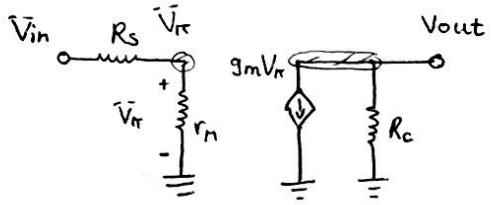
#1



KCL @ Vout : $+g_m V_\pi + \frac{V_{out}}{R_c} = 0$ (I)

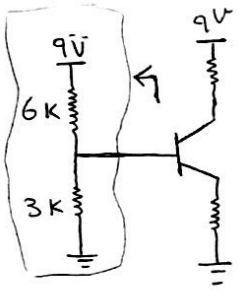
KCL @ V_H : $\frac{V_\pi}{r_\pi} + \frac{V_\pi - V_{in}}{R_S} = 0$

$\Rightarrow V_H \underbrace{\left(\frac{1}{r_\pi} + \frac{1}{R_S}\right)}_{\frac{1}{r_\pi \| R_S}} = \frac{V_{in}}{R_S}$

$\Rightarrow V_H = \frac{r_\pi \| R_S}{R_S} \cdot V_{in}$ (II)

(II) in (I) $\Rightarrow g_m \left(\frac{r_\pi \| R_S}{R_S} \cdot V_{in}\right) + \frac{V_{out}}{R_c} = 0 \Rightarrow V_{out} = \frac{-g_m V_{in} R_c}{R_S} \cdot r_\pi \| R_S$

#2



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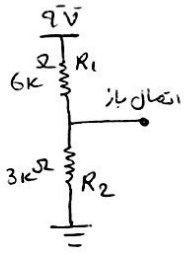

$\equiv \begin{cases} V_{TH} = 9^V \\ R_{TH} = R_1 \overset{\text{سری}}{=\!=} R_2 = 6K + 3K = 9K\Omega \end{cases}$

$\equiv$

$\Rightarrow$ مدار معادل تونن

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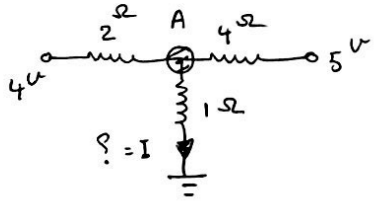
#3 a)

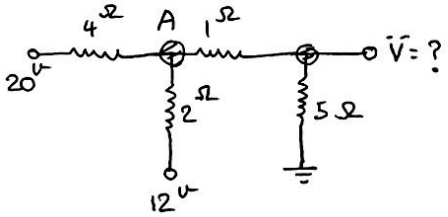


KCL @ A : $\frac{V_A - 4}{2} + \frac{V_A - 5}{4} + V_A = 0$

$\Rightarrow V_A = \frac{13}{4} = 3.25^V \xrightarrow{I = \frac{V_A - 0}{1}}$

$I = V_A = 3.25^V$

b)



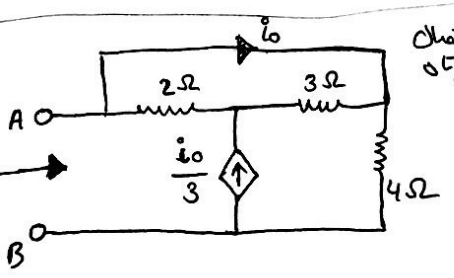
KCL @ V_A : $\frac{V_A - 20}{4} + \frac{V_A - 12}{2} + \frac{V_A - V}{1} = 0$

$\Rightarrow 7V_A - 4V = 44$ (I)

KCL @ V : $\frac{V}{5} + \frac{V - V_A}{1} = 0 \Rightarrow V_A = \frac{6}{5} V = 1.2V$ (II)

(II) in (I) $\Rightarrow 7(1.2V) - 4V = 44 \Rightarrow V = 10\ V$

#4



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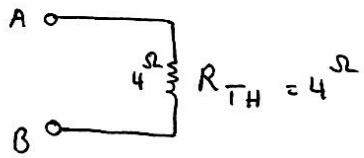
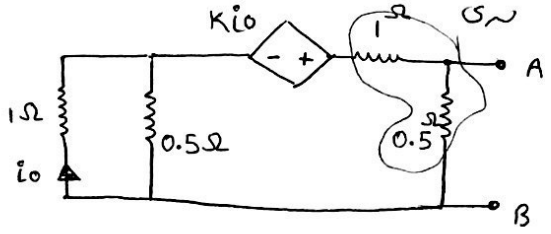


