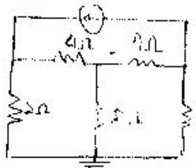
電路學第二次小考

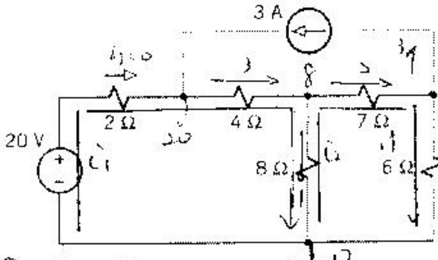
9:10-10:00, 11/5/2008

20V suppressed =>



1. For the circuit shown in Fig. 1, please use mesh analysis to find i_1, i_2, and the power supplied by the 3A current source. [20%]

$P_{3A} = i\,V = 3\times[20-(-6)] = 78\,(W) = \sum i_n^2 R_n$
$= 0^2\times 2 + 3^2\times 4 + 1^2\times 8 + 2^2\times 7 + (-1)^2\times 6$
$= 78\,(W)$



$[R] = \begin{bmatrix} 2+4+8 & -8 \\ -8 & 8+7+6 \end{bmatrix} = \begin{bmatrix} 14 & -8 \\ -8 & 21 \end{bmatrix}$

$[R][i] = [V_s] \Rightarrow \begin{bmatrix} 14 & -8 \\ -8 & 21 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 20-3\times 4 \\ 3\times 7 \end{bmatrix} = \begin{bmatrix} 8 \\ -21 \end{bmatrix}$

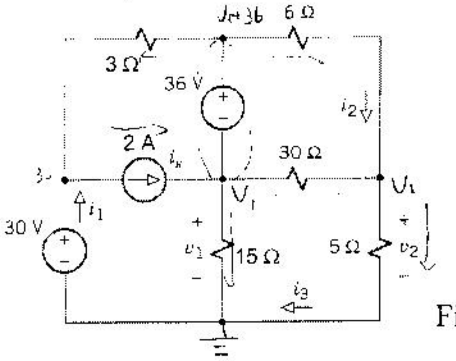
Fig. 1

$\Rightarrow \begin{cases} 14 i_1 - 8 i_2 = 8 \\ -8 i_1 + 21 i_2 = -21 \end{cases}$ $\Delta = \begin{vmatrix} 14 & -8 \\ -8 & 21 \end{vmatrix} = 230$, $\Delta i_1 = \begin{vmatrix} 8 & -8 \\ -21 & 21 \end{vmatrix} = 0$, $\Delta i_2 = \begin{vmatrix} 14 & 8 \\ -8 & -21 \end{vmatrix}$

$(i_1, i_2) = (0, -1)$

$P_{20V} = i_1 V = 0\times 20 = 0$

2. Use supernode analysis to determine v_1, v_2 and i_1 in Fig. 2. [30%]



$2 = \frac{(V_1+36)-30}{3} + \frac{(V_1+36)-V_2}{6} + \frac{V_1}{15} + \frac{V_1-V_2}{30}$

KCL node V_2: $\frac{(V_1-V_2)}{30} + \frac{(V_1+36)-V_2}{6} = \frac{V_2}{5}$

Fig. 2

$\Rightarrow 2V_1 + V_2 = 0$

$(V_1-V_2) + 5[(V_1-V_2)+36] = 6V_2$

3. In Fig 3, $v_{in} = 10$ V and $R_L = 20$ kΩ, please determine i_{out}. [20%]

$\Rightarrow (V_1, V_2) = (-6, 12)$

$i_1 = i_s + \frac{(V_1+36)-30}{3} = 2 + \frac{(-6+36)-30}{3}$

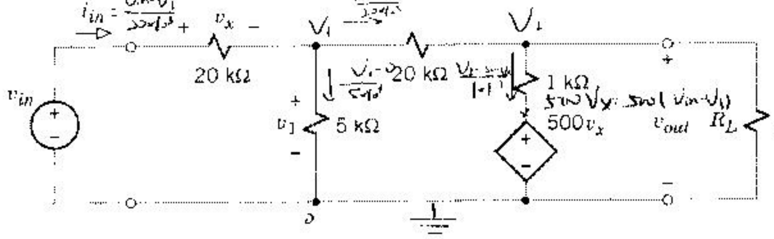
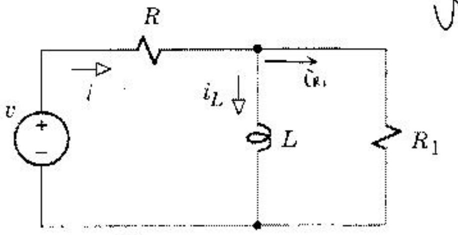


Fig. 3

4. The circuit shown in Fig. 4, where $R = 3$ Ω, $L = 0.5$ H, $R_1 = 5$ Ω, and $v = 5t$ V, can obtain the following question: A di_L/dt + B$i_L = 25t$. (a) please determine the coefficients A and B. [10%] (b) Find the complete response where the initial inductor current $i_L(0) = 2$ A. [20%]

$V_L = L\frac{di_L}{dt}$



$i_{R_1} = \frac{V_L}{R_1} = \frac{L}{R_1}\frac{di_L}{dt}$

Fig. 4

$i = i_L + i_{R_1} = i_L + \frac{L}{R_1}\frac{di_L}{dt}$

$V = iR + V_L = R(i_L + \frac{L}{R_1}\frac{di_L}{dt}) + L\frac{di_L}{dt}$

$= L(1+\frac{R}{R_1})\frac{di_L}{dt} + R i_L = 5t$

$5L(1+\frac{R}{R_1})\frac{di_L}{dt} + 5R i_L = 25t$

$(A, B) = (5L(1+\frac{R}{R_1}), 5R) = (5\times 0.5(1+\frac{3}{5}), 5\cdot 3) = (4, 15)$

$4\frac{di_{LN}}{dt} + 15 i_{LN} = 0$

$\Rightarrow \frac{di_{LN}}{i_{LN}} = -\frac{15}{4}t$

$\Rightarrow i_{LN} = Ce^{-\frac{15}{4}t}$

$4\frac{di_{LF}}{dt} + 15 i_{LF} = 25t \Rightarrow \frac{di_{LF}}{dt} + \frac{15}{4}i_{LF} = \frac{25}{4}t$

$\frac{d}{dt}(i_{LF}e^{\frac{15}{4}t}) = \frac{25}{4}te^{\frac{15}{4}t} \Rightarrow i_{LF}e^{\frac{15}{4}t} = \frac{25}{4}\int te^{\frac{15}{4}t} = \frac{25}{4}(te^{\frac{15}{4}t} - e^{\frac{15}{4}t} + D) \Rightarrow i_{LF} = \frac{25}{4}t - \frac{25}{4} + \frac{25}{4}De^{-\frac{15}{4}t}$