Name: ....

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Electric Circuits - I

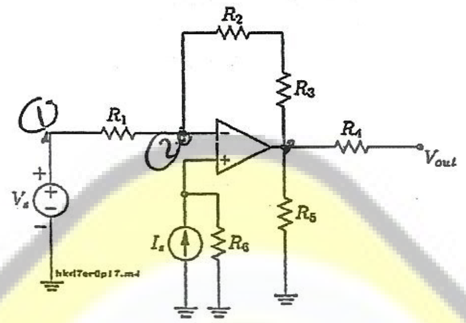
EE210

Tuesday 2009.05.12, 16:15-17:15

The exam has 5 questions for a total of 50 points.

Answer All Questions

1. 10pt For the circuit shown below calculate the voltage v_{out}.
Take $V_s = 5V, R_1 = 2k\Omega, R_2 = 10k\Omega, R_3 = 20k\Omega, R_4 = 200k\Omega, R_5 = 100k\Omega, R_6 = 2Meg\Omega, I_s = 1.5\mu A.$



Vp = 1.5M * 2 meg Ω = 3 V ✓ bcs Ip = In = 0

Vn = Vp = 3

using Nodal Analysis at point (2)

$-\left(\frac{V_n - V_1}{R_1}\right) - \left(\frac{V_n - V_{out}}{R_2 + R_3}\right) = 0$

$V_1 = V_s = 5V$

$-\left(\frac{3-5}{2k}\right) - \left(\frac{3 - V_{out}}{30k}\right) = 0$

$\frac{2}{2k} - \frac{3}{30k} + \frac{V_{out}}{30k} = 0$

$1 - 0.1 = -\frac{V_{out}}{30}$

$-0.9 * 30 = V_{out}$

~~$-2.7 V = V_{out}$~~

$-27 V = V_{out}$ ✓

10

2. 10pt A voltage $v(t) = \begin{cases} 5V & t < 0 \\ 5e^{-t/3}V, & t \geq 0 \end{cases}$ is applied to a $200\mu F$ capacitor.

a. Compute the energy stored in the capacitor at $t = 3ms$.

b. At what time has the energy stored in the capacitor dropped to 50% of its maximum value? (rounded to the nearest second)

c. Determine the current flowing through the capacitor at $t = 1.5s$

d. Calculate the power delivered by the capacitor to the external circuit at $t = 3s$

initial condition $V = 5V$

$W = \frac{1}{2} C \left(V(3m)^2 - (5)^2 \right)$

$\frac{1}{2} * 200 * 10^{-6} \left(\left(5 e^{(-(3m/3))}\right)^2 - 25 \right)$

$= \frac{1}{2} * 200 * 10^{-6} (24.995 - 25)$

$= -4.995 * 10^{-6}$ J ✓

b) Wmax at $t = 0$

thus

$\frac{50}{100} * \frac{1}{2} C (25) = \left(5 e^{-t/3}\right)^2$ *

$12.5 = \left(5 e^{-t/3}\right)^2$

$\frac{3.5355}{5} = \frac{5}{5} e^{-t/3}$

$\ln 0.70711 = \ln e^{-t/3}$

$+0.3466 = +\frac{t}{3}$

$t = 1.04$ second

thus $t = 1$ second ✓

09/10

تكملة حل السؤال على الورقة الأخيرة ←

المقابل لهذا السؤال

c) current at $t = 1.5$ s

$$i_c = c\frac{dv_c}{dt}$$

$$= 200 * 10^{-6} * \frac{-5}{3} e^{-t/3}$$

$$= 200 * 10^{-6} * \frac{-5}{3} e^{-1.5/3}$$

$$= 200 * 10^{-6} * \frac{-5}{3} e^{\frac{-1}{2}}$$

$$= -2.022 * 10^{-7} \text{ A}$$

d) $$P_{\text{delivered to}} = c\, v \frac{dv_c}{dt} = 200 * 10^{-6} * 5e^{-t/3} * \frac{-5}{3} e^{-t/3}$$

