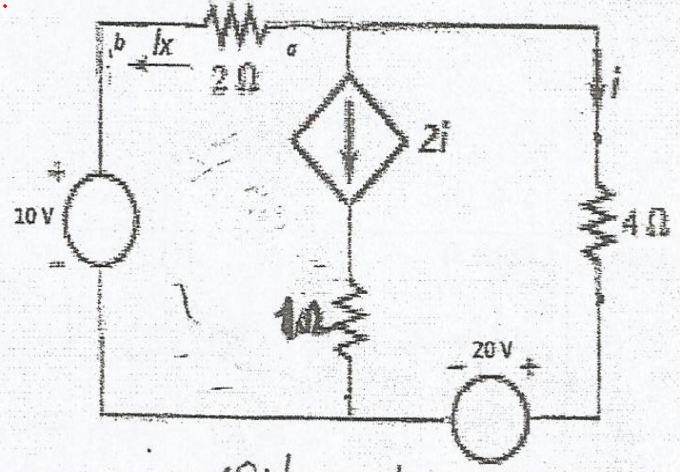
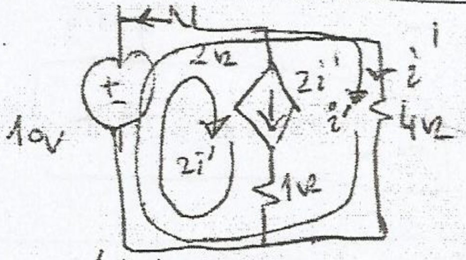
Soru 1) Şekilde verilen devrede a-b arasındaki 2 Ω'luk direncin akımını ($İx$) **Süperpozisyon (toplamsallık) teoremini** kullanarak bulunuz. (35 P)



10V varken (20V → K.D.)
2i devrede



i' için KVL

$4 \cdot i' - 10 + 2 \cdot (i' + 2i') = 0$

$10 i' = 10$

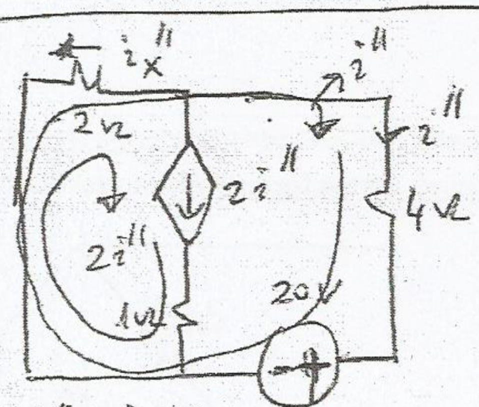
$i' = 1A$

$i_x' = -3 i'$

$\boxed{i_x' = -3A}$

Çözüm 1)

20 V varken
(2i devrede, 10 V K.D.)



i'' için KVL

$4 \cdot i'' + 20 + 2 \cdot (2i'' + i'') = 0$

$10 i'' = -20$

$i'' = -2A$

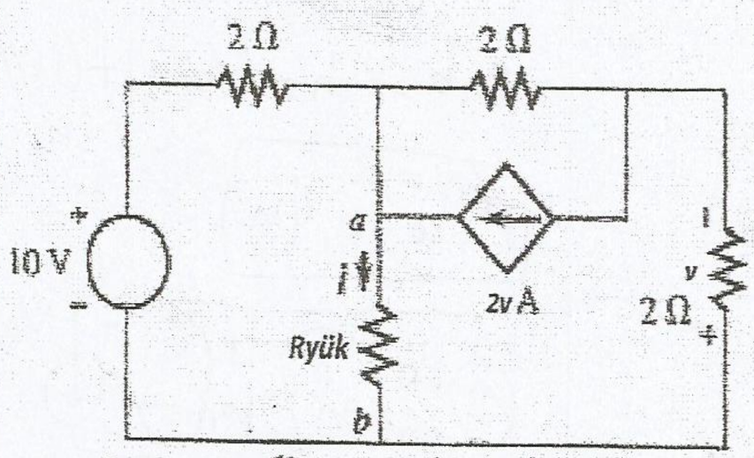
$\boxed{i_x'' = -3 i'' = 6A}$

Sonuç olarak;

$i_x = i_x' + i_x''$

$\boxed{i_x = -3 + 6 = 3A}$

Soru 2) Şekilde verilen devrede a-b arasındaki Ryük direncine iletilebilecek maksimum gücü bulunuz. (35 P)



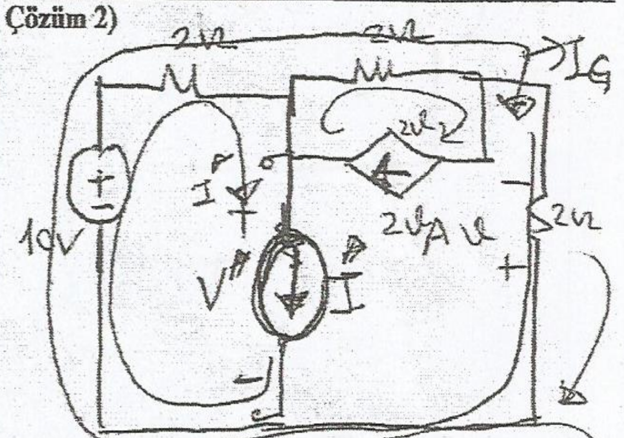
V^{*} için I^{*} gerekli → KVL

$V^{*} - 10 + 2 \cdot (I_G + I^{*}) = 0$

$V^{*} - 10 + 2I^{*} + 2 \cdot (I^{*} - 5) = 0$

$V^{*} = 4(-I^{*}) + 20$

Çözüm 2)



