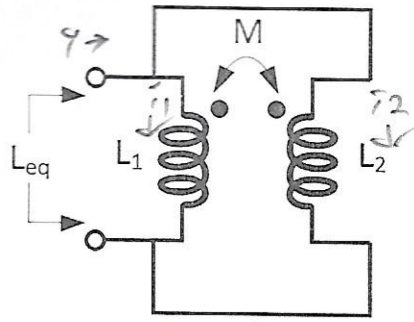
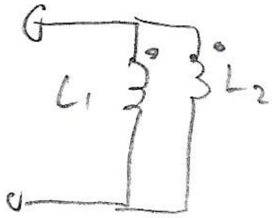
1. Find the equivalent inductance of the circuit below. $L_1 = 5H$, $L_2 = 2H$, and $M = 3H$.



$i = i_1 + i_2$ $\quad i' = i_1' + i_2'$

L_{eq} 

$$V_1 = L_1 \frac{di_1}{dt} + M\frac{di_2}{dt} \qquad \frac{di_1}{dt} = \frac{V_1 - M\frac{di_2}{dt}}{L_1}$$

$$V_2 = L_2 \frac{di_2}{dt} + M\frac{di_1}{dt}$$

$$L_{eq} = \frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M} \qquad \frac{di_2}{dt} = \frac{V_2 - M\frac{di_1}{dt}}{L_2}$$

$$V_1 = V_2 = V$$

$$\frac{di_2}{dt} = \frac{V - M\left(\frac{V - M\frac{di_2}{dt}}{L_1}\right)}{L_2}$$

$$L_1 L_2 \frac{di_2}{dt} = L_1 V - MV + M^2\frac{di_2}{dt}$$

$$\frac{di_2}{dt}(L_1 L_2 - M^2) = V(L_1 - M)$$

$$\frac{di_2}{dt} = \frac{V(L_1 - M)}{L_1 L_2 - M^2}$$

$$\frac{di_1}{dt} + \frac{di_2}{dt} = \frac{V(L_1 + L_2 - 2M)}{L_1 L_2 - M^2} \qquad \frac{di_1}{dt} = \frac{V(L_2 - M)}{L_1 L_2 - M^2}$$

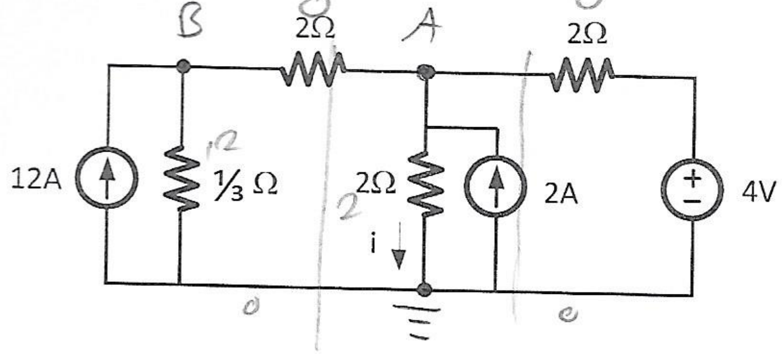
+30

$$i_1' + i_2' = i' = \frac{V}{L_{eq}}$$

$$\therefore L_{eq} = \frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M} = \frac{5 \cdot 2 - 3^2}{5 + 2 - 6} = \frac{10 - 9}{7 - 6} = 1H$$

2

2. In the circuit below, using node analysis,
   a. Find the current i.
   b. Find the power dissipated in the $\frac{1}{3}\Omega$ resistor.



