EE 202 (122) – HW4 – Solution
Due Saturday April 6, 2013
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Question 1:

First, we find the Thevenin Equivalent circuit by finding V_{th} and R_{th}

V_{th} = 8.75 V, R_{th} = 5 kΩ.

a) $R_L = R_{th}$ = 5 kΩ.

b) $P_{max,\ load} = (V_{th})^2/(4\ R_{th})$ = 3.828 mW.

Question 2:

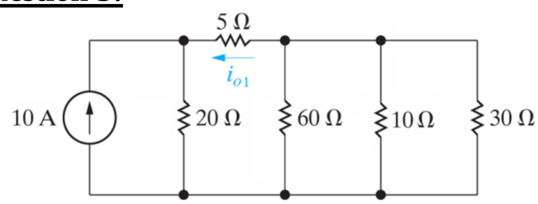
First, we find the Thevenin Equivalent circuit by finding V_{th} and R_{th}

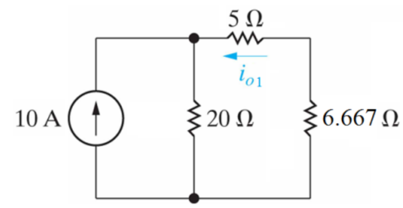
V_{th} = 3775.55 V, R_{th} = 42 Ω.

a) $R_L = R_{th}$ = 42 Ω.

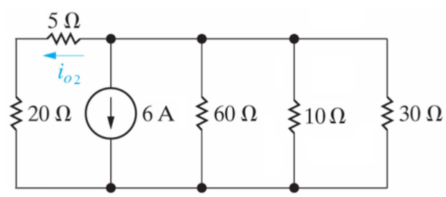
b) $P_{max,\ load} = (V_{th})^2/(4\ R_{th})$ = 84,849.87 W.

Question 3:

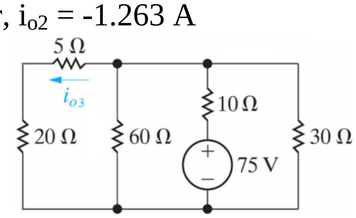


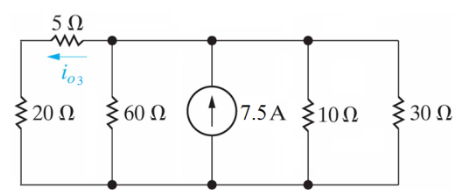


Using cdr, i_{o1} = -7.5 A



Using cdr, i_{o2} = -1.263 A





Using cdr, i_{o3}= 1.579 A

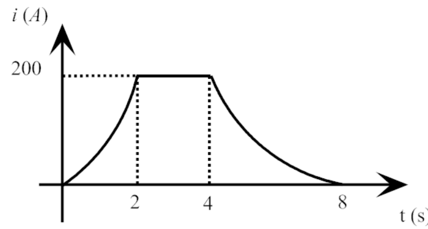
$i_o = i_{o1}+i_{o2}+i_{o3}$ = -7.184 A.

Question 4:

$$v(t)=\begin{cases}10 & 0<t<2\\ 0 & 2<5<4\\ 2.5t-20 & 4<t<8\\ 0 & \text{othewise}\end{cases}$$

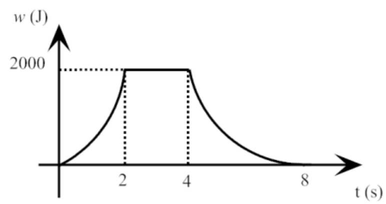
$$i(t)=i(t_o)+\frac{1}{L}\int_{t_o}^{t}v(x)dx$$

$$i(t)=\begin{cases}100t & 0<t<2\\ 200 & 2<5<4\\ 12.5t^2-200t+800 & 4<t<8\\ 0 & \text{othewise}\end{cases}$$



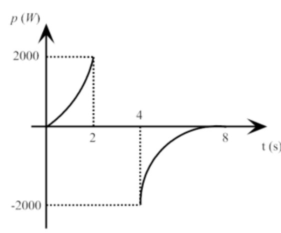
For the energy $w(t) = 0.5Li^2(t)$

$$w(t) = \begin{cases} 0.05(100t)^2 & 0 < t < 2 \\ 2000 & 2 < 5 < 4 \\ 0.05(12.5t^2 - 200t + 800)^2 & 4 < t < 8 \\ 0 & \text{othewise} \end{cases}$$

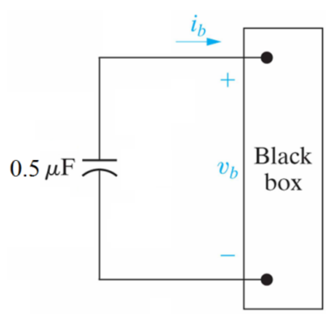


For the power $p(t) = v(t)i(t)$

$$p(t) = \begin{cases} 1000t & 0 < t < 2 \\ 0 & 2 < 5 < 4 \\ (2.5t - 20)(12.5t^2 - 200t + 800) & 4 < t < 8 \\ 0 & \text{othewise} \end{cases}$$