I_G için KVL

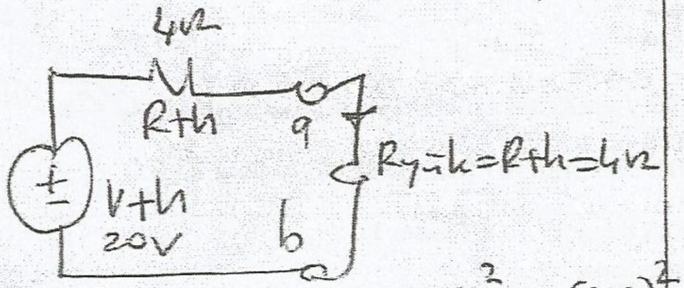
$\boxed{v = -2I_G}$

$2v = -4I_G$

$-10 + 2 \cdot (I^{*} + I_G) + 2 \cdot (-4I_G + I_G) + 2I_G = 0$

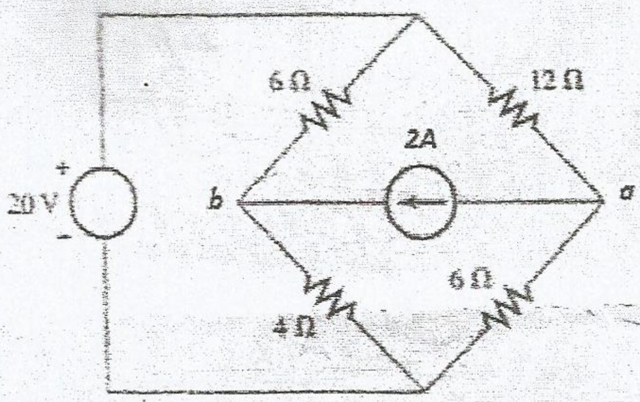
$I_G(\cancel{2} - 6 + 2) + I^{*}(2) - 10 = 0$

$-2I_G = 10 - 2I^{*}$

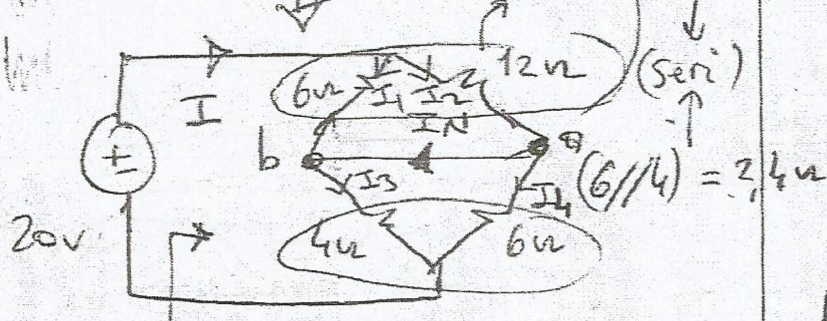


$$P_{max, Ryük} = \frac{V_{th}^2}{4 R_{th}} = \frac{(20)^2}{4\cdot 4} = \frac{20\cdot 20}{4\cdot 4} = 25\,W$$

Soru3) Şekilde verilen devrede, a-b arasındaki akım kaynağının gücünü, Norton Teoremi'ni kullanarak bulunuz. (30 P)



IN için



$R_{eş} = 4 + 2,4 = 6,4\,\Omega$

$I = \frac{20}{6,4}\,A = 3,125\,A$

$I_1 = 3,125 * \frac{12}{18} \cong 2,083\,A$

$I_2 = 3,125 * \frac{6}{18} \cong 1,041\,A$

$I_3 = 3,125 * \frac{6}{10} = 1,875\,A$

Çözüm 3)

a için KCL

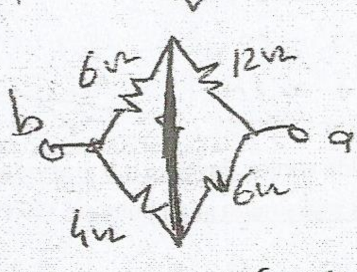
$I_2 - I_N - I_4 = 0$

$I_N = I_2 - I_4$

$I_N = 1,041 - 1,25$

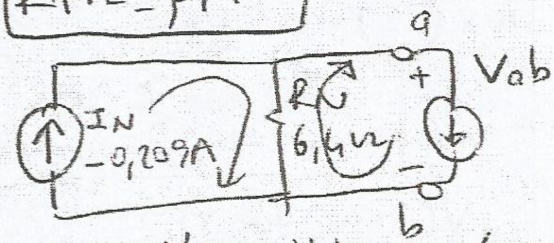
$\boxed{I_N = -0,209\,A}$

RN



$R_{ab} = R_{th} = (6//4) + (12//6)$
$\quad\quad 2,4 + 4$

$\boxed{R_N = R_{th} = 6,4\,\Omega}$



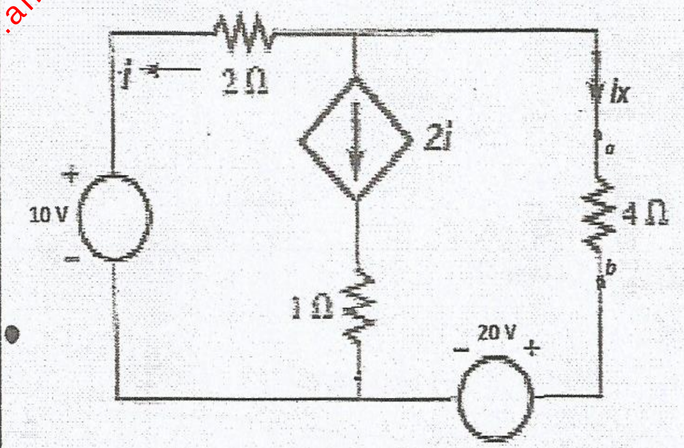
$V_{RN} = V_{ab} = 6,4\cdot(-0,209 - 2)$

$V_{ab} = 13,56\,V$

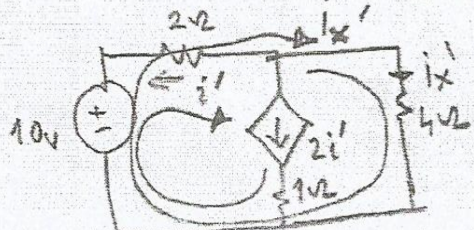
$I_4 = 3,125 * \frac{4}{10} = 1,25\,A$

$P_{ab} = 2 * (-13,56) = -27,12\,W$

Soru 1) Şekilde verilen devrede a-b arasındaki 4 Ω'luk direncin akımını (i_x) **Süperpozisyon (toplamsallık) teoremini** kullanarak bulunuz. **(35 P)**



