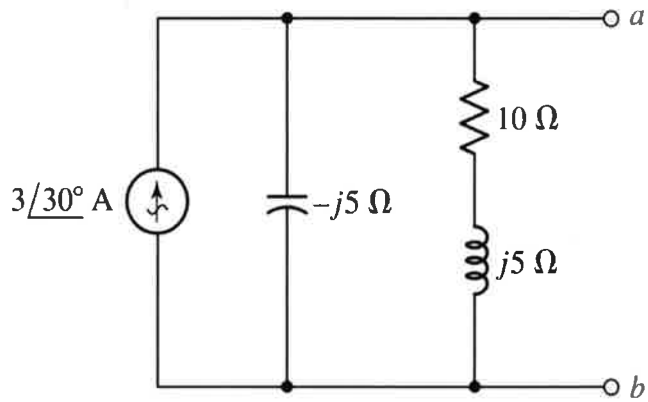
Engr228 **Final Exam** **Spring, 2017**

NAME KEY SCORE ________/60

- This is a closed book test with the exception of your calculator and three cheat sheets.
- There are six main problems, each worth ten points with the points per problem being allocated as indicated.
- Grading considerations include:
  - Your problem solution approach;
  - The difficulty of following your solution;
  - Identifying your final answer properly;
  - Placing units on your final answers.

---

10 pts Phasor and Thévenin Analysis
Find the Thévenin voltage and Thévenin impedance between points *a* and *b*. Express your answers in ***rectangular, polar,*** and ***sinusoidal*** forms.



$$Z_{th} = (10+j5) \,||\, -j5$$

$$= \frac{(10+j5)(-j5)}{10+j5-j5}$$

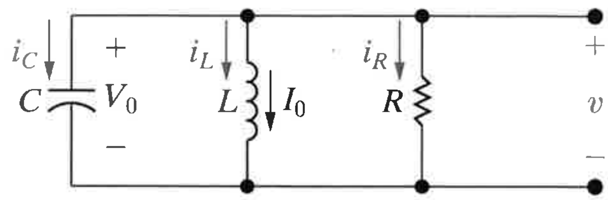
$$\boxed{\begin{aligned} Z_{th} &= 2.5-5j \ \Omega \\ &= 5.59\angle{-63.43^\circ} \ \Omega \\ &= 5.59\cos(\omega t - 63.43^\circ) \ \Omega \end{aligned}}$$

$$V_{th} = I Z_{th}$$

$$= 3\angle{30^\circ}\,(5.59\angle{-63.43^\circ})$$

$$\boxed{\begin{aligned} V_{Th} &= 16.77\angle{-33.43^\circ} \ V \\ &= 14.0-9.24j \ V \\ &= 16.77\cos(\omega t - 33.43^\circ) \ V \end{aligned}}$$

10 pts Second Order Systems
Using the following parameters, find v for $t \geq 0$ seconds:
$C = 0.01\text{F}$
$L = 0.1\text{H}$
$R = 1.0\ \Omega$
$v(0^-) = 5.0\text{V}$
$i_L(0^-) = 1.0\text{A}$



Parallel RLC circuit

$\alpha = \frac{1}{2RC} = 50 \qquad \omega_0 = \frac{1}{\sqrt{LC}} = 31.6228$

$\alpha > \omega_0$ so overdamped

$S_{1,2} = -\alpha \pm \sqrt{\alpha^2 - \omega_0^2} = -50 \pm 38.7298$

$= -11.27, -88.73$

$\alpha = 50$
$\omega_0 = 31.6228$
$S_1 = -11.2702$
$S_2 = -88.7298$

$v(t) = A_1 e^{S_1 t} + A_2 e^{S_2 t}$

$= A_1 e^{-11.27t} + A_2 e^{-88.73t}$

$@t=0, \quad v(0) = 5 = A_1 + A_2 \quad (1)$

KVL $@ t=0$: $i_c + i_L + i_r = 0$

$C\frac{dv_c}{dt} + 1 + \frac{5}{1} = 0$

$C\left[A_1(-11.27) - 88.73 A_2\right] + 6 = 0$

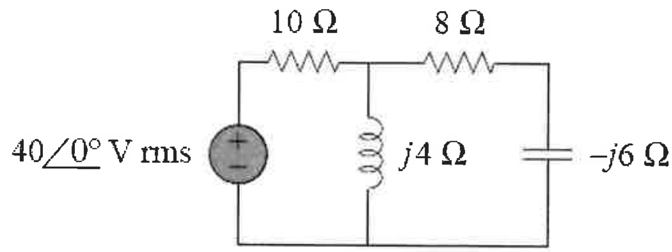
$11.27A_1 + 88.73A_2 = 600 \quad (2)$

Solving (1) + (2) : $A_1 = -2.0185$
$A_2 = 7.0185$

$$\boxed{v(t) = -2.019e^{-11.27t} + 7.019e^{-88.73t} \text{ V} \quad t \geq 0}$$

6 pts AC Power Systems

Calculate the power factor as seen by the source.
Indicate whether the PF is leading or lagging.
Note – the source is sinusoidal.



