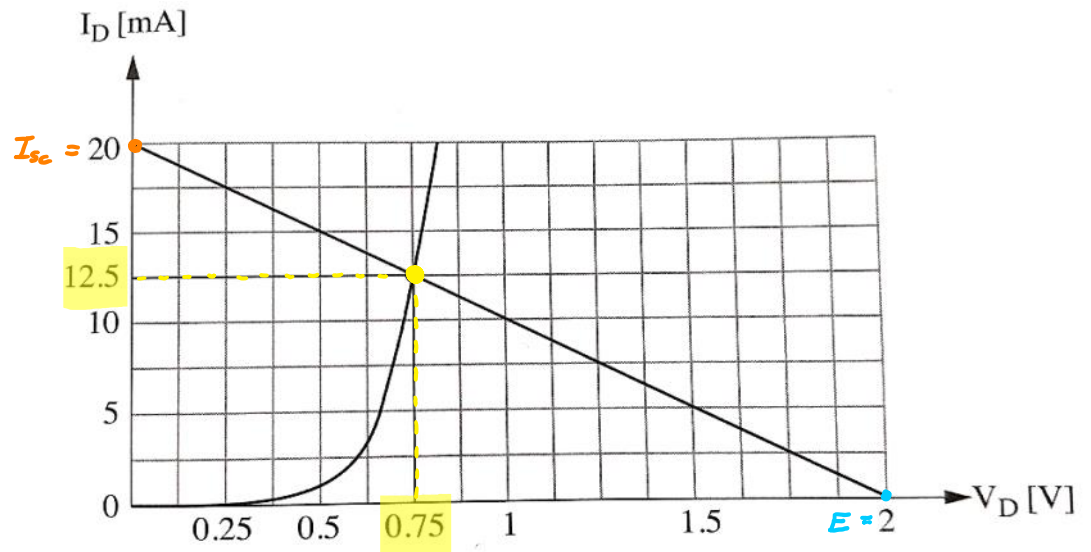
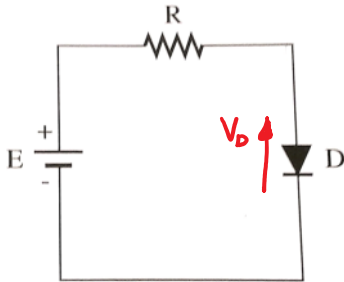


1



Ⓐ כאשר הפינה לא מואכלת, אזי $I_D = 0$, וזהו בן הפינה מתקבל מתוך $V_D = E$

↓

ניתן לראות מקו הגבולה שסביב נמצא עלו
נקבה:

$$E = 2V$$

ניתן לראות מקו הגבולה שסביב $V_D = 0$ נקבה את הזרם כי נמצא נק R , כלומר נק קרה:

$$I_{sc} = \frac{E}{R} \Rightarrow 20 = \frac{2}{R} \Rightarrow R = 0.1k\Omega = 100\Omega$$

Ⓑ צפי נקודות הגבולה נקבה: $I_D = 12.5mA$, $V_D = 0.75V$

↓

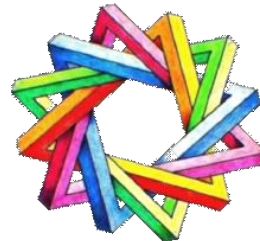
$$P_D = I_D \cdot V_D = 12.5 \cdot 0.75 = 9.375mW$$

$$\begin{aligned} \text{Ⓒ } \eta = 2 \\ V_T = 26mV \end{aligned} \Rightarrow I_D = I_S \left(e^{\frac{V_D}{\eta \cdot V_T}} - 1 \right)$$