10 V varken (20 V kısa devre, 2i devrede)



i_x' için KVL

$i' = -2i' - i_x'$

$3i' = -i_x'$

$\boxed{i' = -\frac{1}{3} i_x'}$

$-10 + 2(i_x' + 2i') + 4 \cdot i_x' = 0$

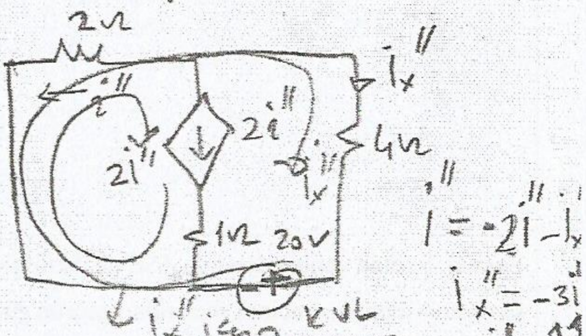
$-10 + 2 \cdot (i_x' + 2 \cdot (-\frac{1}{3} i_x')) + 4 \cdot i_x' = 0$

$i_x'(2 - \frac{4}{3} + 4) = 10 \Rightarrow \frac{14}{3} i_x' = 10$

$\boxed{i_x' = \frac{15}{7} A} \cong 2{,}14 A$

Çözüm 1)

20 V varken (10 V → K.D, 2i → devrede)



$i'' = -2i'' - i_x''$

$i_x'' = -3i''$

$i'' = -\frac{1}{3} i_x''$

i_x'' için KVL

$4 \cdot i_x'' + 2(i_x'' + 2i'') + 20 = 0$

$4 \cdot i_x'' + 2 \cdot (i_x'' + 2 \cdot (-\frac{1}{3} i_x'')) + 20 = 0$

$i_x''(4 + 2 - \frac{4}{3}) = -20$

$\frac{14}{3} i_x'' = -20$

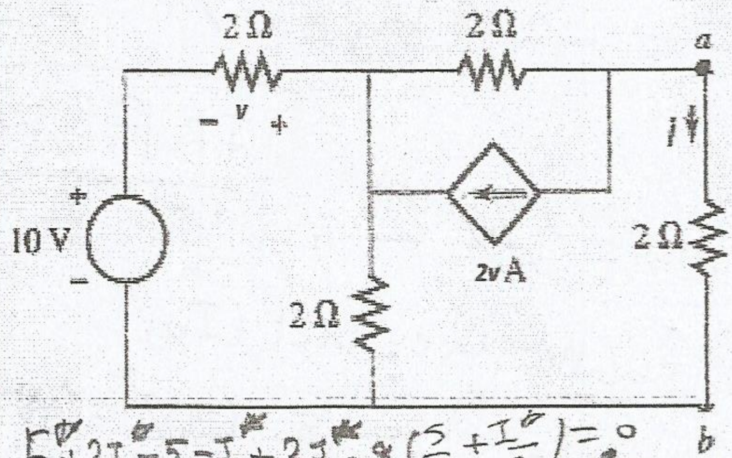
$\boxed{i_x'' = -\frac{30}{7} A} \cong -4{,}28 A$

$\boxed{i_x \cong -2{,}14 A}$

Sonuç olarak

$i_x = i_x' + i_x'' = \frac{15}{7} - \frac{30}{7} = -\frac{15}{7} A$

Soru 2) Şekilde verilen devrede a-b arasındaki 2Ω'luk direncin akımını **Norton teoremini** kullanarak bulunuz. **(35 P)**



$E^{\flat} + 2I^{\flat} - 5 - I^{\flat} + 2I^{\flat} - 8(\frac{5}{2} + \frac{I^{\flat}}{2}) = 0$

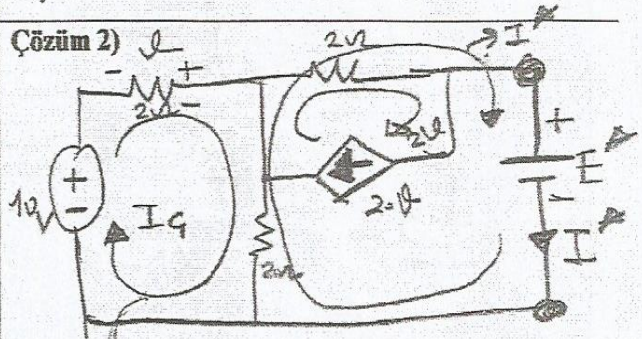
$E^{\flat} + I^{\flat}(2 - 1 + 2 - 4) + (-5 - 20) = 0$

$-I^{\flat} + E^{\flat} - 25 = 0$

$-I^{\flat} = -E^{\flat} + 25$

$I^{\flat} = E^{\flat} - 25$

Çözüm 2)



$v = -2I_G$

KVL

$-10 + 4I_G - 2I^{\flat} = 0$

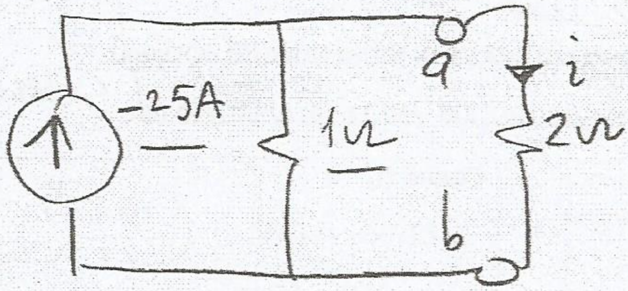
$4I_G = 2I^{\flat} + 10$

$\boxed{I_G = \frac{5}{2} + \frac{I^{\flat}}{2}}$

$I^{\flat}$ için KVL

$E^{\flat} + 2 \cdot (I^{\flat} - I_G) + 2 \cdot (I^{\flat} + 2 \cdot v) = 0$

$E^{\flat} + 2I^{\flat} - 2 \cdot (\frac{5}{2} + \frac{I^{\flat}}{2}) + 2I^{\flat} + 4 \cdot (-2I_G) = 0$



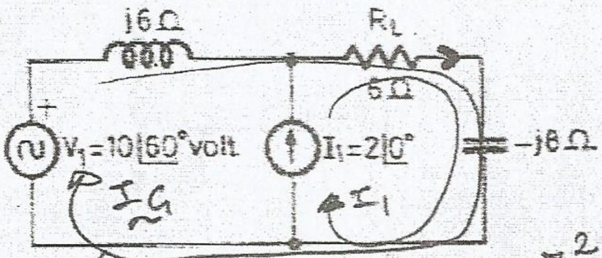
$$i = (-25) \cdot \frac{1}{1+2}$$

$$i = \frac{-25}{3} \cong -8,\overline{33} \text{ A}$$

Soru3) Şekilde verilen devrede, SSH'de (Sinüsoidal Sürekli Hal) R_L direncinin akımını, bobinin ve kondansatörün güçlerini ($Q_L = X_L . i^2$, $Q_c = X_c . i^2$) bulunuz. (30 P)