$$= 200 * 10^{-6} * 5e^{-1} * \frac{-5}{3} e^{-1}$$

$$= -2.25558 * 10^{-4}$$

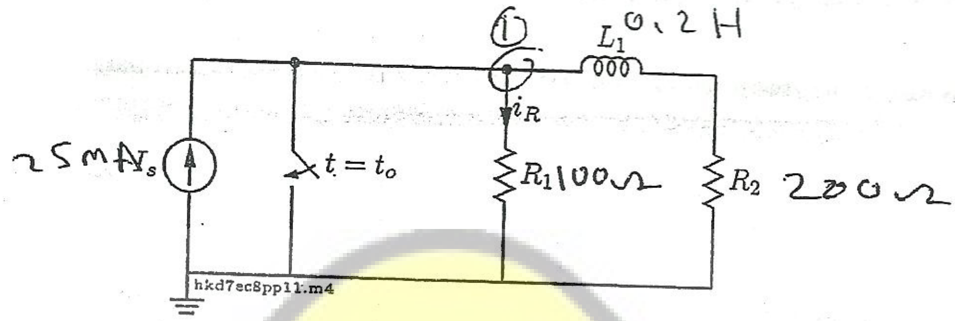
thus power delivered by

$$= -P_{\text{delivered to}}$$

thus $P_{\text{deliver by}} = 2.25558 * 10^{-4}$ W

(4)

3. 10pt The circuit shown below has been in the form shown for a very long time. The switch opens at $t = t_o$. Take $t_o = 3s$, $I_s = 25mA$, $R_1 = 100\Omega$, $L_1 = 0.2H$, $R_2 = 200\Omega$ Find i_R at (a) $t = 3^-$ (b) $t = 3^+$ (c) at $t = \infty$.



a) at $t = 3^-$

the switch was close thus it was short circuit

$i_R = 0$ ✓ no current pass through R and L_1

and $i_L = 0$

b) at $t = 3^+$

the inductor not permitted suddenly change in it's value of current

thus at 3^+ like 3^-

$i_L = 0A$

~~taking~~ KCl at node 1

$+25m - i_R = 0$

$i_R = 25mA$ ✓

c) at $t = \infty$

the inductur be as short ckt

bcs ~~there~~ is it's dc current

this

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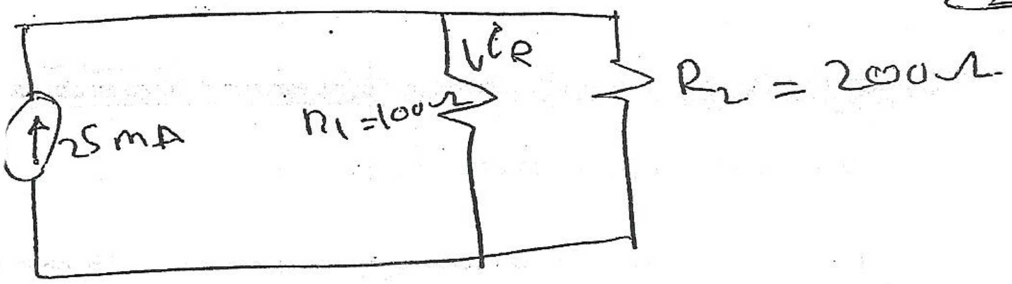
يتبع الصفحة التالية

تابع ذالكرسي



thus using current divison

$$i_R = \frac{25m * \frac{1}{100}}{\frac{1}{100} + \frac{1}{200}} = 0.01667 \text{ A}$$

