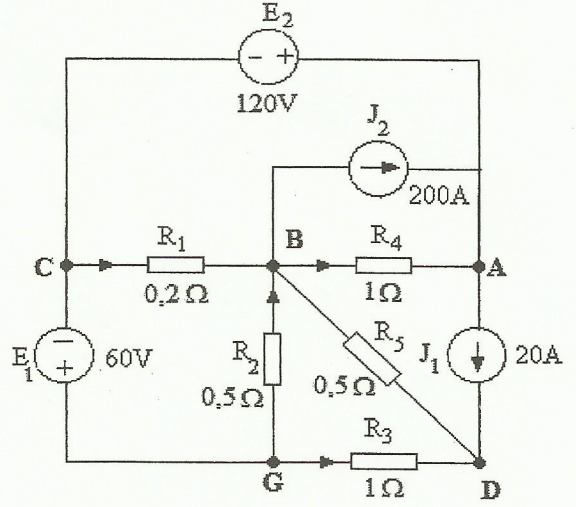


Soru-1.) (40p)

Şekil 1'deki devrede,

a) **Düğüm Gerilimleri Yöntemi (DÜGY)** ile devreye bakarak devre denklemlerini matris biçiminde yazınız.

b) Denklemleri çözünüz ve R_5 direncinin akımını hesaplayınız, akım yönünü belirtiniz.



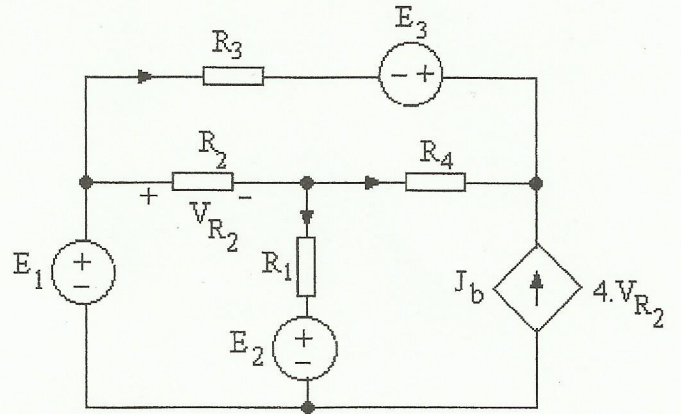
Şekil-1

Soru-2.) (20p)

Şekil 2'deki devrede,

Çevre Akımları Yöntemi (ÇAY) ile devreye bakarak devre denklemlerini matris biçiminde yazınız.

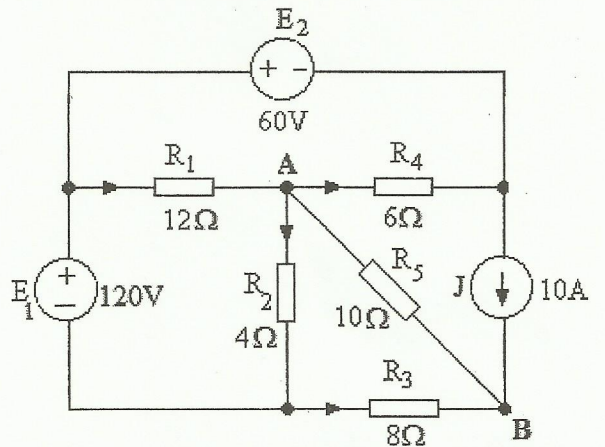
Not: Bağımsız çevre yönleri saat ibresi yönünde seçilecektir.



Şekil-2

Soru-3.) (40p)

Şekil 3'deki devrede, **10 Ohm'luk R_5 direncinden geçen akımı Thevenin Teoremi ile hesaplayınız.**



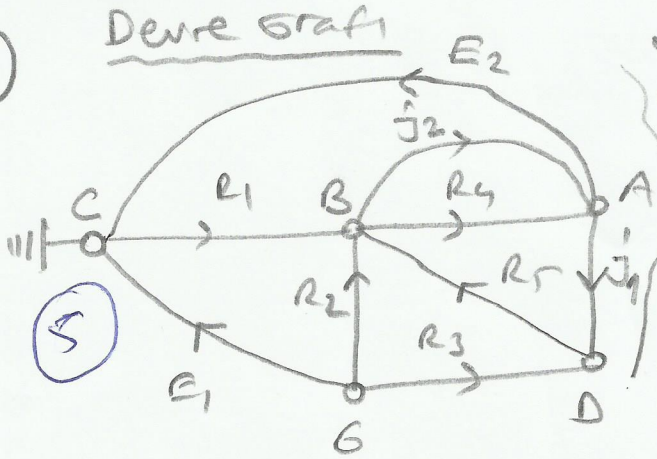
Şekil-3

Başarılar dileriz.

