

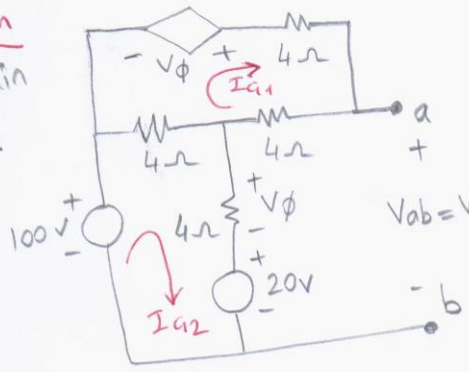
## CEVAPLAR

### SORU 1. [ 25 puan ]

- a) (ab) uçlarına bağlı R yük direncine maksimum güç transferi için R direncinin değeri ne olmalıdır?  
b) R direncinin Maksimum gücü nedir?

Gözüm

$V_{th}$  için R direnci çıkarılır.



$$\begin{bmatrix} 12 & -4 \\ -4 & 8 \end{bmatrix} \begin{bmatrix} I_{a1} \\ I_{a2} \end{bmatrix} = \begin{bmatrix} V_{\phi} \\ 100-20 \end{bmatrix}$$

Ek denklemler

$$V_{\phi} = 4 I_{a2}$$

$$\begin{aligned} 12 I_{a1} - 4 I_{a2} &= 4 I_{a2} \rightarrow 12 I_{a1} - 8 I_{a2} = 0 \\ -4 I_{a1} + 8 I_{a2} &= 80 \rightarrow -4 I_{a1} + 8 I_{a2} = 80 \end{aligned}$$

$$\begin{aligned} 8 I_{a1} &= 80 \\ I_{a1} &= 10A \end{aligned}$$

$$\begin{aligned} -4 \cdot 10 + 8 I_{a2} &= 80 \\ I_{a2} &= 15A \end{aligned}$$

$$V_{ab} = V_{th} = 4 I_{a2} + 4 I_{a2} + 20$$

$$V_{th} = 40 + 60 + 20 \rightarrow V_{th} = 120V \quad (9)$$

$R_{th}$  için, bağımsız kaynaklar yoldan edilip, test gerilim kaynağı bağlayalım.

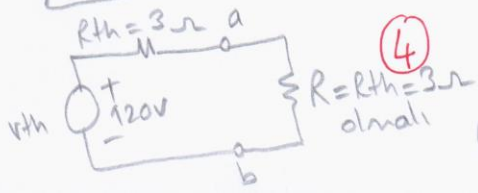
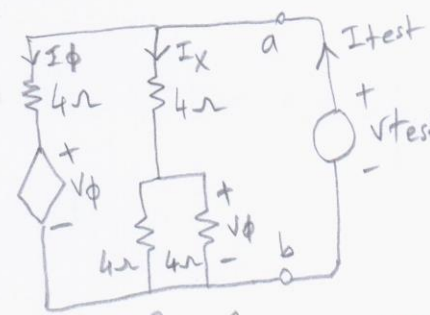
$$I_x = \frac{1}{4 + \frac{4 \cdot 4}{4 + 4}} = \frac{1}{6} A$$