4. 10pt For the circuit shown below find the

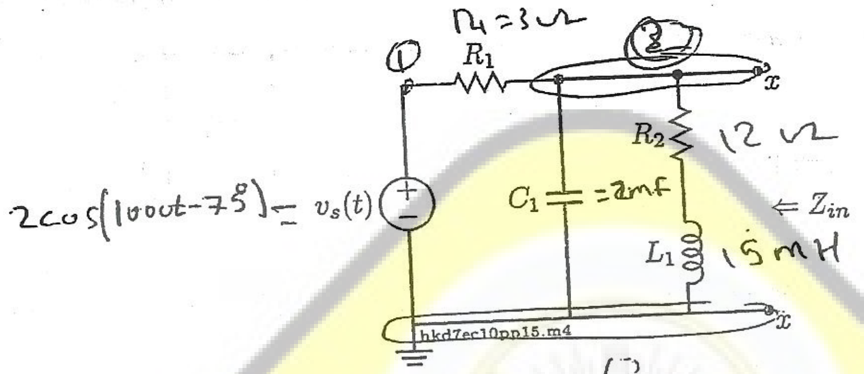
(a) open-circuit voltage V_{xy}

(b) downward current in a short circuit between x and y

(c) Thevenin equivalent impedance as seen from x and y

time domain

Take $v_s(t) = 2\cos(1000t - 75°)V, R_1 = 3\Omega, C_1 = 2$ milli $F, R_2 = 12\Omega, L_1 = 15$ milli H,



a) ~~$V_{xy} = V_{th} = V_2$~~

~~Using nodal Analysis~~

w = 1000

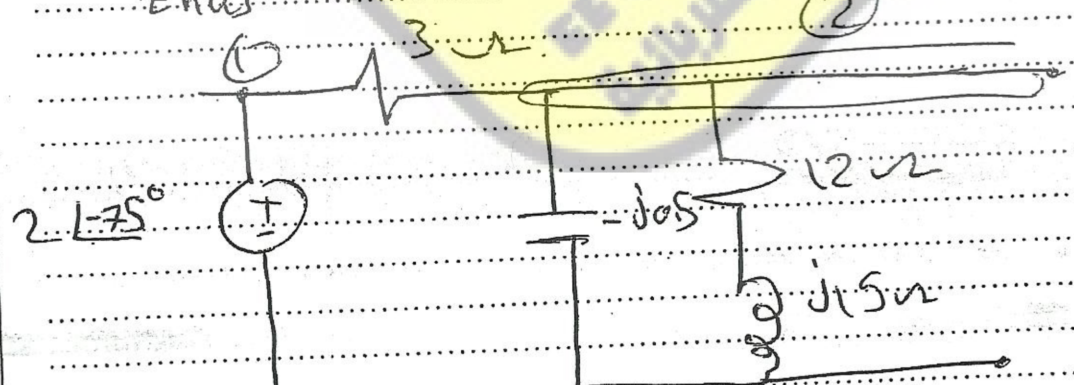
L reactance = $j\omega L$ = j15m × 1000 = j15 Ω

C reactance = $\frac{-j}{\omega C}$ = $\frac{-j}{1000 \times 2 \times 10^{-3}}$ = -j0.5 Ω

$V_s(t) = 2\angle -75$

~~now using~~

thus



$V_1 = 2\angle -75°$

البقية الصفحة المقابلة لهذا الشكل

$V_1 = 2\angle -75^\circ$

KCl 2 : $-\left(\frac{V_2 - V_1}{3}\right) - \frac{V_2}{-j0.5} - \frac{V_2}{12+j15} = 0$

