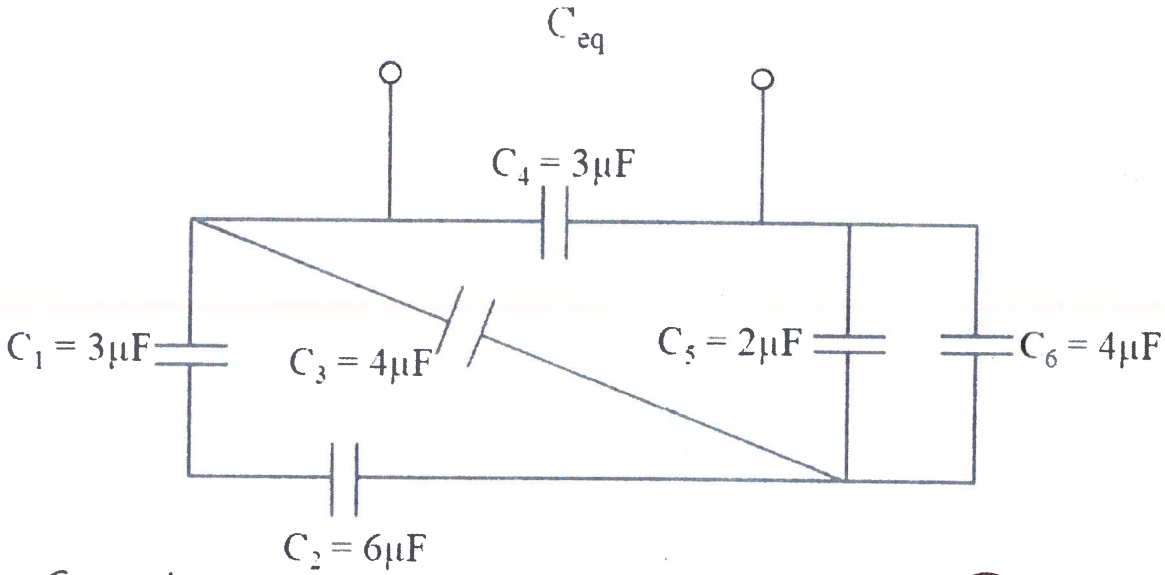
EECS/CSE 70A Spring 2018 **Midterm Exam #2** Name:_____

May 25th, 2018, 12:00 pm to 12:50 pm ID no.:_____

Professor Peter Burke

PROBLEM 1: (10 points)
Find C_{eq}:



C_1 and C_2 series → $C_{e1} = \frac{C_1 \times C_2}{C_1 + C_2} = 2\mu F$ (2)

C_{e1} and C_3 Parrallel → $C_{e2} = C_{e1} + C_3 = 6\mu F$ (2)

C_5 and C_6 Parallel → $C_{e3} = C_5 + C_6 = 6\mu F$ (2)

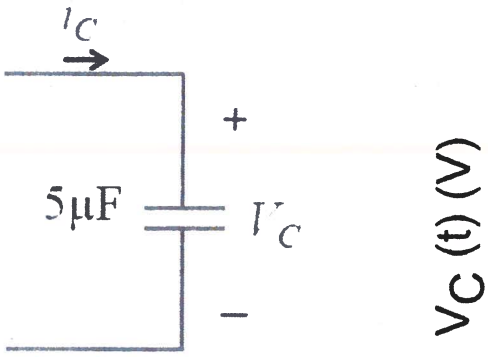
C_{e2} and C_{e3} series → $C_{e4} = \frac{C_{e2} \times C_{e3}}{C_{e2} + C_{e3}} = 3\mu F$ (2)