$$12.5 = I_S \left(e^{\frac{0.75}{2 \cdot 26 \cdot 10^{-3}}} - 1 \right)$$

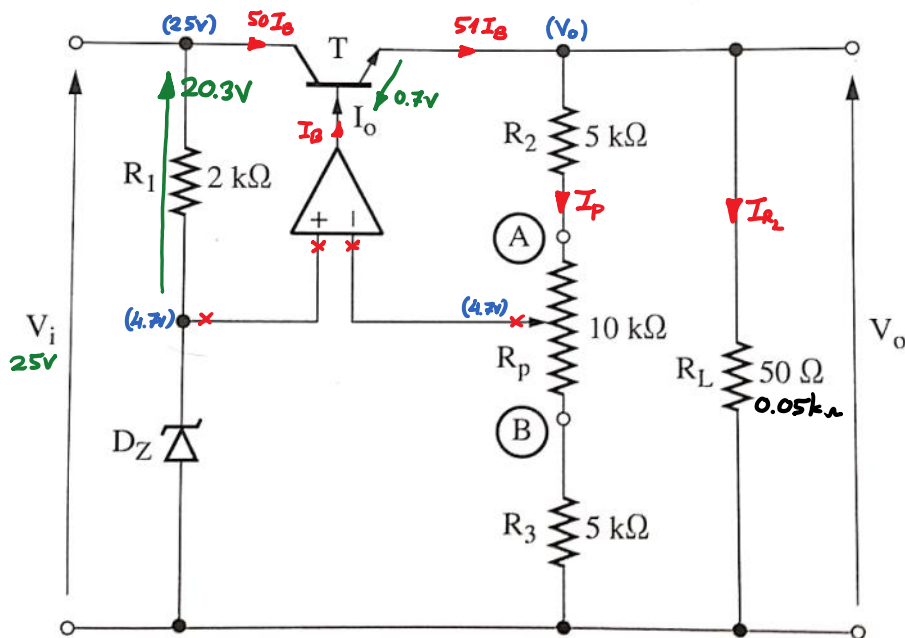
$$I_S = 6.808 \cdot 10^{-6} mA$$

$$I_S = 6.808 nA$$



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2



$$V_{in} = 25V$$

$$V_{D_2} = 4.7V$$

$$V_{BE} = 0.7V$$

$$\beta = 50$$

Ⓐ $V_A = V_{D_2} = 4.7V$

$$I_p = \frac{V_A}{R_p + R_3} = \frac{4.7}{15} = 0.313mA \Rightarrow V_o = I_p \cdot (R_2 + R_p + R_3) = 0.313 \cdot 20 = 6.266V = V_{o_{min}}$$

Ⓑ $V_B = V_{D_2} = 4.7V$

$$I_p = \frac{V_B}{R_3} = \frac{4.7}{5} = 0.94mA \Rightarrow V_o = I_p \cdot (R_2 + R_p + R_3) = 0.94 \cdot 20 = 18.8V = V_{o_{max}}$$

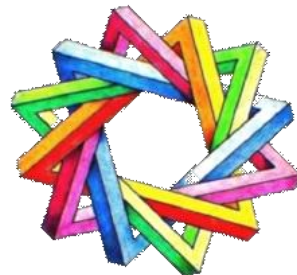
Ⓒ $I_{R_{L_{max}}} = \frac{V_{o_{max}}}{R_L} = \frac{18.8}{0.05} = 376mA = 0.376A$



Ⓓ $I_E = I_p + I_{R_{L_{max}}} = 0.94 + 376 = 376.94mA$

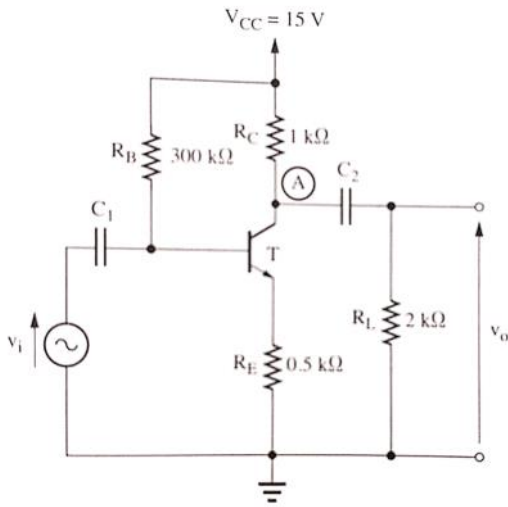
$$I_E = 51I_B = 51I_o \Rightarrow 376.94 = 51I_o$$

$$I_o = 7.39mA$$



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3



Ⓐ $\beta = 100$ $V_{BE} = 0.7V$

בטוחה DC הקבועים מתקנים בפרק



$$V_{CC} - 0 = R_B \cdot I_B + V_{BE} + R_E \cdot 101 I_B$$

$$15 = 300 I_B + 0.7 + 0.5 \cdot 101 I_B$$

$$I_B = 0.0408 mA = 40.8 \cdot 10^{-3} A$$



$$I_C = \beta I_B = 4.08 mA$$



$$V_{CC} - 0 = R_C \cdot 100 I_B + V_{CE} + R_E \cdot 101 I_B$$

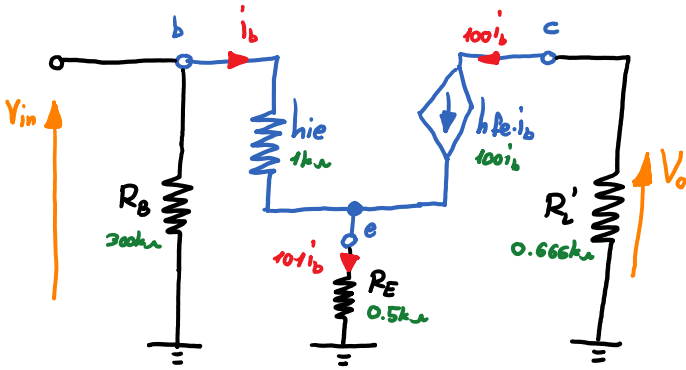
$$15 = 1 \cdot 100 \cdot I_B + V_{CE} + 0.5 \cdot 101 I_B$$

