EECS/CSE 70A Spring 2017 **Final Exam**

June 13, 2017, 10:30 am to 12:30 pm

Professor Peter Burke

Name:________________________

ID no.:________________________

Q1	Q2	Q3	Q4	Q5	Total
/15	/20	/25	/20	/20	/100

EECS / CSE 70A Final Exam

DO NOT BEGIN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

Print your name on all pages.

Write your solutions in clear steps with concise explanations.

Name:____________________________

ID no.:____________________________

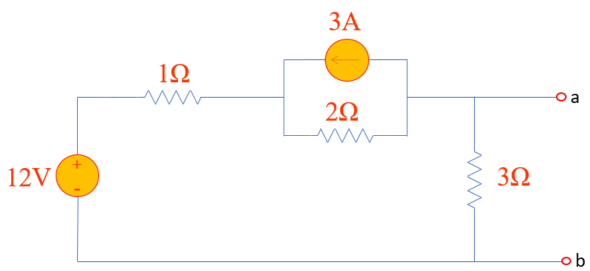
PROBLEM 1: (15 points)

In the following circuit:

(a) Find equivalent Thevenin voltage source

(b) Find equivalent Norton Current source

(c) Find equivalent Thevenin and Norton Resistor and give the equivalent circuits.



V_{th}	3V
I_N	2A
R_{th}	1.5Ω

Super-position Theorem: (effect of two independent sources in a linear circuit is sum of effects of each source while the other one is zero).

(a) $V_{th1} = 12V \times \frac{3\Omega}{1\Omega+2\Omega+3\Omega} = 6V$ $V_{th2} = -3A \times \frac{2\Omega}{1\Omega+3\Omega+2\Omega} \times 3\Omega = -3V$

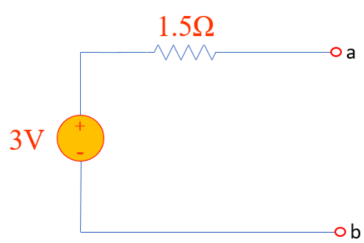
$V_{th} = V_{th1} + V_{th2} = 3V$

(b) $I_{N1} = \frac{12V}{1\Omega+2\Omega} = 4A$ $I_{N2} = -3A \times \frac{2\Omega}{1\Omega+2\Omega} = -2A$

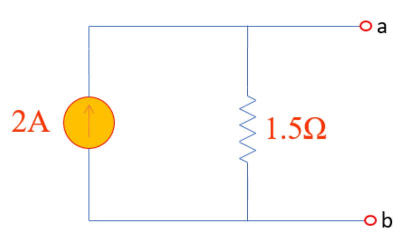
$I_N = I_{N1} + I_{N2} = 2A$

(c) $R_{th} = \frac{V_{th}}{I_N} = \frac{3V}{2A} = 1.5\Omega$

V_{th} and I_N can be found directly without using superposition theorem. Also R_{th} can be directly found by setting sources to zero and finding the equivalent resistance observed from a-b.



Thevenin



Norton

EECS/CSE 70A Spring 2017 **Final Exam** Name:___________________________

June 13, 2017, 10:30 am to 12:30 pm ID no.:___________________________

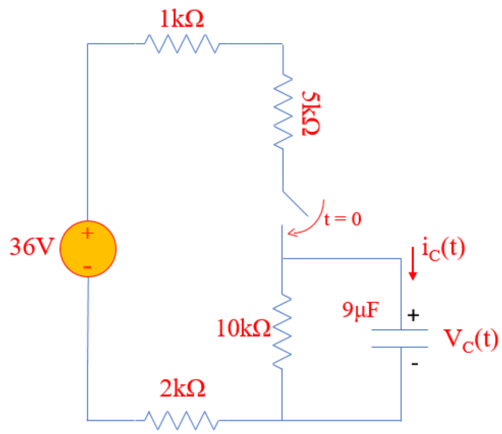
Professor Peter Burke

PROBLEM 2: (20 points)

The switch in the circuit in the figure below was open for a long time and is closed at t = 0.

(a) Find the expression of the $V_C(t)$ for t > 0.

(b) Find the expression of the current of the capacitor, $i_C(t)$ for t > 0.