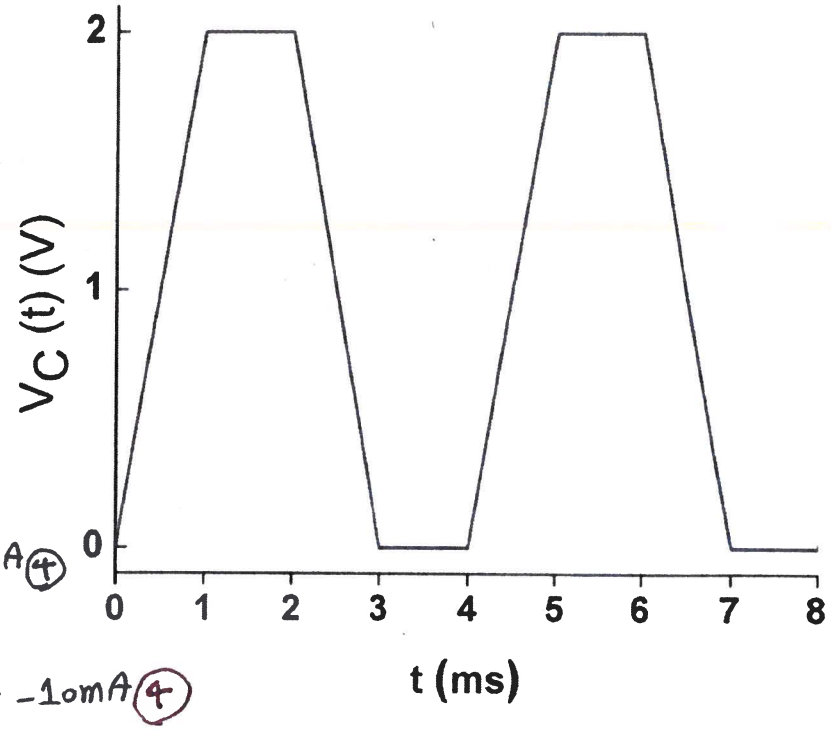
C_{e4} and C_4 Parrallel → $C_{eq} = C_{e4} + C_4 = 6\mu F$ (2)

C_{eq}	$6\mu F$

PROBLEM 2: (20 points)

The voltage of the capacitor is given as a function of time in the following figure between 0ms to 8ms. Plot the current of the capacitor, $i_C(t)$, between 0ms to 8ms. Mark the axes of your plot with numbers and units.





$q = C V_C \rightarrow i_C(t) = C \frac{dv_C}{dt}$ (2)

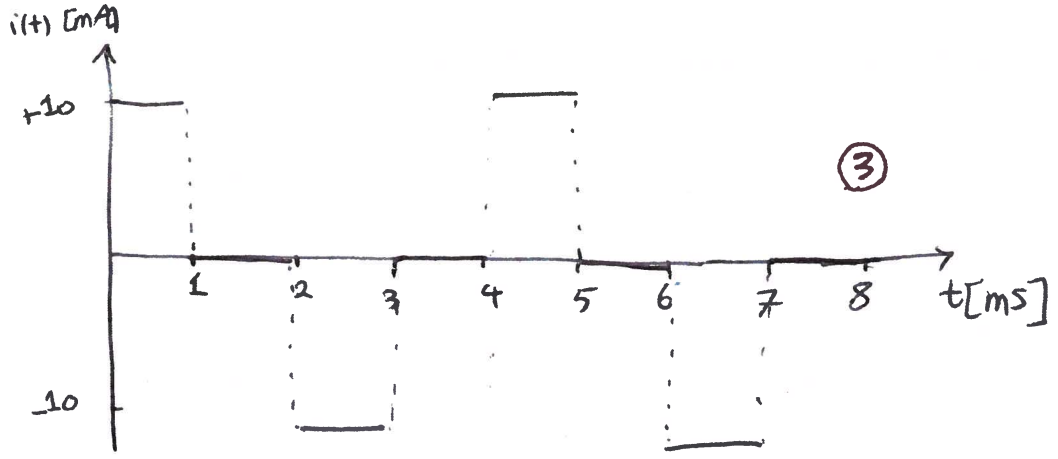
$0 < t < 10^{-3} \rightarrow i_C(t) = 5 \times 10^{-6} \times \frac{2}{10^{-3}} = 10mA$ (4)

$10^{-3} < t < 2 \times 10^{-3} \rightarrow i_C(t) = 0$ (4)

$2 \times 10^{-3} < t < 3 \times 10^{-3} \rightarrow i_C(t) = 5 \times 10^{-6} \times \frac{2}{10^{-3}} = -10mA$ (4)

$3 \times 10^{-3} < t < 4 \times 10^{-4} \rightarrow i_C(t) = 0$ (4)

This repeats again from $t = 4 \times 10^{-3}$ to $t = 8 \times 10^{-3}$.