$$V_{CE} \approx 8.92V$$

$$R_L' = R_L \parallel R_C = 2 \parallel 1 = 0.666 k\Omega$$

Ⓑ $h_{fe} = 100$ $h_{ie} = 1k\Omega$

בטוחה AC הקבועים מתקנים בפרק, ו' e' למקור
אשר V_{CE} יר' מתקצר לאלו האנחה



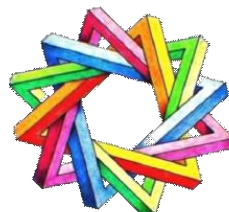
Ⓒ $V_o = -h_{fe} \cdot i_b \cdot R_L' = -100 i_b \cdot 0.666 = -66.666 i_b$

$$V_{in} = h_{ie} \cdot i_b + (h_{fe} + 1) \cdot i_b \cdot R_E = 1 \cdot i_b + 101 \cdot i_b \cdot 0.5 = 51.5 i_b$$

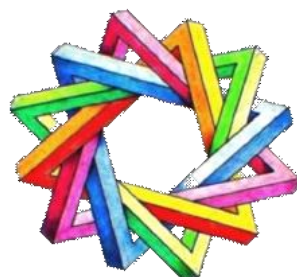
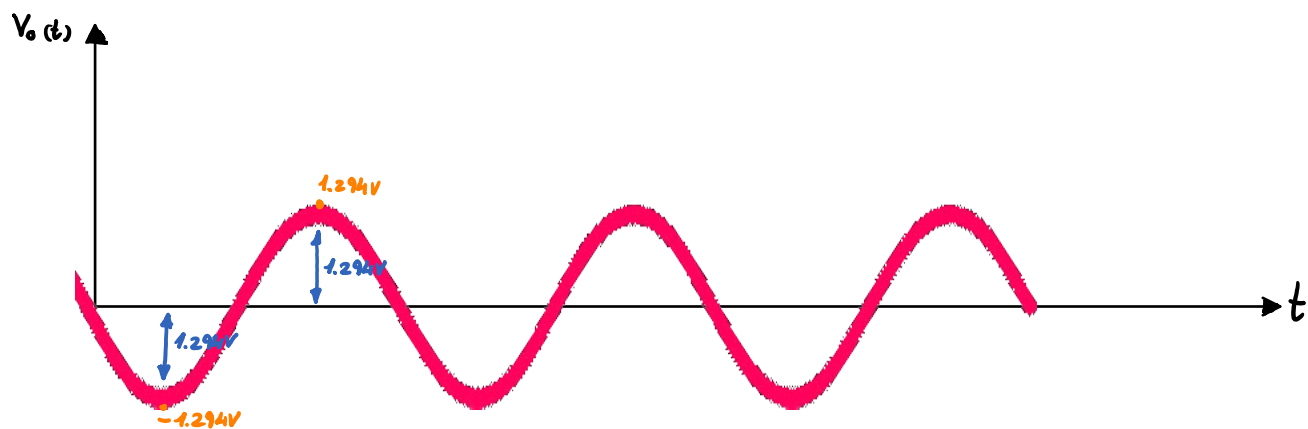
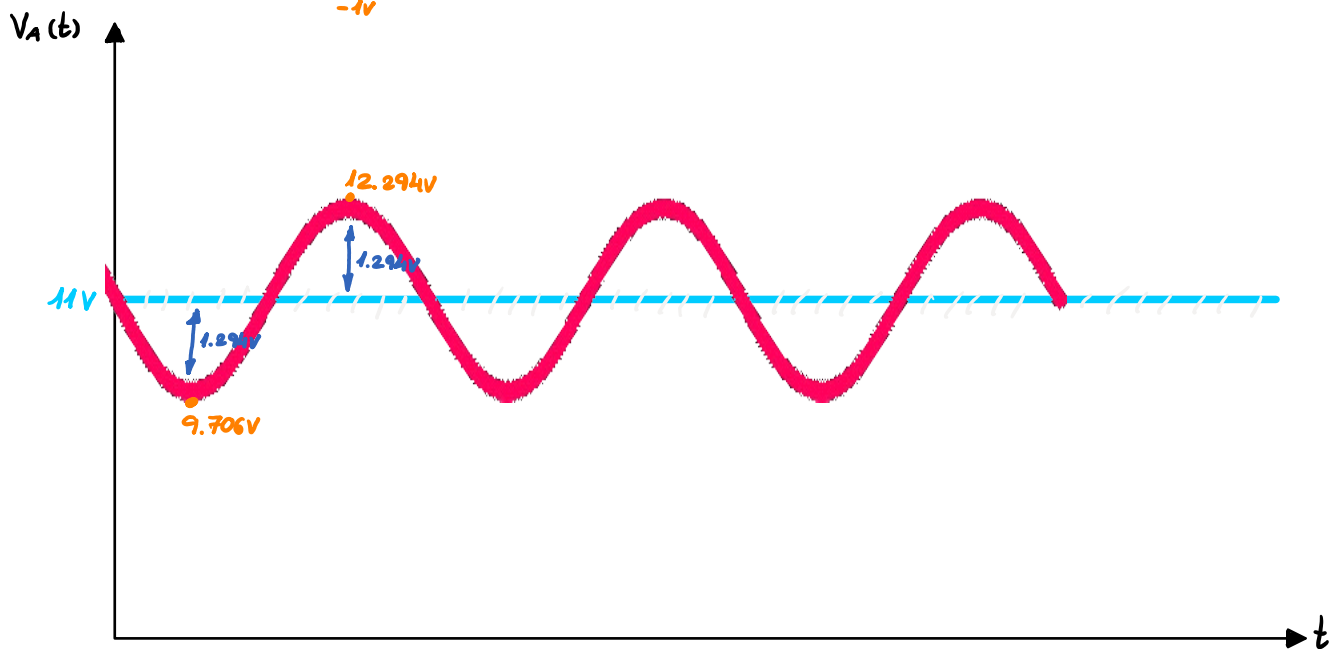
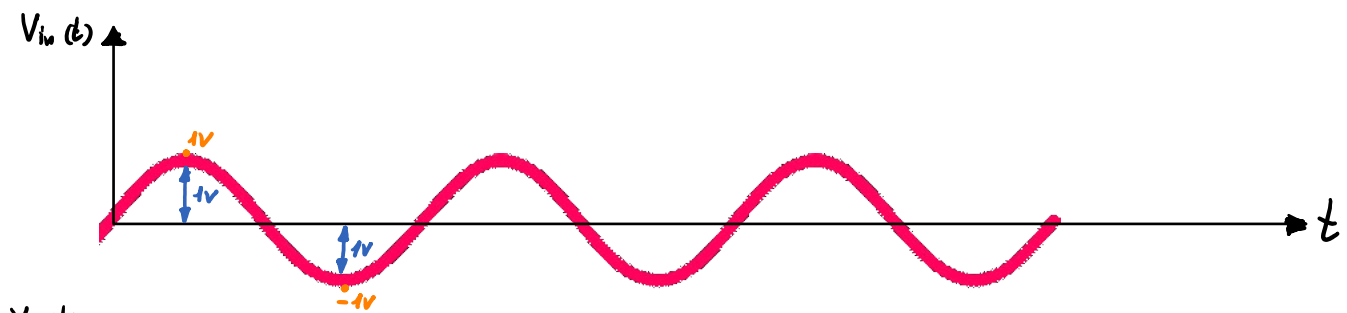