$-\frac{V_2}{3} + \frac{V_1}{3} + \frac{V_2}{j0.5} - \frac{V_2}{12+j15} = 0$

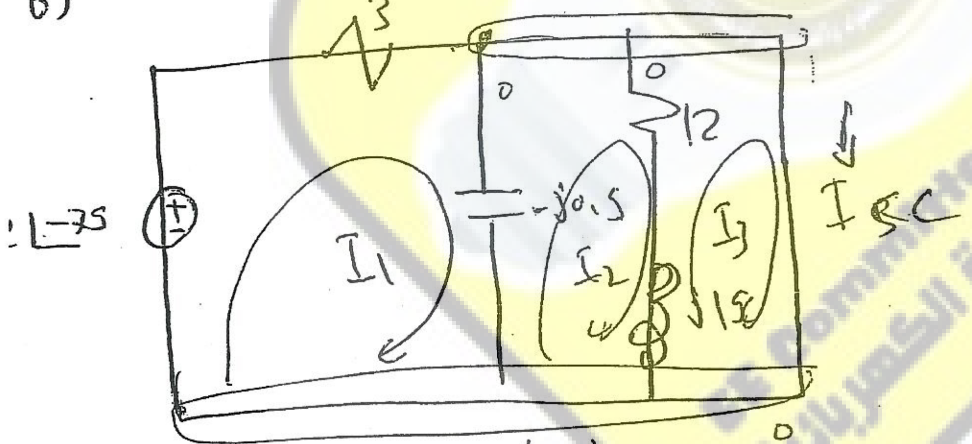
$\left(-1 + \frac{1}{j0.5} - \frac{1}{12+j15}\right) V_2 = -\frac{V_1}{3}$

$\left(+1 - \frac{1}{j0.5} + \frac{1}{12+j15}\right) V_2 = \frac{2}{3}\angle -75$

$V_2 = 0.3010 \angle -137.2^\circ$

thus $V_{xy} = 0.3010 \cos(1000t - 137.2^\circ)$

b)



~~Using mesh Analysis~~

~~$-(2\angle -75 + 3 I_1 - j0.5 (I_1 - I_2) = 0$~~

using nodal Analysis

$V_2 = 0$ (bcs of short ckt)

$-\frac{(V_2 - V_1)}{3} - I_{SC} = 0$

$+ \frac{V_1}{3} = I_{SC}$

$\frac{2\angle -75}{3} A = I_{SC}$

$i_{sc} = \frac{2}{3} \cos(1000t - 75)\ A$

thus $Z_{in} = \frac{V_{Th}}{I_{sc}}$

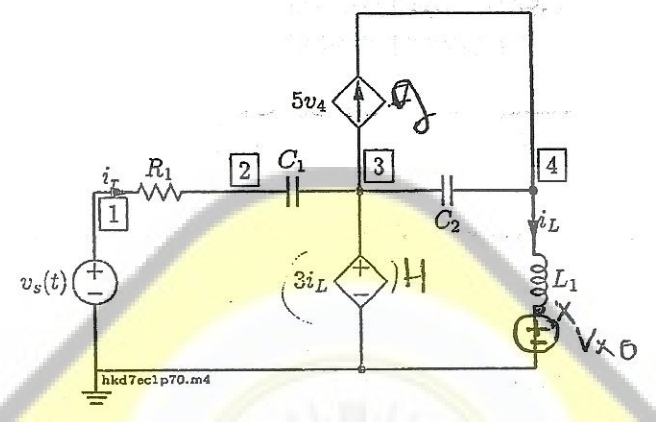
$Z_{in} = \frac{0.301\angle -137.2}{\frac{2}{3}\angle -75}$

$Z_{in} = 0.4519 \angle -62.2$

5. 10pt Use PSpice to find the magnitude and phase of the current I_r and the real and imaginary of the voltage at node 4.

Take $v_s = 3\cos(10^3 t - 37°)V, R_1 = 100\Omega, C_1 = 100uF, C_2 = 300\mu F, L_1 = 0.5H$.

$V_s = 3 \angle -37$



$W = \frac{1000}{2\pi}$

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Title
Vs    1   0   ac    3    -37
R1    1   2   100
C1    2   3   100u
C2    3   4   300u
L1    4   x   0.5
Vxo   x   0   ac    0    0
H1    3   0   Vxo   3
g1    3   4   4     0    5
.ac   Lin     1     159.15   159.15
.print  ac    im(Vs)   Ip(Vs)
.print  ac    Vr(4)    Vi(4)
.end
```

(10)