$$V_{\phi} = 1 \cdot \frac{2}{4+2} = \frac{1}{3} V$$

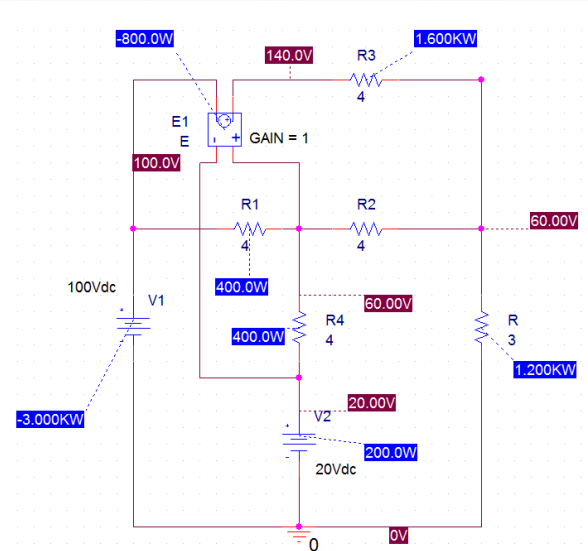
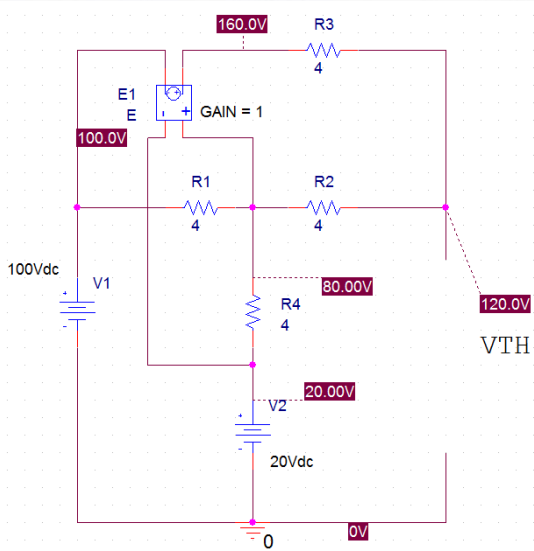
En dış çevreler;  $1 = 4 \cdot I_{\phi} + V_{\phi}$   
KGY  $4 \cdot I_{\phi} = 1 - \frac{1}{3} \rightarrow I_{\phi} = \frac{1}{6} A$

Üstteki dipom için KAY;  $I_{test} = I_{\phi} + I_x = \frac{1}{6} + \frac{1}{6} = \frac{1}{3} A$

$$R_{th} = \frac{V_{test}}{I_{test}} = \frac{1}{1/3} \Rightarrow R_{th} = 3\Omega \quad (8)$$



$$R_{max} = \frac{V_{th}^2}{4R} = \frac{120^2}{4 \cdot 3} = 1200 W \quad (4)$$



**SORU 2. [ 30 puan ]**

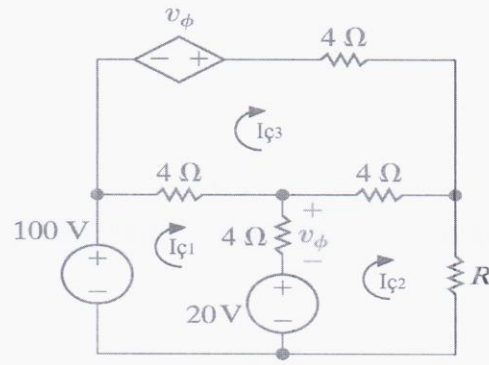
R direnci 9 ohm olarak veriliyor.

Çevre akımları yöntemini kullanarak

Tüm elamanlara ait güçleri bulunuz.

Tellegen Teoreminin sağlandığını gösteriniz.

(Çevre akımlarını saat yönünde seçiniz)



Görüm:

$$\begin{bmatrix} 8 & -4 & -4 \\ -4 & 17 & -4 \\ -4 & -4 & 12 \end{bmatrix} \begin{bmatrix} I_{\phi 1} \\ I_{\phi 2} \\ I_{\phi 3} \end{bmatrix} = \begin{bmatrix} 100 - 20 \\ 20 \\ v_{\phi} \end{bmatrix}$$

$$\begin{bmatrix} 8 & -4 & -4 \\ -4 & 17 & -4 \\ -8 & 0 & 12 \end{bmatrix} \begin{bmatrix} I_{\phi 1} \\ I_{\phi 2} \\ I_{\phi 3} \end{bmatrix} = \begin{bmatrix} 80 \\ 20 \\ 0 \end{bmatrix}$$

Ek denklem:  $v_{\phi} = 4 \cdot (I_{\phi 1} - I_{\phi 2})$ , eşitliğin soluna atılırsa, matrisin 3. satırı değişir.