$$A_v = \frac{-h_{fe} \cdot i_b \cdot R_L'}{h_{ie} \cdot i_b + (h_{fe} + 1) \cdot i_b \cdot R_E} = \frac{-h_{fe} \cdot R_L'}{h_{ie} + (h_{fe} + 1) \cdot R_E} = \frac{-66.666}{51.5} = -1.294$$

Ⓓ $V_A = V_{CE} + U_{R_E} = 8.92 + 101 \cdot 0.0408 \cdot 0.5 = 10.98V \approx 11V$

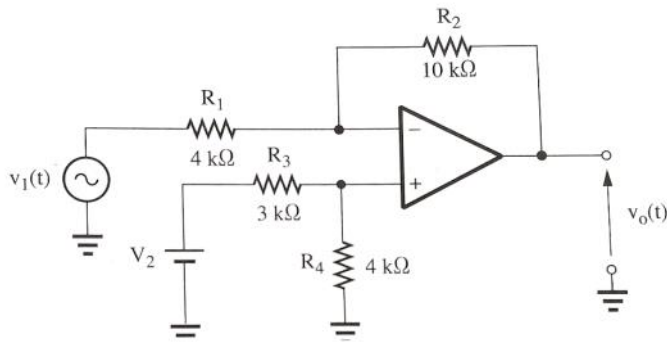


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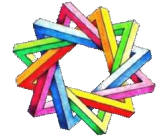
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4



$$V_1(t) = 0.8 \cdot \sin(1000\pi t)$$

$$V_2 = 2V$$



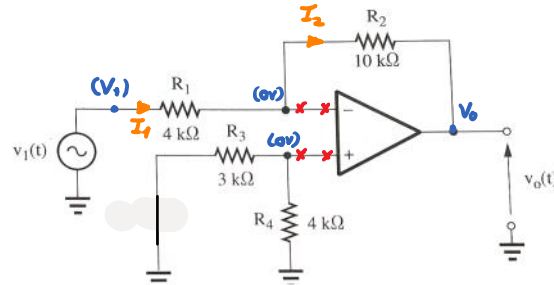
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$$I_1 = I_2$$