$\boldsymbol{V_C(t)}$	$20(1 - e^{-\frac{t}{\tau}})$ V
$\boldsymbol{i_C(t)}$	$4.5e^{-\frac{t}{40ms}}$ mA

(a) For t<0: $V_C(t) = 0V$

For t>0:

$V_C(t=0^+) = V_C(t=0^-) = 0V$

$V_C(t=\infty) = \frac{10k\Omega}{1k\Omega+5k\Omega+10k\Omega+2k\Omega} \times 36V = 20V$

$R\times C = \{10K\Omega || (1K\Omega + 5K\Omega + 2K\Omega)\} \times 9\mu F = \frac{40}{9} K\Omega \times 9\mu F = 40ms$

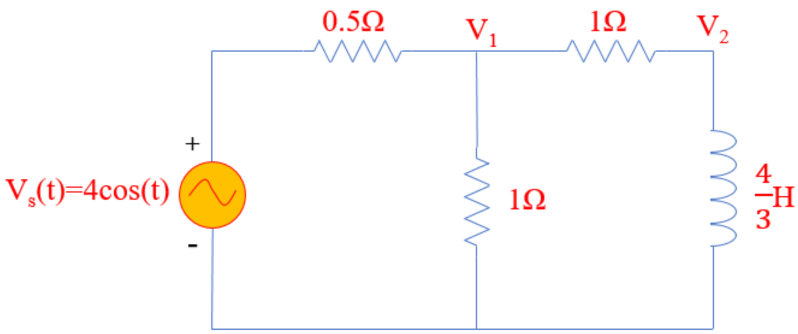
$V_C(t>0) = V_C(t=\infty) + \{V_C(t=0^+) - V_C(t=\infty)\}e^{-\frac{t}{\tau}}$

$V_C(t>0) = 20(1 - e^{-\frac{t}{40ms}})$ V

(b) $i_C(t) = C\frac{dV_C(t)}{dt} = 4.5e^{-\frac{t}{40ms}}$ mA

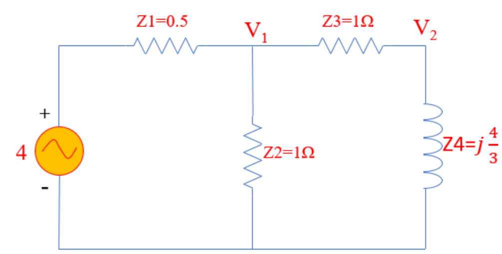
PROBLEM 3: (25 points)

Find $v_1(t)$ and $v_2(t)$ and V_1 and V_2. (V_1 is phasor of $v_1(t)$). tan(8°)=1/7



$V_1(t)$	$\frac{5\sqrt{2}}{3}\cos(t+8\times\frac{\pi}{180})V$
$V_2(t)$	$\frac{4\sqrt{2}}{3}\cos(t+\frac{\pi}{4})V$
V_1	$\frac{5\sqrt{2}}{3}e^{j8^o}V$
V_2	$\frac{4\sqrt{2}}{3}e^{j45^o}V$

Voltage Division:



$$V_1 = V_s\times\frac{Z_2||(Z_3+Z_4)}{Z_2||(Z_3+Z_4)+Z_1} = 4\times\frac{\frac{1+\frac{4}{3}j}{2+\frac{4}{3}j}}{\frac{1+\frac{4}{3}j}{2+\frac{4}{3}j}+0.5}$$

$$= 4\times\frac{1+\frac{4}{3}j}{2+2j} = \frac{1}{3}\times(7+j) = \frac{5\sqrt{2}}{3}e^{j8^o}$$

$$\rightarrow V_1(t) = \frac{5\sqrt{2}}{3}\cos(t+8\times\frac{\pi}{180})$$

Voltage Division 2:

$$V_2 = V_1\times\frac{Z_4}{Z_3+Z_4} = V_1\times\frac{\frac{4}{3}j}{1+\frac{4}{3}j}$$

So:

$$V_2 = 4\times\frac{1+\frac{4}{3}j}{2+2j}\times\frac{\frac{4}{3}j}{1+\frac{4}{3}j} = \frac{4}{3}(1+j) = \frac{4\sqrt{2}}{3}e^{j45^o} \rightarrow V_2(t) = \frac{4\sqrt{2}}{3}\cos(t+\frac{\pi}{4})$$

EECS/CSE 70A Spring 2017 **Final Exam** — Name:____________________

June 13, 2017, 10:30 am to 12:30 pm — ID no.:____________________

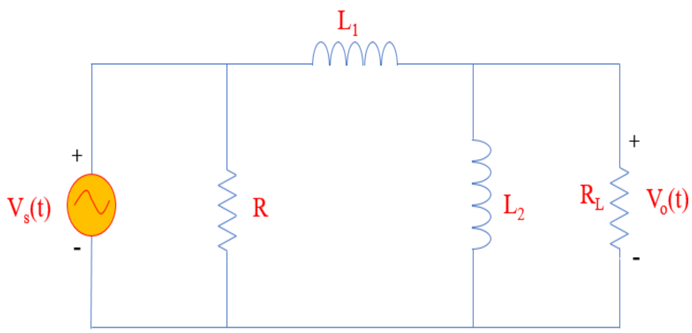
Professor Peter Burke

PROBLEM 4: (20 points)

In the circuit below, the Transfer Function is defined as: $$\boldsymbol{H(\omega) = \frac{V_o(\omega)}{V_s(\omega)}}$$

a) Find the transfer function H(ω) in terms of R, R_L, L_1 and L_2.

b) Find $\lim_{\omega\to 0}|H(\omega)|$ and $\lim_{\omega\to\infty}|H(\omega)|$.