Çözüm 3)

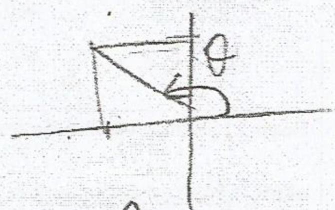
(~) → fazörel işaret



KVL

$$-V_1 + (j6) \times I_G + 6 \cdot (\overset{2\angle 0°}{I_1} + I_G) - (j8) \cdot (\overset{2\angle 0°}{I_1} + I_G) = 0$$

$$-10\angle 60° + I_G (j6 + 6 - j8) + (12 - 16j) = 0$$



$$I_G (6 - 2j) = 10\angle 60° + 16j - 12$$

$$I_G = \frac{10\angle 60° + 16j - 12}{6 - 2j} = -2,28 + j3,35 \text{ A}$$

$$I_G \cong 4\angle 124° \text{ A}$$

$$I_{RL} = I_1 + I_G = 2\angle 0° + 4\angle 124° \cong 3,32\angle 94°$$

$$\boxed{|I_{RL}| \cong 3,32 \text{A}}$$

$$P_{RL} = |R_L| \, |I_{RL}|^2 = 6 \cdot (3,32)^2 \cong 66 \text{W}$$

$$Q_L = |X_L| \, |I_L|^2 = 6 \cdot (4)^2 = 96 \text{VAr}$$

(+)
end.

$$Q_c = |X_c| \cdot (I_c)^2$$

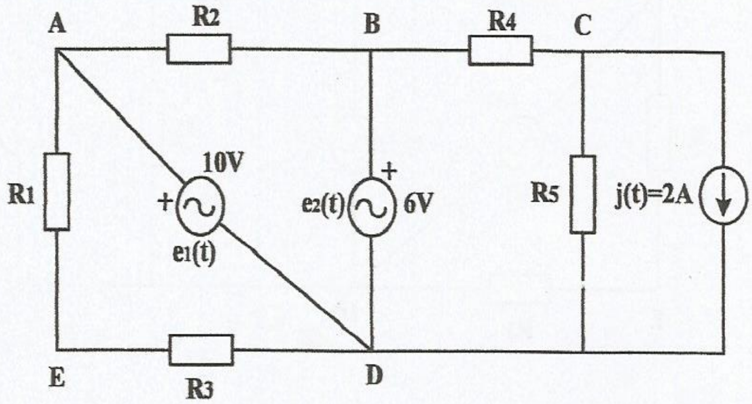
(=)

$$Q_c = (8) \cdot (3,32)^2 \cong 88 \text{VAr}$$

(−)
kap.

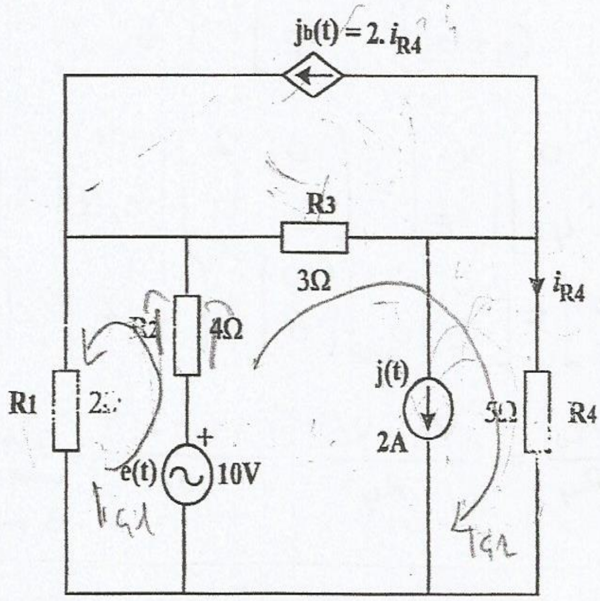
SORU 1) (30 puan)
Şekil-1'deki devre için **Düğüm Gerilimleri Yöntemi** (DÜGY) ile,
a) Devre denklemlerini matris biçiminde yazınız.
b) Denklemi çözerek R_4 direncinin gücünü hesaplayınız ve akım yönünü belirtiniz.

$R_1 = R_2 = R_3 = R_4 = R_5 = 0{,}5\Omega$



Şekil-1

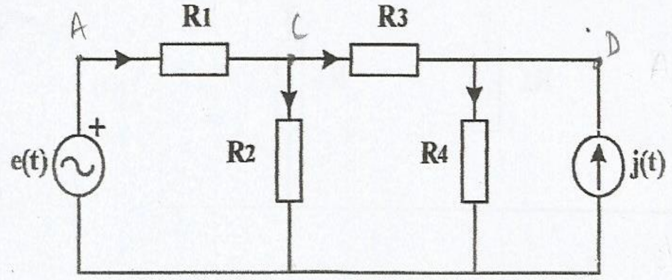
SORU 2) (40 puan)
Şekil-2'deki devre için,
a) Çevre Akımları Yöntemi (ÇAY) ile devre denklemlerini matris biçiminde elde ediniz.
b) R_3 direncinin gücünü hesaplayınız.



Şekil-2

V=I.R
10=5.I
I=2

SORU 3) (30 puan)
Şekil-3'deki devreye bakarak,
a) Kiriş Akımları Yöntemi (KAY) ile devre denklemlerini matris biçiminde yazınız.
b) Dal Gerilimleri Yöntemi (DGY) ile devre denklemlerini matris biçiminde yazınız.



Şekil-3

Not: R_1 ve R_2 dirençleri kiriş olarak seçilecek ve dirençlerin akım yönleri şekildeki gibi alınacaktır.

SORU 4) (30 puan) Birinci mertebeden bir devrenin **Durum Denklemi** aşağıdaki biçimde elde edilmiştir.