$$\frac{V_1 - 0}{R_1} = \frac{0 - V_0}{R_2}$$

$$\frac{V_1}{R_1} = \frac{-V_0}{R_2}$$

$$V_0 = -\frac{R_2}{R_1} \cdot V_1 = -\frac{10}{4} \cdot V_1 = -2.5V_1$$



Ⓒ נ"מ AC

בגלל R1 ו-R2 לא
זרים זרם, ולכן הם
מתחברים כמו חוט
נקודות

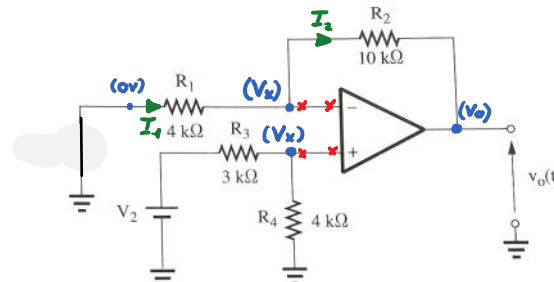
$$I_1 = I_2$$

$$\frac{0 - V_X}{R_1} = \frac{V_X - V_0}{R_2}$$

$$\frac{-V_X}{R_1} = \frac{V_X}{R_2} - \frac{V_0}{R_2}$$

$$-V_X \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = -\frac{V_0}{R_2}$$

$$V_0 = \left(\frac{R_2}{R_1} + \frac{R_2}{R_2} \right) \cdot V_X = \left(\frac{R_2}{R_1} + 1 \right) \cdot V_X = \left(1 + \frac{R_2}{R_1} \right) \cdot \frac{4}{7} \cdot V_2 = \left(1 + \frac{10}{4} \right) \cdot \frac{4}{7} \cdot V_2 = 2V_2$$



Ⓒ נ"מ DC

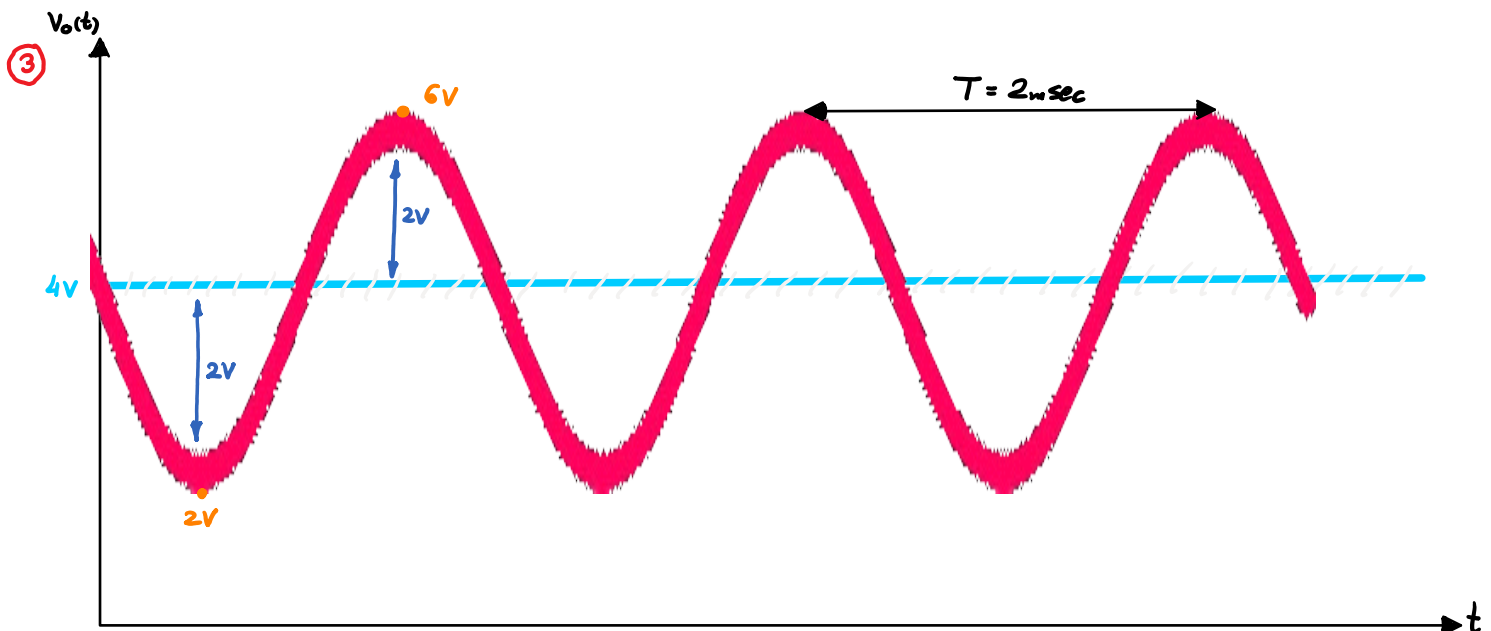
$$V_X = V_2 \cdot \frac{R_4}{R_3 + R_4}$$