H(ω)	$\frac{L_2 R_L}{(L_1 + L_2)R_L + j\omega L_1 L_2}$
$\lim_{\omega\to 0}\lvert H(\omega)\rvert$	$\frac{L_2}{(L_1 + L_2)}$
$\lim_{\omega\to\infty}\lvert H(\omega)\rvert$	0

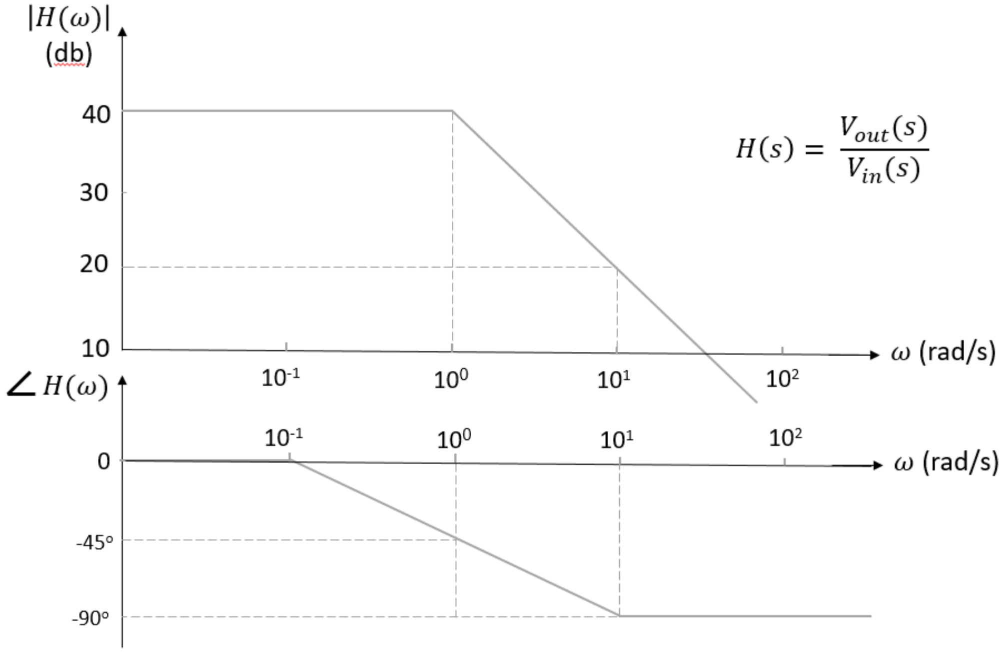
(a) $H(\omega) = \frac{V_O(\omega)}{V_S(\omega)} = \frac{R_L || j\omega L_2}{\{R_L || j\omega L_2\} + j\omega L_1} = \frac{j\omega L_2 R_L}{j\omega(L_1+L_2)R_L - \omega^2 L_1 L_2} = \frac{L_2 R_L}{(L_1+L_2)R_L + j\omega L_1 L_2}$

(b) $\lim_{\omega\to 0}|H(\omega)| = \lim_{\omega\to 0}\left|\frac{L_2 R_L}{(L_1+L_2)R_L + j\omega L_1 L_2}\right| = \frac{L_2}{(L_1+L_2)}$

$$\lim_{\omega\to\infty}\left|\frac{L_2 R_L}{(L_1 + L_2)R_L + j\omega L_1 L_2}\right| = 0$$

PROBLEM 5: (20 points)

The bode plots in the following represent the magnitude and phase for Transfer Function of an amplifier. If the input voltage is $V_{in}(t) = \cos(t) + 10\sin(10t)$, find the output voltage $V_{out}(t)$.



$$V_{in1}(t) = \cos t, (|H(\omega)|)_{\omega=1} = 40db = 10^{\frac{40}{20}} = 100, Phase(H(\omega))_{\omega=1} = -45^o \rightarrow V_{out1}(t) = 100\cos(t - \frac{\pi}{4})$$

$$V_{in2}(t) = 10\sin 10t, (|H(\omega)|)_{\omega=10} = 20db = 10^{\frac{20}{20}} = 10, Phase(H(\omega))_{\omega=10} = -90^o \rightarrow V_{out2}(t) = 100\sin(10t - \frac{\pi}{2})$$

$$V_{in}(t) = V_{in1}(t) + V_{in2}(t) \rightarrow V_{out}(t) = V_{out1}(t) + V_{out2}(t)$$

$$V_{out}(t) = 100\cos(t - \frac{\pi}{4}) + 100\sin(10t - \frac{\pi}{2})$$

V_o(t)	$V_{out}(t) = 100\cos(t - \frac{\pi}{4}) + 100\sin(10t - \frac{\pi}{2})$