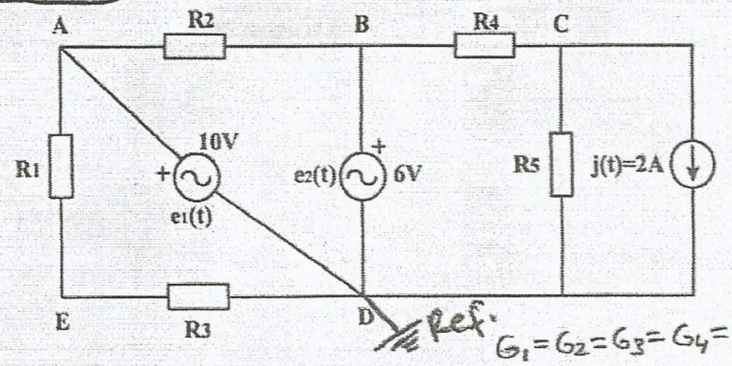
$$\frac{d}{dt}i_L(t) = -2.i_L(t) + 3 - 4.e^{-3t} + 2\cos 2t \;, \qquad i_L(0) = 5\text{ A olduğuna göre,}$$

a) Öz çözümü bulunuz.
b) Özel çözümü ve zorlanmış çözümü bulunuz.
c) Tam çözümü bulunuz.

NOT: 1. ve 2. sorular zorunludur. 3. ve 4. sorulardan sadece bir tanesi seçilecektir.

Süre: 90 dk. Başarılar dileriz.

SORU 1)



$V_A = e_1(t) = 10V$ } Biliniyor
$V_B = e_2(t) = 6V$

$V_C = ?$ } Bilinmiyor
$V_E = ?$

$V_D = 0 =$ Referans Düğüm

$G_1 = G_2 = G_3 = G_4 = G_5 = 2 \text{mho}$

a)
$$\begin{bmatrix} G_4+G_5 & 0 \\ 0 & G_1+G_3 \end{bmatrix} \cdot \begin{bmatrix} V_C \\ V_E \end{bmatrix} + \begin{bmatrix} 0 & -G_4 \\ -G_1 & 0 \end{bmatrix} \begin{bmatrix} e_1(t) \\ e_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} j(t) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

($e_1(t) \to V_A$, $e_2(t) \to V_B$)

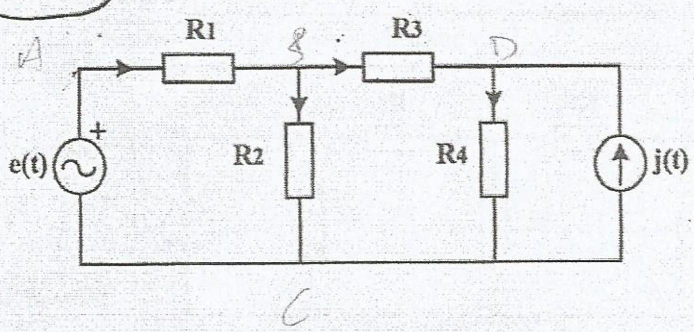
$$\begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix} \begin{bmatrix} V_C \\ V_E \end{bmatrix} = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix} \begin{bmatrix} e_1(t) \\ e_2(t) \end{bmatrix} + \begin{bmatrix} -1 \\ 0 \end{bmatrix} j(t)$$

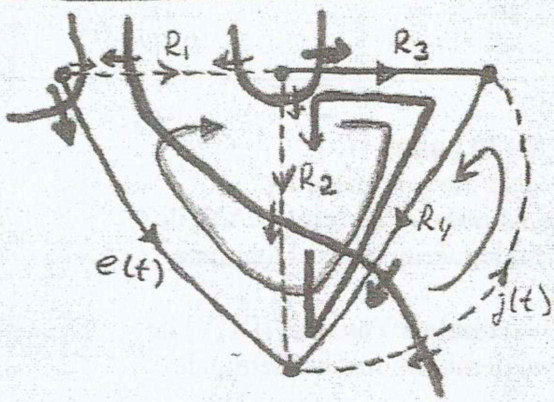
$$\begin{bmatrix} 4V_C \\ 4V_E \end{bmatrix} = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix} \begin{bmatrix} 10 \\ 6 \end{bmatrix} + \begin{bmatrix} -1 \\ 0 \end{bmatrix} 2 \Rightarrow \begin{bmatrix} 4V_C \\ 4V_E \end{bmatrix} = \begin{bmatrix} 10 \\ 20 \end{bmatrix} \Rightarrow \boxed{V_C = 2{,}5V} \quad \boxed{V_E = 5V}$$

b)
$$i_{R_4} = \frac{V_{R_4}}{R_4} = \frac{V_B - V_C}{R_4} = \frac{6-2{,}5}{0{,}5} = \underline{7A} \Rightarrow P_{R_4} = i_{R_4}^2 \cdot R_4 = \underline{24{,}5\,W}$$

B → R_4 → C, $i_{R_4} = 7A$ [B → C yönünde]

SORU 3)





a) KAY ile

$$\begin{bmatrix} R_1+R_3+R_4 & -(R_3+R_4) \\ -(R_3+R_4) & R_2+R_3+R_4 \end{bmatrix} \begin{bmatrix} i_{R_1} \\ i_{R_2} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} e(t) + \begin{bmatrix} -R_4 \\ R_4 \end{bmatrix} j(t)$$

b) DGY ile

$$\begin{bmatrix} G_1+G_2+G_3 & G_1+G_2 \\ G_1+G_2 & G_1+G_2+G_4 \end{bmatrix} \begin{bmatrix} V_{R_3} \\ V_{R_4} \end{bmatrix} = \begin{bmatrix} G_1 \\ G_1 \end{bmatrix} e(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} j(t)$$