$$V_X = \frac{4}{7} V_2$$

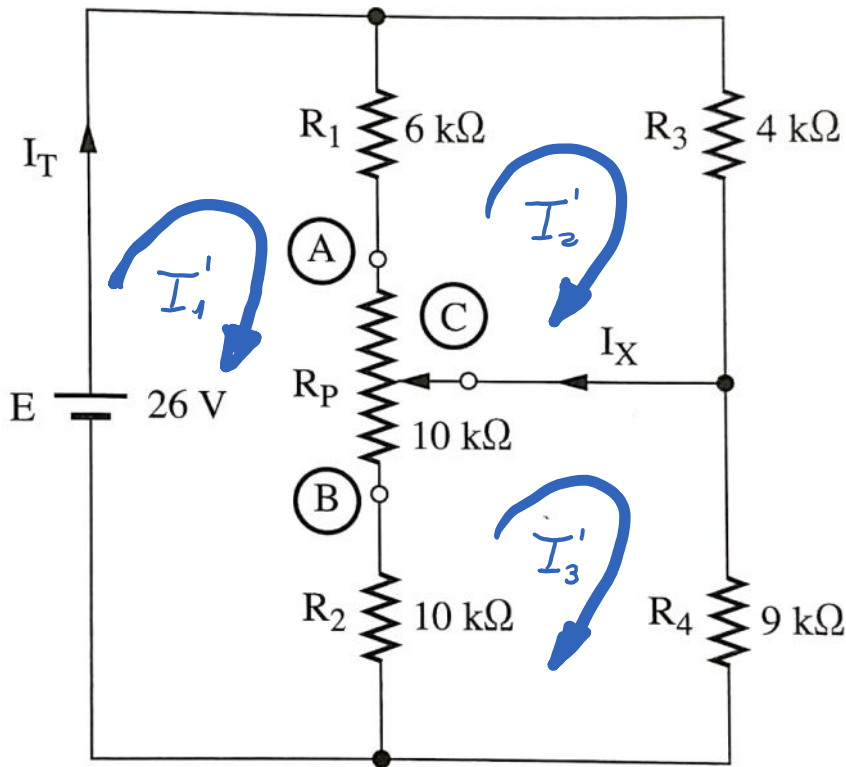


Ⓒ שילוב AC ו-DC

$$V_0(t) = V_0 + V_0 = -2.5 \cdot [0.8 \cdot \sin(1000\pi t)] + 2 \cdot 2 = 4 - 2 \sin(1000\pi t)$$



5



$$\textcircled{E} \begin{pmatrix} +R_{11} & -R_{12} & -R_{13} \\ -R_{21} & +R_{22} & -R_{23} \\ -R_{31} & -R_{32} & +R_{33} \end{pmatrix} \begin{pmatrix} I_1' \\ I_2' \\ I_3' \end{pmatrix} = \begin{pmatrix} E_1' \\ E_2' \\ E_3' \end{pmatrix} \Rightarrow \begin{pmatrix} 26 & -6 & -20 \\ -6 & 10 & 0 \\ -20 & 0 & 29 \end{pmatrix} \begin{pmatrix} I_1' \\ I_2' \\ I_3' \end{pmatrix} = \begin{pmatrix} 26 \\ 0 \\ 0 \end{pmatrix}$$