a) $\frac{e_A}{2} + \frac{e_A - e_B}{2} + \frac{e_A - 4}{2} - 2 = 0$

$3e_B + \frac{e_B - e_A}{2} - 12 = 0$

$6e_B + e_B - e_A = 24$

$e_A = 7e_B - 24$

$e_A + e_A - e_B + e_A - 4 = 4$

$3e_A - e_B = 8$

$-e_A + 7e_B = 24$

$21e_A - 7e_B = 56$

$20e_A = 56 + 24 = 80$

$e_A = 4$ V

$i = \frac{e_A}{2} = 2A$

b) $3 \cdot 4^2 = 48$ w

+30

$12 - e_B = 8$

$e_B = 4$ V

$3e_b = 12$

$i^2R = \frac{144}{3} = 48$

V = 4 i = 12

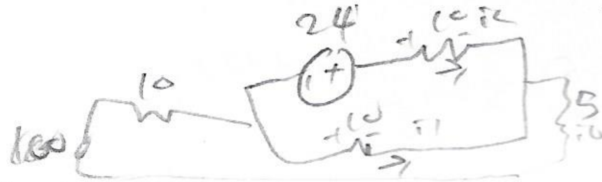
48

$-3e_A + 21e_B = 72$

$20e_B = 80$

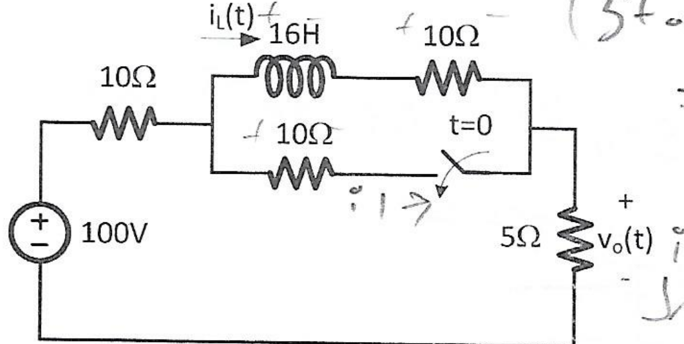
$e_B = 4$

$-24+10i_L-10i_1$
$24 = 10i_L + 10i_1$
$24 = 10i_L \cdot 10i_1$
$100 = 15i_0 + 10i_1$
$100 = 15i_L + 25i_1$

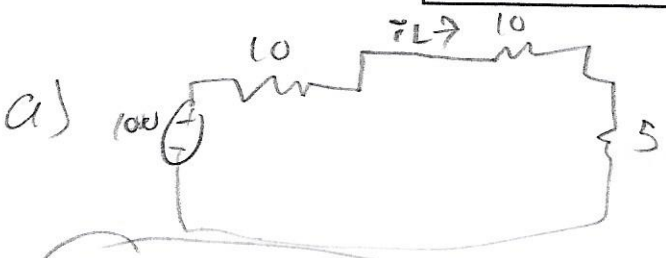


3. The circuit below has been idle for a long time (switch is open). At $t = 0$, the switch is closed.
   a. Find the inductor current right before and after the switch is closed ($i_L(0^-)$, and $i_L(0^+)$).
   b. Find v_o right before and after the switch is closed ($v_o(0^-)$, and $v_o(0^+)$).
   c. Find and plot $v_o(t)$.

$(5+.6e^{-t})15$
$= 75 + 9e^{-t}$
$+25 - 9e^{-t} = 10$



a)



$i_L = \frac{100}{25} = 4A = i_L(0^-)$

$i_L(0^-) = i_L(0^+) = 4A$ +7

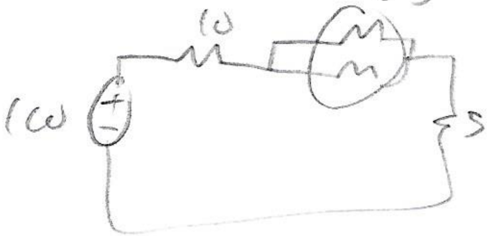
$i_L(0^+) = i_L(0^-) = 4A$
since infinite voltage is not allowed (finite so...

b) $V_o(0^-) = 5 \cdot 4 = 20v$ $\quad V_o(0^+) = 5 \cdot (5+.6) = 28v$ +7

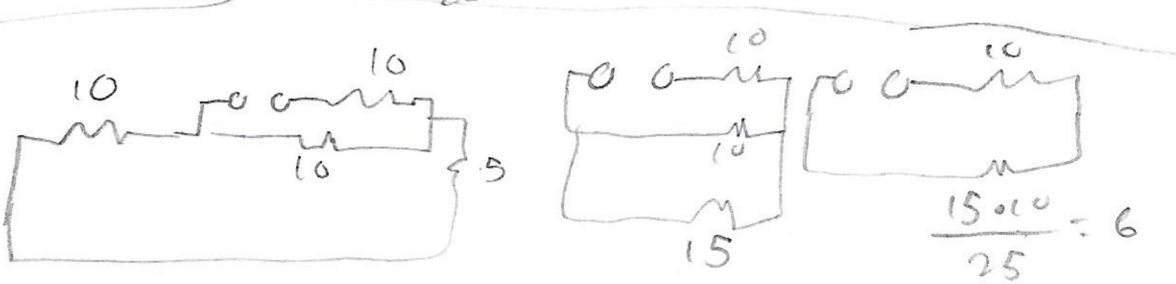
$i_L(0^+) = 4A$
$i_L(\infty) = \frac{5}{2}A$
$R_{eq} = 5$

$i_L(t) = \frac{5}{2} + (4 - \frac{5}{2})e^{-\frac{16}{16}t} = \frac{5}{2} + \frac{3}{2}e^{-t}$

$V_L(t) = L\frac{di_L}{dt} = 16(-\frac{3}{2}e^{-t})$
$= -24e^{-t}$



$\frac{100}{20} = 5A$
$\frac{5 \cdot 10}{20} = \frac{5}{2}A$



$\frac{15 \cdot 10}{25} = 6$
$R_{eq} = 16\Omega$