Dış Devre Teo. (20071) 1. Vize Cevap Anahtarı 15.11.2007

$\to a=-2$ $\to \alpha=-3$ $(a\neq\alpha)$

(4) $\frac{d}{dt} i_L(t) = -2 \cdot i_L(t) + 3 - 4e^{-3t} + 2\cos 2t$ $\quad i_L(0) = 5A$

a) Öz çözüm, $i_{L_{öz}}(t) = i_L(0).e^{at} \Rightarrow \boxed{i_{L_{öz}}(t) = 5e^{-2t}}$

b) Özel çözüm, $\boxed{i_{L_{özel}}(t) = A + Be^{-3t} + C\cos 2t + D\sin 2t}$

Bu özel çözümün dif. denklemi sağlaması gerekir,

$$\frac{d}{dt} i_{L_{özel}}(t) = -3Be^{-3t} - 2C\sin 2t + 2D\cos 2t$$

$$\frac{d}{dt} i_{L_{özel}}(t) = -2\, i_{L_{özel}}(t) + 3 - 4e^{-3t} + 2\cos 2t$$

$$-3Be^{-3t} - 2C\sin 2t + 2D\cos 2t = -2\,(A + Be^{-3t} + C\cos 2t + D\sin 2t) + 3 - 4e^{-3t} + 2\cos 2t$$

$$-3Be^{-3t} - 2C\sin 2t + 2D\cos 2t = \overbrace{(3-2A)}^{0} + (-2B-4)e^{-3t} - 2D\sin 2t + (2-2C)\cos 2t$$

$3-2A=0$, $\boxed{A=\frac{3}{2}}$

$-2C=-2D$, $\underline{C=D}$

$2D = 2-2C$, $C=D$ idi, $2C = 2-2C$, $4C=2$, $\boxed{C=\frac{1}{2}}$

$C=D \Rightarrow \boxed{D=\frac{1}{2}}$

$-3B=-2B-4$, $\boxed{B=4}$

$$i_{L_{özel}}(t) = A + Be^{-3t} + C\cos 2t + D\sin 2t$$

$$\boxed{i_{L_{özel}}(t) = \frac{3}{2} + 4e^{-3t} + \frac{1}{2}\cos 2t + \frac{1}{2}\sin 2t}$$

$i_{L_{özel}}(0) = \frac{3}{2} + 4e^{0} + \frac{1}{2}\cos 0$

$\boxed{i_{L_{özel}}(0) = 6}$

Zorlanmış çözüm, $i_{L_{zor}}(t) = i_{L_{özel}}(t) - e^{at} i_{L_{özel}}(0)$

$$\boxed{i_{L_{zor}}(t) = \frac{3}{2} + 4e^{-3t} + \frac{1}{2}\cos 2t + \frac{1}{2}\sin 2t - 6e^{-2t}}$$

Tam çözüm; $i_{L_{tam}}(t) = i_{L_{öz}}(t) + i_{L_{zor}}(t)$

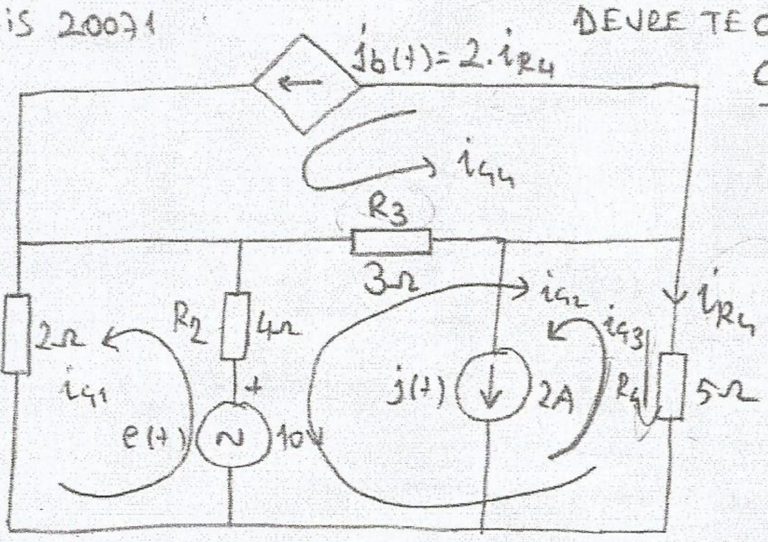
$$i_{L_{tam}}(t) = 5e^{-2t} + \frac{3}{2} + 4e^{-3t} + \frac{1}{2}\cos 2t + \frac{1}{2}\sin 2t - 6e^{-2t}$$

$$\boxed{i_{L_{tam}}(t) = -e^{-2t} + \frac{3}{2} + 4e^{-3t} + \frac{1}{2}\cos 2t + \frac{1}{2}\sin 2t}$$

Kontrol: $i_L(0) = -e^{0} + \frac{3}{2} + 4e^{0} + \frac{1}{2}\cos 0 + \frac{1}{2}\sin 0 = 5$ (doğru)

SİSİS 20071 — DEVRE TEO. 1 VİZE SINAVI CEVAP ANAHTARI

2



$i_{ç_1} = ?$

$i_{ç_2} = ?$

$i_{ç_3} = j(t) = 2A$

$i_{ç_4} = j_b(t) = 2 i_{R_4}$
$= 2(i_{ç_2} - j(t))$

$$\begin{bmatrix} R_1+R_2 & R_2 \\ R_2 & R_2+R_3+R_4 \\ & +2R_3 \end{bmatrix}\begin{bmatrix} i_{ç_1} \\ i_{ç_2} \end{bmatrix} + \begin{bmatrix} -1 \\ -1 \end{bmatrix} e(t) + \begin{bmatrix} 0 \\ -R_4 \\ -2R_3 \end{bmatrix} j(t) + \begin{bmatrix} 0 \\ R_3 \end{bmatrix} j_b(t) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$j_b(t) \downarrow \; 2 i_{R_4} = 2(i_{ç_2} - j(t))$

$$\boxed{\begin{bmatrix} R_1+R_2 & R_2 \\ R_2 & R_2+3R_3+R_4 \end{bmatrix}\begin{bmatrix} i_{ç_1} \\ i_{ç_2} \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix} e(t) + \begin{bmatrix} 0 \\ 2R_3+R_4 \end{bmatrix} j(t)}$$

$$\begin{bmatrix} (2+4) & 4 \\ 4 & (4+9+5) \end{bmatrix}\begin{bmatrix} i_{ç_1} \\ i_{ç_2} \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix} + \begin{bmatrix} 0 \\ 11 \end{bmatrix} \cdot 2$$

$$\begin{bmatrix} 6 & 4 \\ 4 & 18 \end{bmatrix}\begin{bmatrix} i_{ç_1} \\ i_{ç_2} \end{bmatrix} = \begin{bmatrix} 10 \\ 32 \end{bmatrix} \Rightarrow i_{ç_1} = \frac{\begin{vmatrix} 10 & 4 \\ 32 & 18 \end{vmatrix}}{\begin{vmatrix} 6 & 4 \\ 4 & 18 \end{vmatrix}} = \frac{52}{92} \Rightarrow \boxed{i_{ç_1} = 0{,}565A}$$