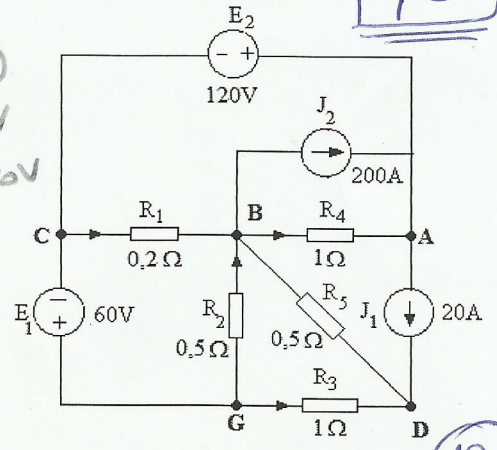
Süre : 90 dk

1

Devre Grafi



$V_C = 0$ (Ref.)
 $V_G = E_1 = 60V$
 $V_A = E_2 = 120V$
 $V_B = ?$
 $V_D = ?$



$$\begin{bmatrix} (G_1 + G_2 + G_4 + G_5) & -G_5 \\ -G_5 & (G_3 + G_5) \end{bmatrix} \begin{bmatrix} V_B \\ V_D \end{bmatrix} + \begin{bmatrix} -G_2 & -G_4 \\ -G_3 & 0 \end{bmatrix} \begin{bmatrix} E_1 \\ E_2 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} J_1 \\ J_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

↑ 15p

b) $G_1 = \frac{1}{R_1} = \frac{1}{0,2} = 5S$, $G_2 = \frac{1}{0,5} = 2S$, $G_3 = \frac{1}{1} = 1S$, $G_4 = \frac{1}{1} = 1S$, $G_5 = \frac{1}{0,5} = 2S$
 (Siemens)

$$\begin{bmatrix} (5+2+1+2) & -2 \\ -2 & (1+2) \end{bmatrix} \begin{bmatrix} V_B \\ V_D \end{bmatrix} + \begin{bmatrix} -2 & -1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 60 \\ 120 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 20 \\ 200 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 10 & -2 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} V_B \\ V_D \end{bmatrix} + \begin{bmatrix} -120 & -120 \\ -60 & \end{bmatrix} + \begin{bmatrix} 200 \\ -20 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 10 & -2 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} V_B \\ V_D \end{bmatrix} = \begin{bmatrix} 40 \\ 80 \end{bmatrix}$$

$$V_B = \frac{\begin{vmatrix} 40 & -2 \\ 80 & 3 \end{vmatrix}}{\begin{vmatrix} 10 & -2 \\ -2 & 3 \end{vmatrix}} = \frac{280}{26} \Rightarrow V_B = \frac{140}{13} = 10,77V$$