I_o 6 pts
τ 7 pts
$i_L(t)$ 7 pts
$v_L(t)$ 10 pts
Total 30 pts

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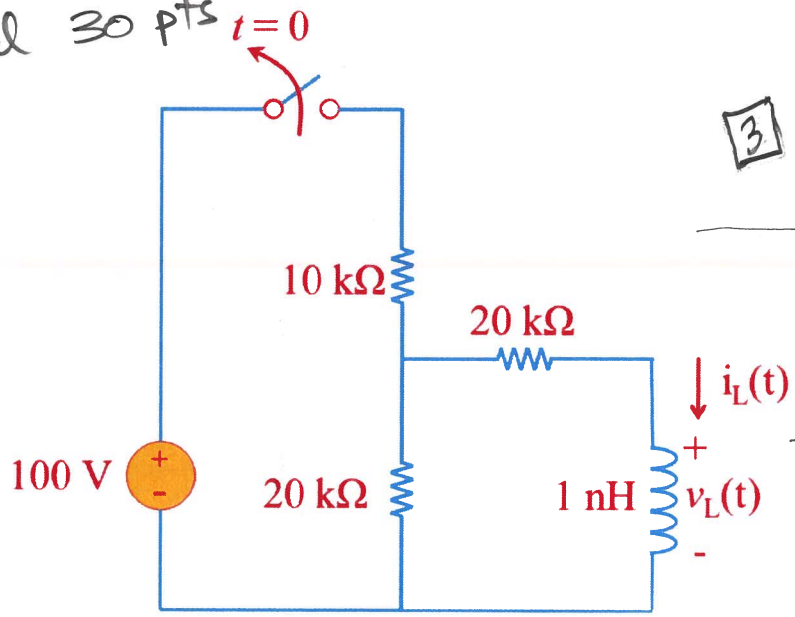
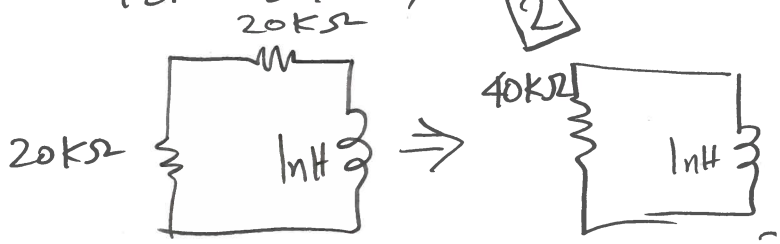
PROBLEM 3: (30 points)

Find $i_L(t)$ and $v_L(t)$.



For $t > 0$,



[2]

[3] $\tau = \frac{L}{R} = \frac{1\,nH}{40k\Omega} = 2.5\times10^{-14}\,s$ [2]

$i_L(t) = I_o e^{-t/\tau}$ [5]

$= (2.5\times10^{-3}) e^{-t/(2.5\times10^{-14}\,s)}$ A

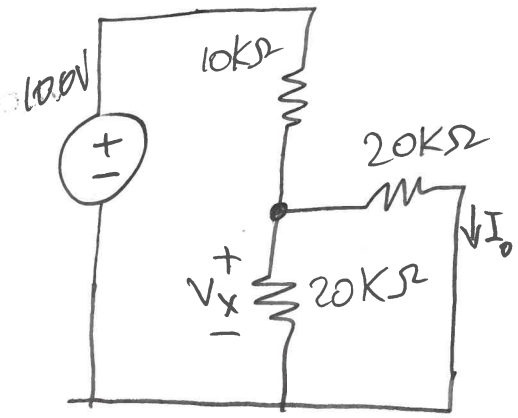
$v_L = L\frac{di_L}{dt}$ [5]

$= -\frac{(1\times10^{-9})(2.5\times10^{-3}) \cdot e^{-t/(2.5\times10^{-14})}}{2.5\times10^{-14}}$ [3]

$= -1\times10^{2}\, e^{-t/(2.5\times10^{-14})}$ V

$= -100\, e^{-t/(2.5\times10^{-14})}$ V

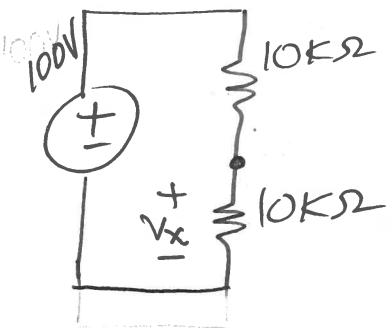
For $t < 0$,



$V_x = 100\frac{10}{20}$

$= 50$ V

$i_L(0) = \frac{50}{20k} = 2.5\,mA = I_o$ [4] [2]



