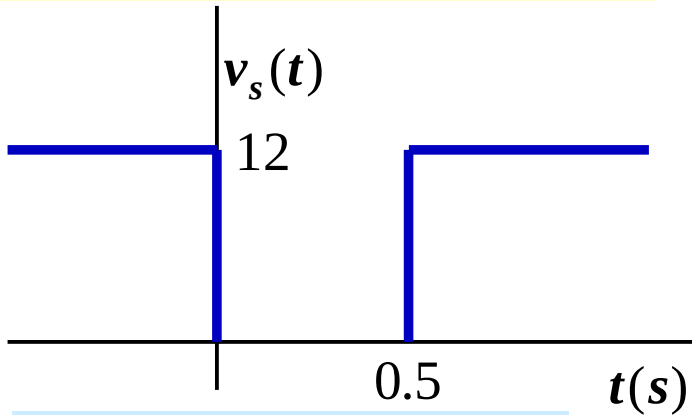
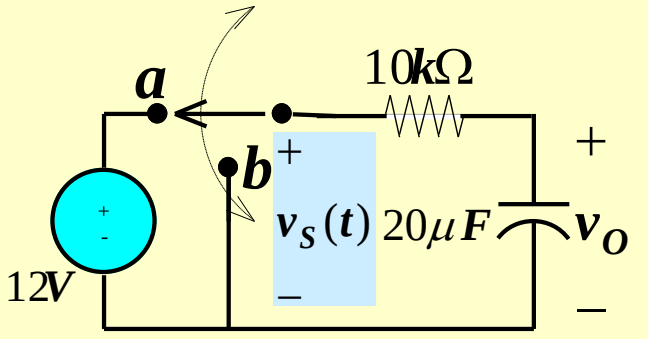
$$0 < t < 0.3$$

$$v_o(t) = 4 \left(1 - e^{-\frac{t}{0.4}} \right)$$



ÖRNEK Anahtar başlangıçta **a** noktasındadır. $t = 0$ 'da **b**'ye alınmaktadır ve $t = 0.5$ 'de tekrar **a**'ya alınmaktadır.

$t > 0$ için $v_o(t)$ 'yi bulun



Parçalı sabit kaynak

Her bir aralıkta kaynak sabittir ve çıkış şu formdadır

$$v_o(t) = K_1 + K_2 e^{-\frac{t-t_0}{\tau}} \quad \text{Sabitler olağan şekilde belirlenir.}$$

$$0 < t < 0.5 \text{ (anahtar } b' \text{ de)} \quad t_0 = 0$$

$$v_o(t) = K_1' + K_2' e^{-\frac{t}{\tau}} \quad v(0+) = 12[V] = K_1' + K_2'$$

$$v_o(\infty) = 0 = K_1' \quad \tau = (10k\Omega)(20\mu F) = 0.2s$$

$$v_o(t) = 12e^{-\frac{t}{0.2}}, 0 < t < 0.5$$

$$t > 0.5 \text{ (anahtar } a' \text{ da)} \quad t_0 = 0.5$$

$$v_o(0.5+) = v_o(0.5-) = 12e^{-\frac{0.5}{0.2}} = 0.985$$

$$v_o(t) = K_1'' + K_2'' e^{-\frac{(t-0.5)}{\tau'}}$$

$$v_o(0.5+) = 0.985 = K_1'' + K_2''$$

$$v_o(\infty) = 12 = K_1'' \quad K_2'' = 0.985 - 12 = -11.015$$

$$v_o(t) = 12 - 11.015e^{-\frac{t-0.5}{0.2}}, t > 0.5$$

ÇIKIŞ GERİLİMİNİ ÇİZMEK İÇİN MATLAB KULLANIMI

```
%pulse1.m  
% displays the response to a pulse response  
tmin=linspace(-0.5,0,50); %negative time segment  
t1=linspace(0,0.5,50); %first segment  
t2=linspace(0.5, 1.5,100); %second segment  
vomin=12*ones(size(tmin));  
vo1=12*exp(-t1/0.2); %after first switching  
vo2=12-11.015*exp(-(t2-0.5)/0.2); %after second switching  
plot(tmin,vomin,'bo',t1,vo1,'rx',t2,vo2,'md'),grid  
title('OUTPUT VOLTAGE'), xlabel('t(s)'),ylabel('Vo(V)')
```