↑ 20p

$$V_D = \frac{440}{13} = 33,85V$$

↑ 25p

$$I_{R5} = 46,16A$$

↑ 35p

$V_D > V_B \Rightarrow$ Akım yönü $D \rightarrow B$ olur. ↑ 40p

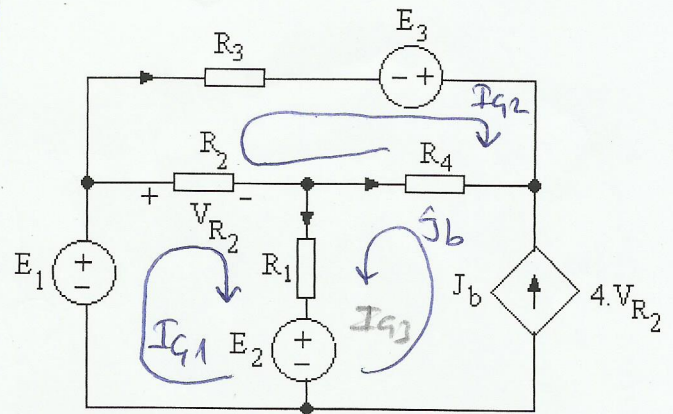
2

$I_{q3} = J_b$

$I_{q1} = ?$

$I_{q2} = ?$

20



10

$4R_1.R_2$

$-4R_1.R_2$

$$\begin{bmatrix} (R_1+R_2) & -R_2 \\ -R_2 & (R_2+R_3+R_4) \end{bmatrix} \cdot \begin{bmatrix} I_{q1} \\ I_{q2} \end{bmatrix} + \begin{bmatrix} -1 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \cdot \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} + \begin{bmatrix} R_1 \\ R_4 \end{bmatrix} J_b = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$4 \cdot R_2 (I_{q1} - I_{q2})$

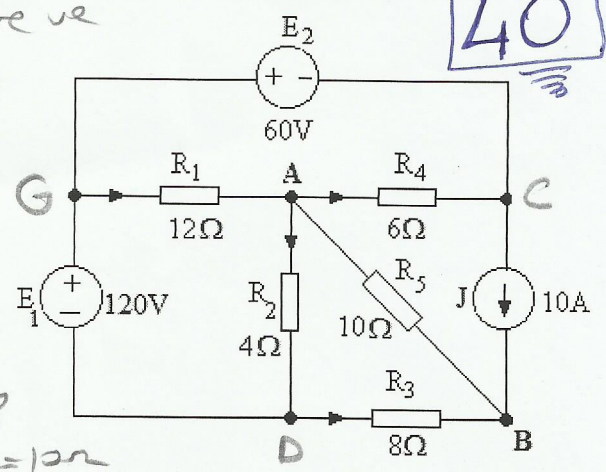
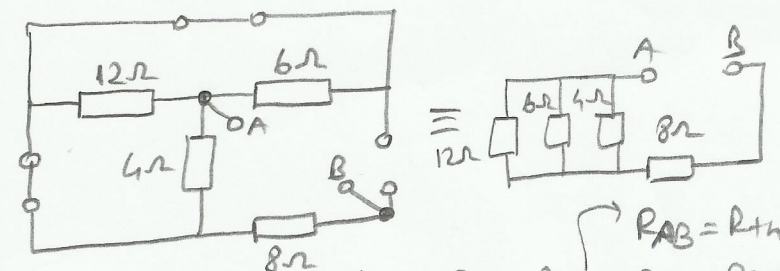
Denklemin son hali:

10

$$\begin{bmatrix} (R_1+R_2+4.R_1.R_2) & (-R_2-4.R_1.R_2) \\ (4.R_4.R_2-R_2) & (R_2+R_3+R_4-4.R_1.R_2) \end{bmatrix} + \begin{bmatrix} -1 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \cdot \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

3) $R_{th} = ?$ (E_1 kısa devre, E_2 kısa devre ve açık devre iken $R_{AB} = R_{th}$ olur.)

40



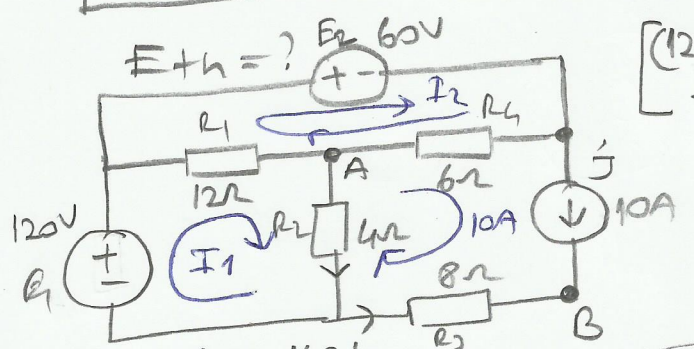
$$\frac{1}{R_{e1}} = \frac{1}{12} + \frac{1}{4} + \frac{1}{6} = \frac{6}{12} \Rightarrow R_{e1} = 2\Omega$$