$$\Delta = -8 \cdot (16 + 68) + 12 \cdot (136 - 16) = 768$$

$$\Delta_1 = 12 \cdot (80 \cdot 17 + 80) = 17280$$

$$\Delta_2 = -8 \cdot (-320 + 80) + 12 \cdot (160 + 320) = 7680$$

$$\Delta_3 = -8 \cdot (-80 - 1360) = 11520$$

$$I_{\phi 1} = \frac{\Delta_1}{\Delta} = \frac{17280}{768} = 22.5 \text{ A}$$

$$I_{\phi 2} = \frac{\Delta_2}{\Delta} = \frac{7680}{768} = 10 \text{ A}$$

$$I_{\phi 3} = \frac{\Delta_3}{\Delta} = \frac{11520}{768} = 15 \text{ A}$$

$$v_{\phi} = 4 \cdot (22.5 - 10) = 50 \text{ V}, I_{\phi} = -I_{\phi 3} = -15 \text{ A}$$

$$P_{\phi} = 50 \cdot (-15) = -750 \text{ W}$$

$$I_{100V} = -I_{\phi 1} = -22.5 \text{ A}$$

$$P_{100V} = 100 \cdot (-22.5) = -2250 \text{ W}$$

$$I_{20V} = I_{\phi 1} - I_{\phi 2} = 22.5 - 10 = 12.5 \text{ A}$$

$$P_{20V} = 20 \cdot 12.5 = 250 \text{ W}$$

$$P_{4\Omega} = I_{\phi 3}^2 \cdot 4\Omega = 22.5^2 \cdot 4 = 900 \text{ W}$$

$$P_{4\Omega} = (I_{\phi 3} - I_{\phi 2})^2 \cdot 4 = 2.5^2 \cdot 4 = 100 \text{ W}$$

$$P_{4\Omega} = (I_{\phi 3} - I_{\phi 1})^2 \cdot 4 = \frac{22.5}{4} \cdot 4 = 225 \text{ W}$$

$$P_{4\Omega} = (I_{\phi 1} - I_{\phi 2})^2 \cdot 4 = \frac{62.5}{4} \cdot 4 = 625 \text{ W}$$

$$P_{9\Omega} = I_{\phi 2}^2 \cdot 9 = 100 \cdot 9 = 900 \text{ W}$$

$$\Sigma P_{\text{verilen}} = -750 - 2250$$

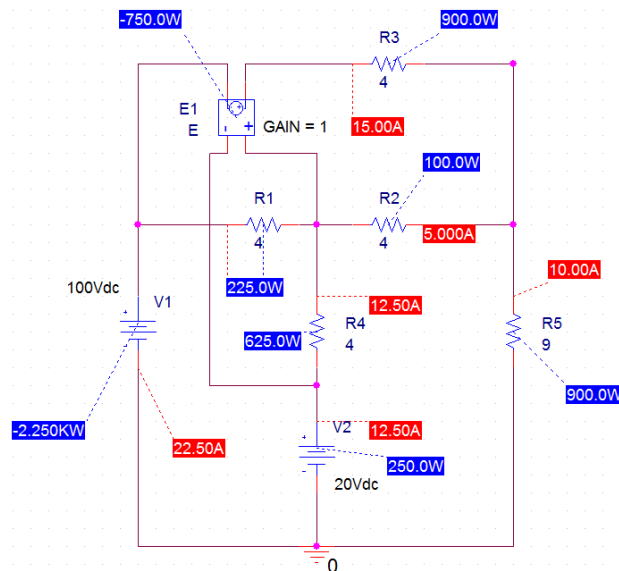
$$\Sigma P_{\text{verilen}} = -3000 \text{ W}$$

$$\Sigma P_{\text{alınan}} = 900 + 100 + 225 + 625 + 900$$

$$\Sigma P_{\text{alınan}} = +3000 \text{ W}$$

$$\Sigma P = \Sigma P_{\text{verilen}} + \Sigma P_{\text{alınan}}$$

$$\Sigma P = -3000 + 3000 = 0$$



**SORU 3.) [ 20 puan ]**

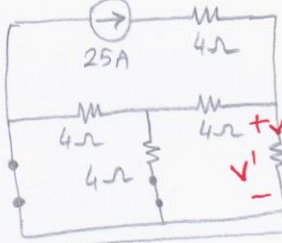
R direnci 15 ohm olarak veriliyor.

Toplamsallık ilkesi(Süperpozisyon) ile

R direncinin gerilimini bulunuz.