$\cancel{12}$

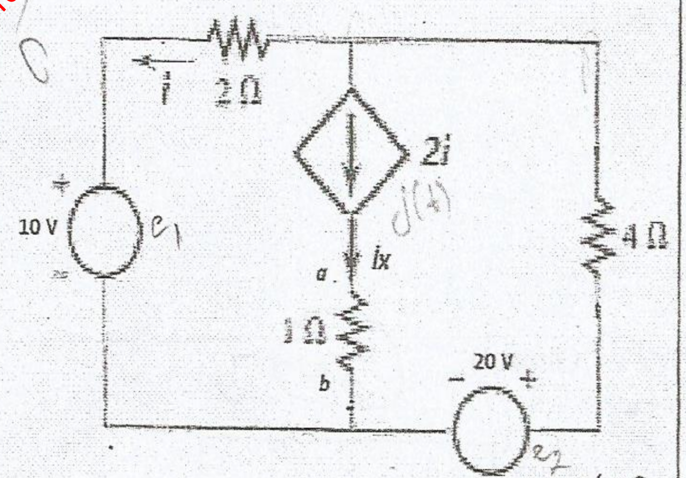
$$i_{ç_2} = \frac{\begin{vmatrix} 6 & 10 \\ 4 & 32 \end{vmatrix}}{\begin{vmatrix} 6 & 4 \\ 4 & 18 \end{vmatrix}} = \frac{152}{92} \Rightarrow \boxed{i_{ç_2} = 1{,}652\ A}$$

$$P_{R_3} = R_3\, i_{R_3}^2 \Rightarrow i_{R_3} = i_{ç_2} + j_b(t) = i_{ç_2} + 2 i_{R_4} = i_{ç_2} + 2(i_{ç_2} - j(t))$$

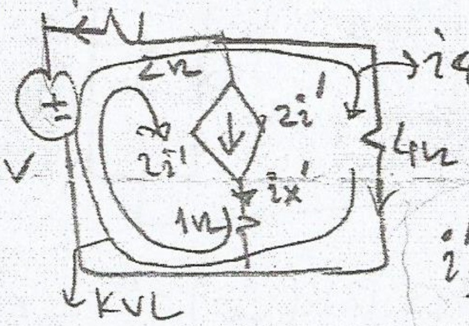
$$i_{R_3} = 3 i_{ç_2} - 2 j(t) = 3\ 1{,}652 - 2\ 2 \Rightarrow \boxed{i_{R_3} = 0{,}956\ A}$$

$$P_{R_3} = R_3\, i_{R_3}^2 = 3 \cdot 0{,}956^2 \Rightarrow \boxed{P_{R_3} = 2{,}742\ W}$$

Soru 1) Şekilde verilen devrede a-b arasındaki 1Ω'luk direncin akımını *(Ix)* **Süperpozisyon (toplamsallık) teoremini** kullanarak bulunuz. (35 P)



10 V varken (20 V → K.D, 2i devrede)



$i' = -2i' - I_g$

$3i' = -I_g$

$I_g = -3i'$

$4i_g - 10 + 2\cdot(2i' + I_g) = 0$

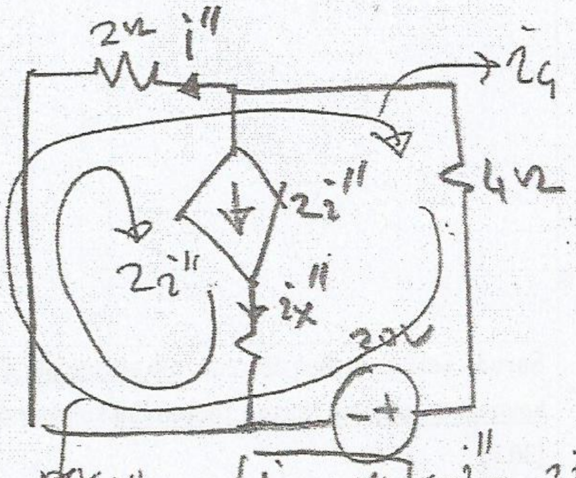
$6i_g - 10 + 4i' = 0$

$6\cdot(-3i') + 4i' = 10$

$-14i' = 10 \Rightarrow i' = -\frac{5}{7}A \Rightarrow i_x' = -\frac{10}{7}A$

Çözüm 1)

20 V varken (10 V → K.D, 2i devrede)



$I_g = 3i'' \Leftarrow i'' = -2i'' - I_g$

$4i_g + 20 + 2\cdot(2i'' + i_g) = 0$

$6i_g + 20 + 4i'' = 0$

$6(-3i'') + 4i'' = -20$

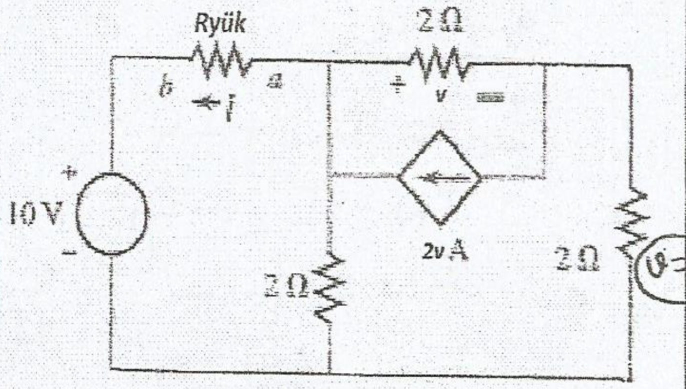
$-14i'' = -20$

$i'' = \frac{10}{7}A$ $\quad i_x'' = \frac{20}{7}A$

Sonuç olarak

$$i_x = i_x' + i_x'' = -\frac{10}{7} + \frac{20}{7} = \frac{10}{7}A$$

Soru 2) Şekilde verilen devrede a-b arasındaki Ryük direncine iletilebilecek maksimum gücü bulunuz. (35 P)