#5



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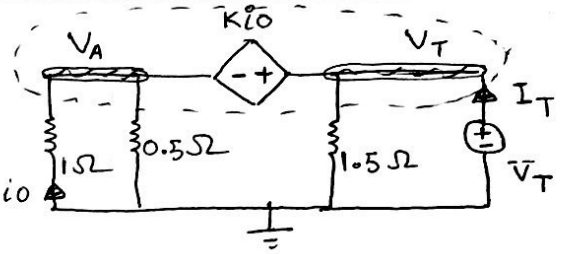


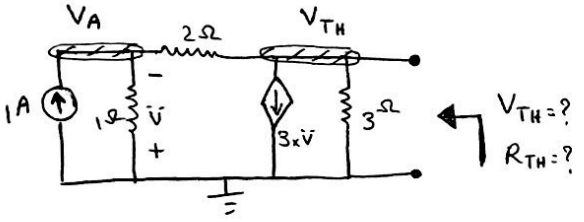
KCL @ V_A, V_T : $-I_T + \frac{V_T}{1.5} + \frac{V_A}{0.5} + V_A = 0 \Rightarrow -I_T + \frac{V_T}{1.5} + 3V_A = 0$ (I)

$V_T - V_A = Ki_o = K\left(\frac{-(V_A - 0)}{1}\right) \Rightarrow V_T - V_A = -KV_A \Rightarrow V_A = \frac{V_T}{1-K}$ (II)

(II) in (I) $\longrightarrow -I_T + \frac{V_T}{1.5} + \frac{3V_T}{1-K} = 0 \Rightarrow V_T\left(\frac{1}{1.5} + \frac{3}{1-K}\right) = I_T \Rightarrow \frac{V_T}{I_T} = R_{TH} = \frac{1.5 - 1.5K}{5.5 - K}$

$K=0 \longrightarrow \boxed{R_{TH} = \frac{1.5}{5.5} = \frac{3}{11}}$

#6



KCL @ V_{TH} : $3\bar{V} + \frac{V_{TH}}{3} + \frac{V_{TH} - V_A}{2} = 0 \xrightarrow{V_A = -\bar{V}}$

$= 3\bar{V} + \frac{V_{TH}}{3} + \frac{V_{TH}}{2} + \frac{\bar{V}}{2} = 3.5\bar{V} + \frac{5}{6}V_{TH} = 0$ (I)

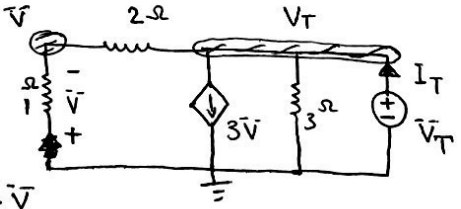
KCL @ V_A : $-1 + V_A + \frac{V_A - V_{TH}}{2} = 0$

$\xrightarrow{V_A = -\bar{V}} -\left(1 + \frac{V_{TH}}{2}\right) = 1.5\bar{V} \Rightarrow \bar{V} = \frac{-(1 + \frac{V_{TH}}{2})}{1.5}$ (II)

(II) in (I) $\longrightarrow 3\left(\frac{-(1 + \frac{V_{TH}}{2})}{1.5}\right) + \frac{5}{6}V_{TH} + \frac{-(1 + \frac{V_{TH}}{2})}{3} = 0$

$\Rightarrow -2 - V_{TH} + \frac{5}{6}V_{TH} - \frac{1}{3} - \frac{V_{TH}}{6} = 0 \Rightarrow \boxed{V_{TH} = \frac{-42}{6} = -7\ V}$

$R_{TH} = ? \longrightarrow$ منابع مستقل $= 0 \longrightarrow$

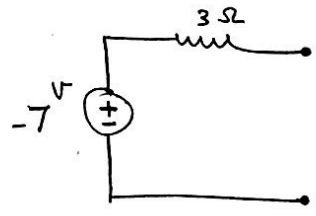


KCL @ V_T : $+3\bar{V} + \frac{V_T}{3} - I_T + \frac{V_T + \bar{V}}{2} = 0$ (I)

KCL @ $\bar{V}$: $-\bar{V} + \frac{-\bar{V} - \bar{V}_T}{2} = 0 \Rightarrow -1.5\bar{V} = \frac{V_T}{2} \Rightarrow \bar{V} = \frac{-1}{3}\bar{V}_T$ (II)

(II) in (I) $\longrightarrow 3\left(\frac{-1}{3}V_T\right) + \frac{1}{3}\bar{V}_T - I_T + \frac{1}{2}\bar{V}_T + \frac{1}{2}\left(\frac{-1}{3}V_T\right) = 0 = -V_T + \frac{1}{3}V_T + \frac{1}{2}V_T - \frac{1}{6}V_T$

$= \frac{-1}{3}\bar{V}_T = I_T \Rightarrow \frac{V_T}{I_T} = R_{TH} = -3\Omega$ $= I_T'$



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