Gözüm

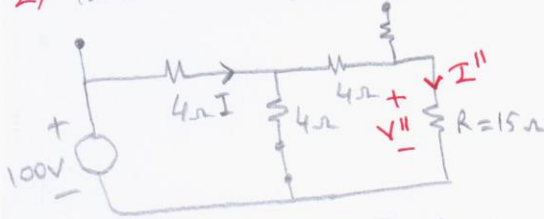
1) 25 A devrede, 100V ve 20V devre dışı iken



$$I' = 25 \cdot \frac{2+4}{2+4+15} = \frac{150}{21} = \frac{50}{7} \text{ A}$$

$$V' = 15 \cdot I' = 15 \cdot \frac{50}{7} = \frac{750}{7} \text{ V} \quad (6)$$

2) 100V devrede, 20V kısa devre, 25A açık devre



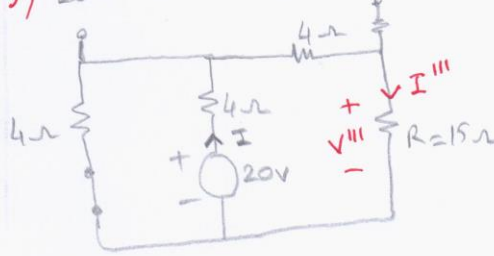
$$I = \frac{100}{4 + \frac{4 \cdot 19}{4+19}} = \frac{100}{\frac{92+76}{23}}$$

$$I = \frac{2300}{168} = \frac{575}{42} \text{ A}$$

$$I'' = I \cdot \frac{4}{4+19} = \frac{575}{42} \cdot \frac{4}{23} = \frac{50}{21} \text{ A}$$

$$V'' = 15 \cdot I'' = 15 \cdot \frac{50}{21} = \frac{750}{21} = \frac{250}{7} \text{ V} \quad (6)$$

3) 20V devrede, 100V kısa devre, 25A açık devre



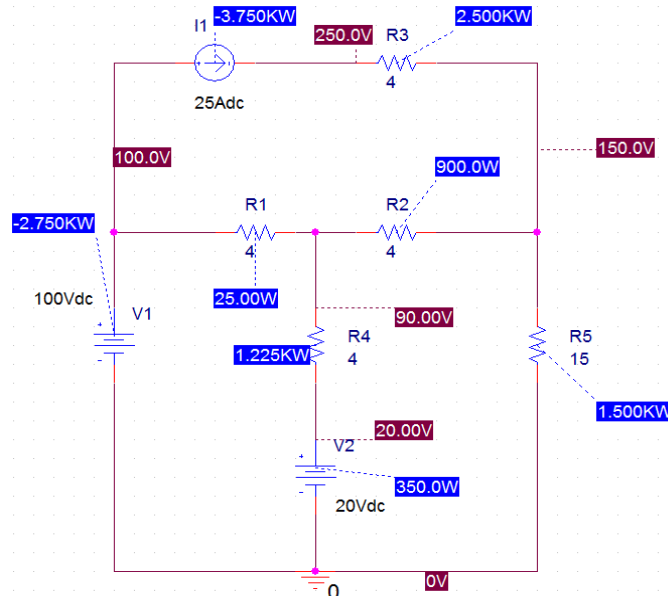
$$I = \frac{20}{4 + \frac{4 \cdot 19}{4+19}} = \frac{115}{42} \text{ A}$$

$$I''' = I \cdot \frac{4}{4+19} = \frac{115}{42} \cdot \frac{4}{23} = \frac{10}{21} \text{ A}$$

$$V''' = 15 \cdot I''' = 15 \cdot \frac{10}{21} = \frac{150}{21} = \frac{50}{7} \text{ V} \quad (6)$$

$$V = V' + V'' + V''' = \frac{750}{7} + \frac{250}{7} + \frac{50}{7} = \frac{1050}{7}$$

$$V = 150 \text{ V} \quad (2)$$





**SORU 4. [ 25 puan ]**

R direnci 4 ohm olarak veriliyor.

Düğüm denklemlerini ve ek denklemleri matris formunda yazarak düzenleyiniz.

(Bilgisayarda çözülebilecek hale getiriniz.)