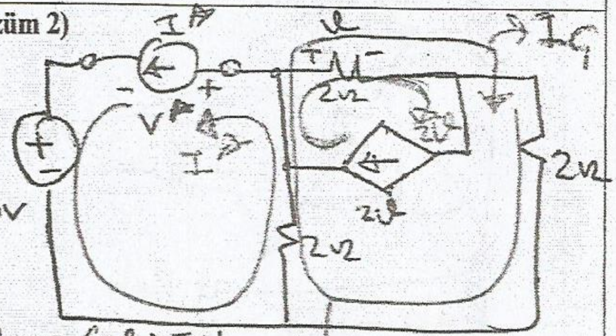


$R_{th} = \frac{4}{5}\Omega$ $\quad V_{th} = -10V$

$P_{max,Ryük} = \frac{V_{th}^2}{4R_{th}} = \frac{100}{4\cdot(\frac{4}{5})}$

$P_{max,Ryük} = \frac{500}{16} = 31{,}25W$

Çözüm 2)



$v = 2\cdot(2v + I_g)$ $\quad v = -\frac{2}{3}I_g$ $\quad I_g = (-\frac{3}{2}v)$

$I_g \rightarrow KVL$

$2I_g + 2\cdot(I_g + I^*) + 2\cdot(I_g + 2v) = 0$

$6I_g + 4\cdot(-\frac{2}{3}I_g) + 2I^* = 0$

$\frac{10}{3}I_g = -2I^* \Rightarrow I_g = -\frac{6}{10}I^*$

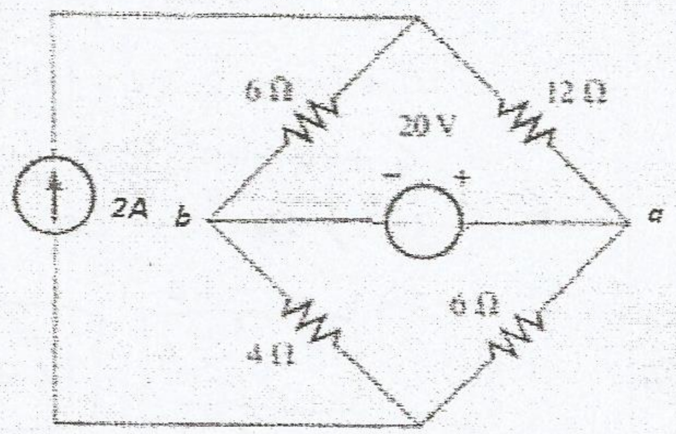
$I_g = -\frac{3}{5}I^*$

I^* için KVL

$\Downarrow$

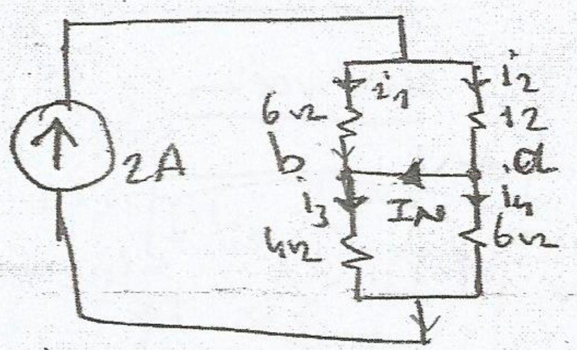
$V^* + 10 + 2\cdot(I^* - \frac{3}{5}I^*)$

Soru3) Şekilde verilen devrede, **a-b arasındaki ~~akım~~ gerilim kaynağının gücünü, Norton Teoremi'ni** kullanarak bulunuz.
(30 P)



Çözüm 3)

I_N



$$i_1 = (2)\cdot\left(\frac{12}{18}\right) = \frac{24}{18} = \frac{4}{3}\,A$$

$$i_2 = (2)\cdot\left(\frac{6}{18}\right) = \frac{12}{18} = \frac{2}{3}\,A$$

$$i_3 = (2)\cdot\left(\frac{6}{10}\right) = \frac{12}{10} = \frac{6}{5}\,A$$

$$i_4 = (2)\cdot\left(\frac{4}{10}\right) = \frac{8}{10} = \frac{4}{5}\,A$$

a → KCL

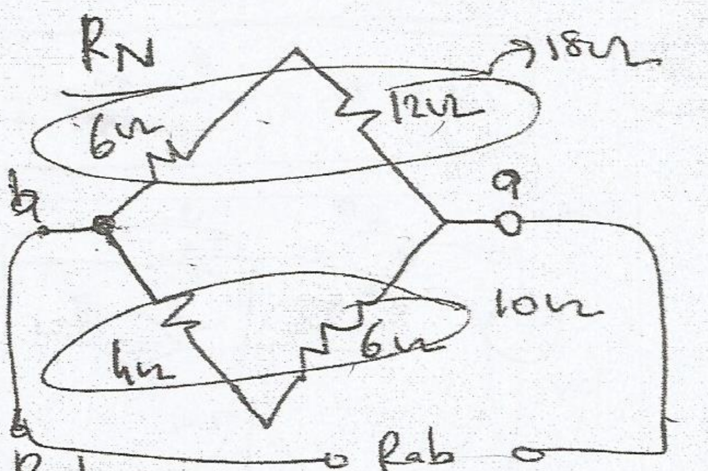
$$I_2 = I_N + I_4$$

$$I_N = I_2 - I_4$$

$$I_N = \underset{(5)}{\frac{2}{3}} - \underset{(3)}{\frac{4}{5}} = \frac{-2}{15}\,A$$

$$\boxed{I_N \cong -0{,}13\,A}$$

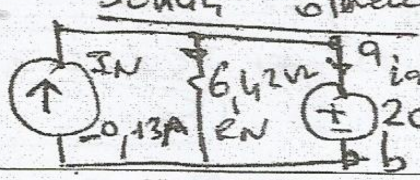
R_N



$$R_{ab} = (18) // 10$$

$$R_{ab} = \frac{18 \cdot 10}{28} = \frac{180}{28} \cong 6{,}42\,\Omega$$

Sonuç olarak



$$I_{R_N} = \frac{20}{6{,}42} \cong 3{,}11\,A$$

$$i_{ab} = 0{,}13 - 3{,}11$$

$$i_{ab} = -2{,}98\,A$$

Süre: 60 DK

BAŞARILAR.,

[redacted]

$$P_{ab} = (20)\cdot(-2{,}98) \cong -59{,}6\,W$$