$$R_{11} = R_1 + R_p + R_2 = 26k\Omega$$

$$R_{12} = R_{21} = R_1 = 6k\Omega$$

$$E_1' = E = 26V$$

$$R_{22} = R_1 + R_3 = 10k\Omega$$

$$R_{23} = R_{31} = R_p + R_2 = 20k\Omega$$

$$E_2' = 0V$$

$$R_{33} = R_p + R_2 + R_4 = 29k\Omega$$

$$R_{32} = R_{23} = 0k\Omega$$

$$E_3' = 0V$$

$$I_1' = \frac{145}{48} = 3.02mA$$

$$I_2' = \frac{29}{16} = 1.812mA$$

$$I_3' = \frac{25}{12} = 2.083mA$$

$$I_T = I_1' = 3.02mA$$

$$I_X = I_3' - I_2' = 2.083 - 1.812 = 0.27mA$$

② $I_X = 0mA \Rightarrow$ נשר ויטסלון / נאטון

$$(R_1 + R_{Ac}) \cdot R_4 = R_3 \cdot (R_{C3} + R_2)$$

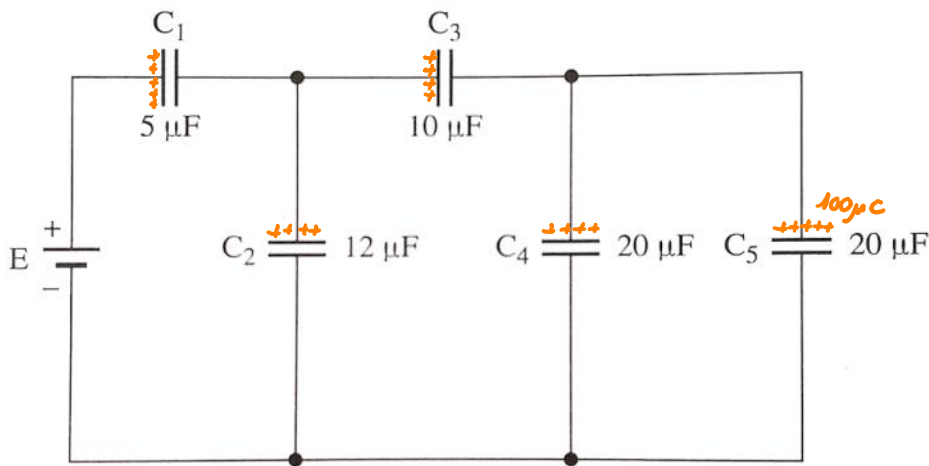
$$(6 + R_{Ac}) \cdot 9 = 4 \cdot (10 - R_{Ac} + 10)$$

$$R_{Ac} = 2k\Omega$$



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6



Ⓔ $Q_5 = 100 \mu C \Rightarrow U_5 = \frac{Q_5}{C_5} = \frac{100}{20} = 5V$

↓

Ⓕ הקבוצה C_4 מקבלת Q_4 ושווה לו בזרימה, ולכן:
 $Q_4 = 100 \mu C$
 $U_4 = 5V$

↓

$Q_3 = Q_4 + Q_5 = 100 + 100 = 200 \mu C \Rightarrow U_3 = \frac{Q_3}{C_3} = \frac{200}{10} = 20V$

↓

Ⓖ $U_2 = U_3 + U_4 = 20 + 5 = 25V$

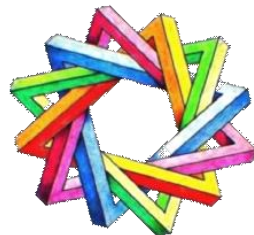
↓

$Q_T = Q_1 = Q_2 + Q_3 = 300 + 200 = 500 \mu C \Leftarrow Q_2 = C_2 \cdot U_2 = 12 \cdot 25 = 300 \mu C$

↓

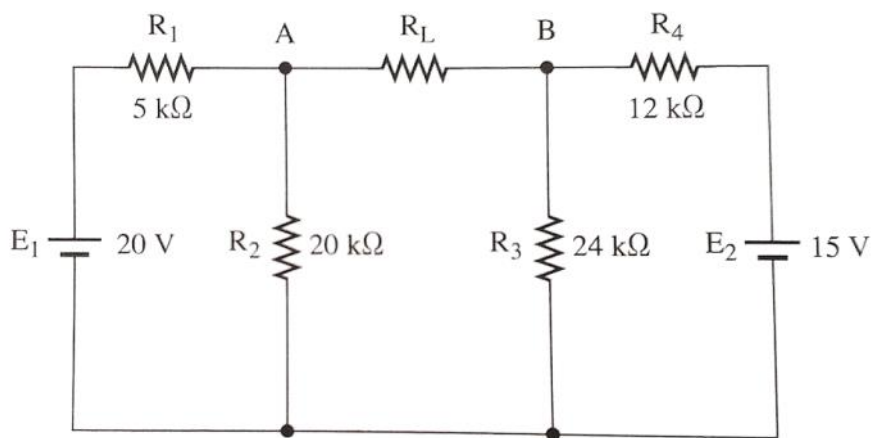
$U_1 = \frac{Q_1}{C_1} = \frac{500}{5} = 100V \Rightarrow E = U_1 + U_2 = 100 + 25 = 125V$

Ⓙ $W_T = \frac{Q_T \cdot E}{2} = \frac{500 \cdot 10^{-6} \cdot 125}{2} = 31.25 mJ$



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 פשוט להבין!

7

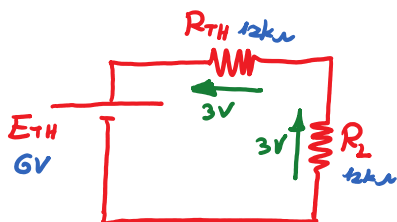


Ⓐ $R_{TH} = (R_1 \parallel R_2) + (R_3 \parallel R_4) = (5 \parallel 20) + (24 \parallel 12) = 4 + 8 = 12k\Omega$

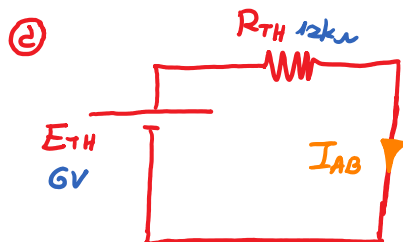
$R_L = R_{TH} = 12k\Omega$

Ⓑ $E_{TH} = V_A - V_B = U_{R_2} - U_{R_3} = E_1 \cdot \frac{R_2}{R_1 + R_2} - E_2 \cdot \frac{R_3}{R_3 + R_4} =$
 $= 20 \cdot \frac{20}{20 + 5} - 15 \cdot \frac{24}{24 + 12} =$
 $= 16 - 10 = 6V$