$$R_{AB} = R_{th}$$

$$R_{th} = R_{e1} + 8$$

$$R_{th} = 2 + 8 = 10\Omega$$

$R_{th} = 10\Omega$ (10) $\uparrow 10P$



$$\begin{bmatrix} (12+4) & -12 \\ -12 & (12+6) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} + \begin{bmatrix} -10 \\ 0 \end{bmatrix} \begin{bmatrix} 120 \\ 60 \end{bmatrix} + \begin{bmatrix} -4 \\ 6 \end{bmatrix} \cdot 10 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 16 & -12 \\ -12 & 18 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 160 \\ 0 \end{bmatrix} \Rightarrow I_1 = \frac{160 \cdot 18}{16 \cdot 18 - (-12 \cdot 12)}$$

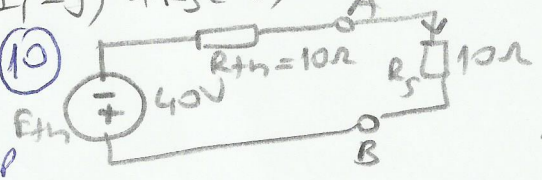
$$I_1 = \frac{160 \cdot 18}{144} \Rightarrow I_1 = 20A \quad (5)$$

$$I_2 = \frac{\begin{vmatrix} 16 & 160 \\ -12 & 0 \end{vmatrix}}{144} = \frac{12 \cdot 160}{144} \Rightarrow I_2 = \frac{40}{3} \approx 13,333A \quad (5)$$

$$I_2 = \frac{40}{3} \approx 13,333A \quad (5) \quad \uparrow 20P$$

$$V_{AB} = V_{R2} + V_{R3} = R_3(I_1 - J) + R_3(-J) = 4(20 - 10) + 8 \cdot (-10) = -40V$$

$E_{th} = V_{AB} = -40V$ (10) $\uparrow 30P$



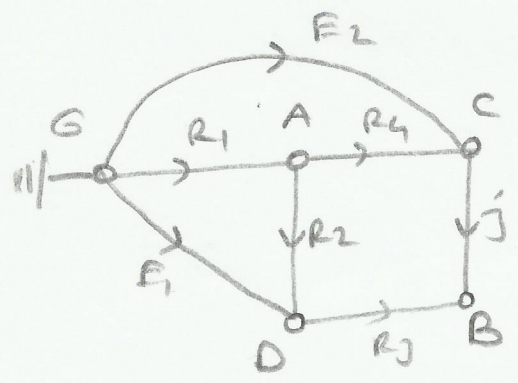
$$I_{R5} = \frac{E_{th}}{R_{th} + R_5}$$

$$I_{R5} = \frac{40}{10 + 10}$$

$I_{R5} = 2A$ (10) $\uparrow 40P$

E_{th} in DÜĞY re hesaplanır

A-B üzeri açık iken



$V_G = 0$ (Referans)
 $V_C = -E_2$
 $V_D = -E_1$
 $V_A = ?$, $V_B = ?$

$$\begin{bmatrix} (G_1 + G_2 + G_3) & 0 \\ 0 & G_3 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} + \begin{bmatrix} -G_2 & -G_4 \\ -G_3 & 0 \end{bmatrix} \begin{bmatrix} -E_1 \\ -E_2 \end{bmatrix} + \begin{bmatrix} 0 \\ -1 \end{bmatrix} J = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} (\frac{1}{12} + \frac{1}{4} + \frac{1}{6}) & 0 \\ 0 & \frac{1}{8} \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} + \begin{bmatrix} -\frac{1}{4} & \frac{1}{6} \\ -\frac{1}{8} & 0 \end{bmatrix} \begin{bmatrix} -120 \\ -60 \end{bmatrix} + \begin{bmatrix} 0 \\ -1 \end{bmatrix} \cdot 10 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{8} \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} -40 \\ -5 \end{bmatrix} \Rightarrow \begin{bmatrix} V_A = -80V \\ V_B = -40V \end{bmatrix} \quad (5)$$

$$E_{th} = V_{AB} = V_A - V_B = -80 - (-40) = -40V \quad (10)$$

$$I_{R5} = \frac{E_{th}}{R_{th} + R_5} = \frac{40}{10 + 10} \Rightarrow I_{R5} = 2A \quad (10)$$