**Gözüm :**

$$\begin{bmatrix} 1/4 & 0 & 0 & -1/4 & 0 \\ 0 & 1/4 & -1/4 & 0 & 0 \\ 0 & -1/4 & 3/4 & -1/4 & -1/4 \\ -1/4 & 0 & -1/4 & 3/4 & 0 \\ 0 & 0 & -1/4 & 0 & 1/4 \end{bmatrix} \begin{bmatrix} V_{d1} \\ V_{d2} \\ V_{d3} \\ V_{d4} \\ V_{d5} \end{bmatrix} = \begin{bmatrix} -I_{\phi} \\ I_{\phi} - I_{100} \\ 0 \\ 0 \\ -I_{20} \end{bmatrix}$$

$$1) V_{d2} = 100 \text{ V} \quad 2) V_{d5} = 20 \text{ V} \quad 3) V_{\phi} = V_{d1} - V_{d2} = V_{d3} - V_{d5}$$

$$V_{d1} - 100 = V_{d3} - 20$$

$$V_{d1} = 80 + V_{d3}$$

Denklemler aşağıdaki gibi düzenlenirse ;

$$\frac{1}{4}(80 + V_{d3}) - \frac{1}{4}V_{d4} = -I_{\phi} \Rightarrow \frac{1}{4}V_{d3} - \frac{1}{4}V_{d4} + I_{\phi} = -20 \quad (1)$$

$$\frac{1}{4} \cdot 100 - \frac{1}{4}V_{d3} = I_{\phi} - I_{100} \Rightarrow -\frac{1}{4}V_{d3} - I_{\phi} + I_{100} = -25 \quad (2)$$

$$-\frac{1}{4} \cdot 100 + \frac{3}{4}V_{d3} - \frac{1}{4}V_{d4} - \frac{1}{4} \cdot 20 = 0 \Rightarrow \frac{3}{4}V_{d3} - \frac{1}{4}V_{d4} = 30 \quad (3)$$

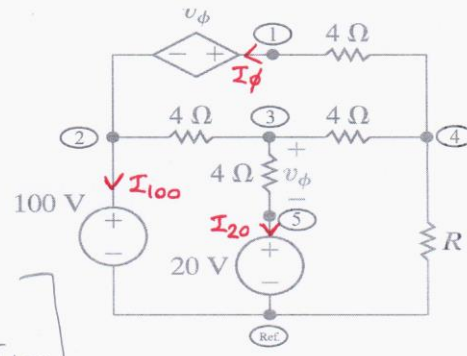
$$-\frac{1}{4}(80 + V_{d3}) - \frac{1}{4}V_{d3} + \frac{3}{4}V_{d4} = 0 \Rightarrow -\frac{1}{2}V_{d3} + \frac{3}{4}V_{d4} = 20 \quad (4)$$

$$-\frac{1}{4}V_{d3} + \frac{1}{4} \cdot 20 = -I_{20} \Rightarrow -\frac{1}{4}V_{d3} + I_{20} = -5 \quad (5)$$

$$\begin{bmatrix} 1 & 0 & 0 & 1/4 & -1/4 \\ -1 & 0 & 1 & -1/4 & 0 \\ 0 & 0 & 0 & 3/4 & -1/4 \\ 0 & 0 & 0 & -1/2 & 3/4 \\ 0 & 1 & 0 & -1/4 & 0 \end{bmatrix} \begin{bmatrix} I_{\phi} \\ I_{20} \\ I_{100} \\ V_{d3} \\ V_{d4} \end{bmatrix} = \begin{bmatrix} -20 \\ -25 \\ 30 \\ 20 \\ -5 \end{bmatrix}$$

**Matlab kodları**

```
>> G=[1 0 0 0.25 -0.25;
-1 0 1 -0.25 0;
0 0 0 0.75 -0.25;
0 0 0 -0.5 0.75;
0 1 0 -0.25 0];
>> I=[-20;-25;30;20;-5];
>> V=inv(G)*I
V =
-18.5714
10.7143
-27.8571
62.8571
68.5714
```



8 bilinmeyen, 5 denklem  
8-5=3 ek denklem gerekli