[2]	$i_L(t)$	$(2.5\times10^{-3}) e^{-t/(2.5\times10^{-14})}$ A
[2]	$v_L(t)$	$-100\, e^{-t/(2.5\times10^{-14})}$ V

$1/2.5\times10^{-14} = 4\times10^{13}$

PROBLEM 4: (20 points)

a) Given $i(t) = 5\cos(\omega t + \pi/6)$ amps. Find the phasor **I** that represents i(t) (express your answer for **I** in rectangular/cartesian form x + jy)

$\mathbf{I} = 5\angle\pi/6$

[2] $x = r\cos\theta = 5\cos(\pi/6) = 5\frac{\sqrt{3}}{2}$ [2]

[2] $y = r\sin\theta = 5\sin(\pi/6) = \frac{5}{2}$ [2]

[2]

I	$\frac{5\sqrt{3}}{2} + j\frac{5}{2}$

b) Convert the phasor $\mathbf{V} = 1 + j\sqrt{3}$ to time domain expression v(t). (express the angle in **radians** not degrees)

[2] $r = \sqrt{x^2+y^2} = \sqrt{1+3} = \sqrt{4} = 2$ [2]

[2] $\theta = \tan^{-1}\left(\frac{y}{x}\right) = \tan^{-1}(\sqrt{3}) = \pi/3$ [2]

$v(t) = 2\cos(\omega t + \pi/3)$

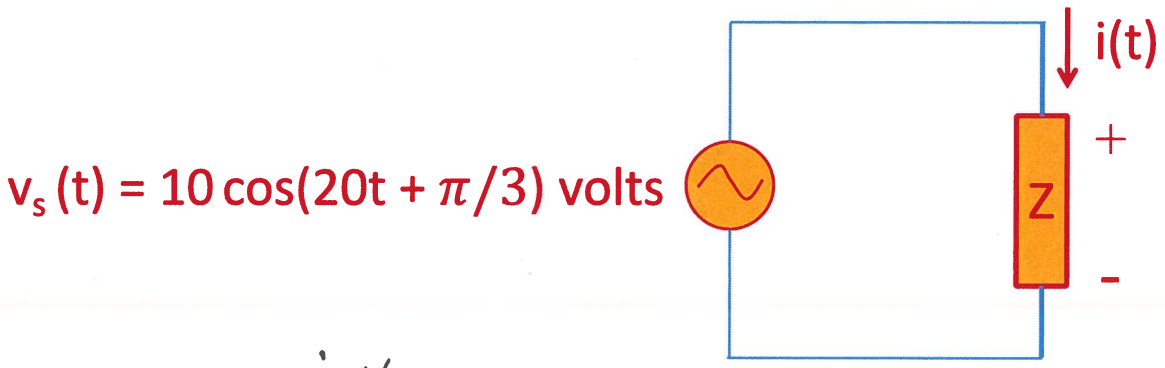
Each fully correct part: [2] points
Each part with any mistake: zero

[2]

v(t)	$2\cos(\omega t + \pi/3)$

PROBLEM 5: (20 points)

Find **V, I,** and i(t) if $\mathbf{Z} = 10\, e^{j\pi/4}\ \Omega$.
(express your answers for **V** and **I** in polar form $re^{j\theta}$)
(express all angles in **radians** not degrees)



$v_s(t) = 10\cos(20t + \pi/3)$ volts

$$\bar{V}_s = 10\, e^{j\pi/3} \quad V$$

$$\bar{I} = \frac{\bar{V}_s}{\bar{Z}} = \frac{10\, e^{j\pi/3}}{10\, e^{j\pi/4}} = e^{j\pi/12} \quad A$$

$$i(t) = \cos(20t + \pi/12)\ A$$

Each fully correct part : [5] points
Each part with any mistake : zero

[5]	**V**	$10\, e^{j\pi/3}$ V
[5]	**I**	$e^{j\pi/12}$ A
[5]	**i(t)**	$\cos(20t + \pi/12)$ A