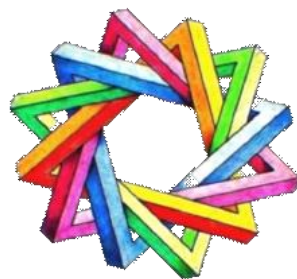
⇓



$P_{R_{L_{max}}} = \frac{U_{R_L}^2}{R_L} = \frac{3^2}{12} = 0.75mW$

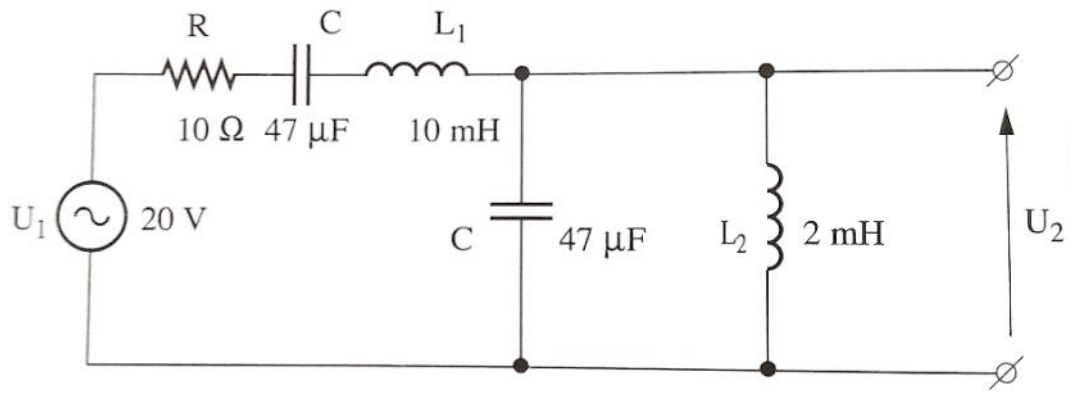


$I_{AB} = I_{sc} = \frac{E_{TH}}{R_{TH}} = \frac{6}{12} = 0.5mA$



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 פשוט להבין!

8



$$\textcircled{א} \quad f_0 = \frac{1}{2\pi\sqrt{L_1 C}} = \frac{1}{2\pi\sqrt{10 \cdot 10^{-3} \cdot 47 \cdot 10^{-6}}} = 232.151 \text{ Hz}$$

$$\textcircled{ב} \quad f_0 = \frac{1}{2\pi\sqrt{L_2 C}} = \frac{1}{2\pi\sqrt{2 \cdot 10^{-3} \cdot 47 \cdot 10^{-6}}} = 519.106 \text{ Hz}$$

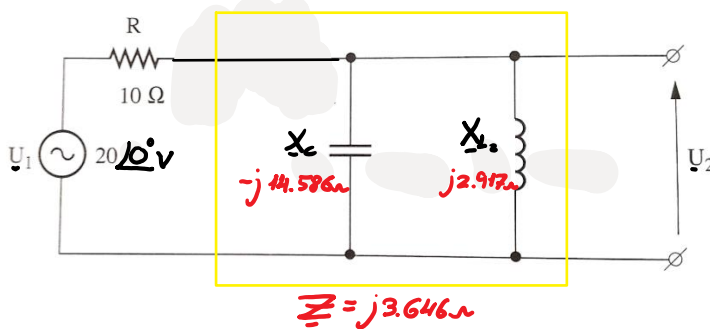


אוניברסיטת בר-אילן
פשוט להבין!

כאשר המוצא יזכור במצב התהווה במקביל, L_2 ו- C במקביל יתכנו ל- 0 A .
ואם נקבע ל- 0 A .

$$I_{\min} = 0 \Leftrightarrow f = 519.106 \text{ Hz}$$

כאשר המוצא יזכור במצב התהווה באופן, L_1 ו- C שאלו מתקנים
כ- 0 A , ואם נקבע יתכנו.



$$X_c = -j \frac{1}{2\pi f C} = -j \frac{1}{2\pi \cdot 232.151 \cdot 47 \cdot 10^{-6}} = -j14.586 \Omega$$

$$X_L = j 2\pi f L = j 2\pi \cdot 232.151 \cdot 2 \cdot 10^{-3} = j2.917 \Omega$$

$\Downarrow$

$$Z = X_c \parallel X_L = j3.646 \Omega$$

$$U_2 = U_1 \cdot \frac{Z}{Z + R} = 20 \angle 0^\circ \cdot \frac{j3.646}{10 + j3.646} = 6.851 \angle 70^\circ \text{ V}$$