<u>Question 5:</u>



$v_b(0) = -v_a(0) - v_d(0) - v_c(0) = -25 - 45 + 20 = -50$ V.

$$v_b(t) = v_b(0) - \frac{1}{0.5\mu}\int_0^t i_b(x)dx = -50 - \frac{1}{0.5\mu}\int_0^t 500e^{-40x}\ \mu dx = 25e^{-40t} - 75$$

$$v_a(t) = v_a(0) + \frac{1}{5\mu}\int_0^t i_b(x)dx = 25 + \frac{1}{5\mu}\int_0^t 500e^{-40x}\ \mu dx = -2.5e^{-40t} + 27.5$$

$$v_c(t) = v_c(0) + \frac{1}{1.25\mu}\int_0^t i_b(x)dx = -20 + \frac{1}{1.25\mu}\int_0^t 500e^{-40x}\ \mu dx = -10e^{-40t} - 10$$

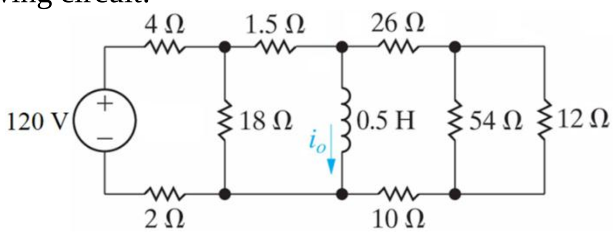
$$v_d(t) = v_d(0) + \frac{1}{1\mu}\int_0^t i_b(x)dx = 45 + \frac{1}{1\mu}\int_0^t 500e^{-40x}\ \mu dx = -12.5e^{-40t} + 57.5$$

$$i_1(t) = 200nF\frac{dv_d(t)}{dt} = 200nF\frac{d\left[-12.5e^{-40t} + 57.5\right]}{dt} = 100e^{-40t}\ \mu\text{A}$$

$$i_2(t) = 800nF\frac{dv_d(t)}{dt} = 800nF\frac{d\left[-12.5e^{-40t} + 57.5\right]}{dt} = 400e^{-40t}\ \mu\text{A}$$

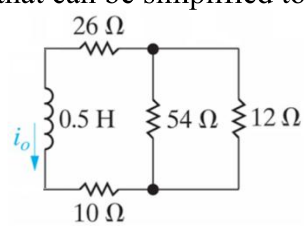
Question 6:

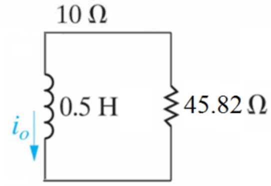
For t < 0 we have the following circuit:



The inductor will be act as a short circuit. Start with a source transformation from the left then apply CDR to get $i_o(0) = 15$ A.

For $t \geq 0$ we have the following circuit that can be simplified to RL circuit shown below:





From the circuit we find the time constant

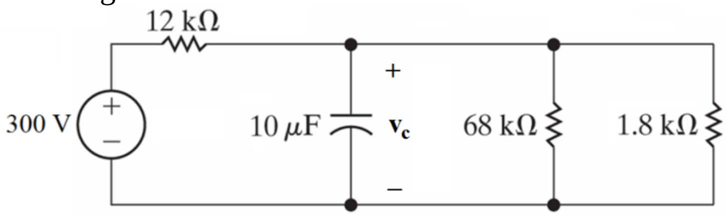
$$\tau = L / R = 0.01091 \text{ s}$$

And the current in the inductor becomes

$$i_o(t) = 15\, e^{-91.64\, t}\ \text{A}$$

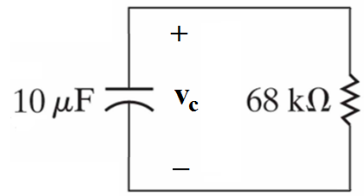
Question 7:

For t < 0, we have the following circuit:



The capacitor will act as an open circuit and $v_c(0) = 38.25$ V.

For t ≥ 0, we have the following RC circuit.



From the circuit we find the time constant of the RC circuit as follows:

$$\tau = RC = 0.68 \text{ s}$$

And the voltage across the capacitor becomes.

$$v(t) = 38.25\, e^{-1.4706\, t} \text{ V}$$

a) The amount of energy dissipated in the 68 kΩ is the initial energy stored in the capacitor which is equal to 0.5 C v^2 = 7.315 mJ.
b) To dissipate 90% of the initial energy the voltage across the capacitor has to be 12.096 V and to reach this we need 782.88 ms.