$PF = \cos(\theta_v - \theta_i)$

also, $\theta_z = \theta_v - \theta_i$ so

we can find Z_{eq} as seen by the Source

$Z_{eq} = 10 + j4 \,||\, (8 - j6)$

$= 11.88 + 4.47j = 12.695 \angle 20.618° \ \Omega$

$\boxed{PF = \cos(20.618°) = 0.936 \text{ lagging}}$ since ∠ of Z is positive.

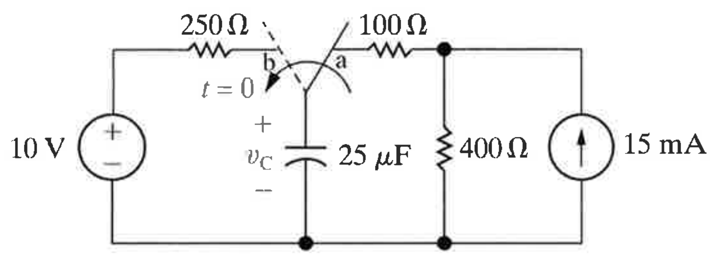
Engr228 **Exam #2** **Spring, 2018**

NAME KEY SCORE_______/30

This test is 60 minutes in length and is closed book except for your calculator and one side of a cheat sheet.

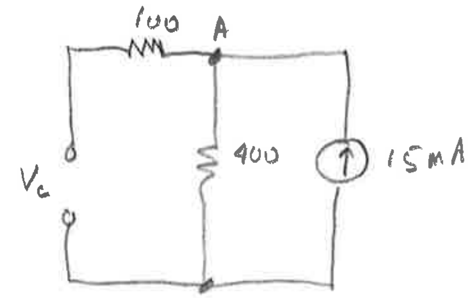
First-Order Circuits

The switch has been in position **a** for a long time. At t = 0 seconds, the switch moves to position **b**.



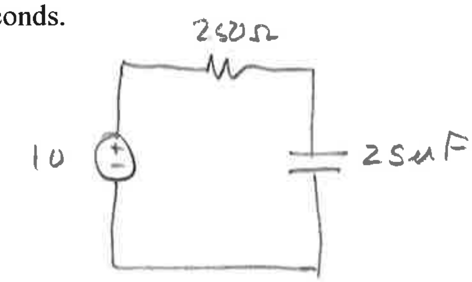
3 pts Find the capacitor voltage at t = 0 seconds.

$$V_c = V_A$$
$$= 400(15mA)$$
$$= 6.0 V$$
$$\boxed{V_c(0) = 6.0 V}$$



2 pts Find the time constant (τ) of this circuit for t > 0 seconds.

$$\tau = RC$$
$$= 250(25\mu F)$$
$$\boxed{\tau = 6.25 ms}$$



1 pt Find the voltage across the capacitor at time infinity, i.e. $V_C(\infty)$.

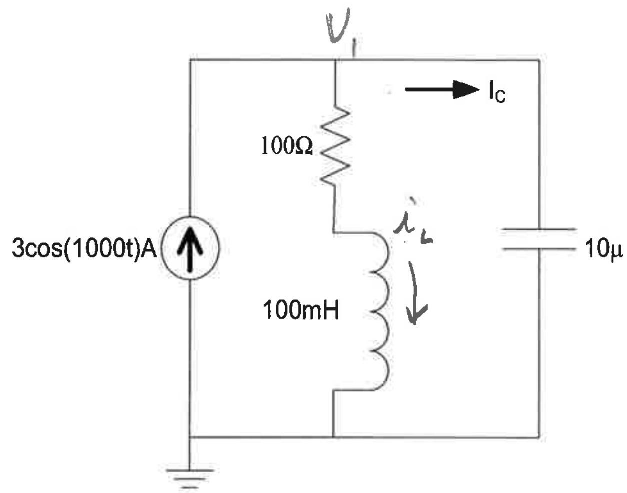
$$\boxed{V_c(\infty) = 10 V}$$

2 pts Find $V_C(t)$ for t ≥ 0 seconds.

$$V_c(t) = V_c(\infty) + [V_c(0) - V_c(\infty)]e^{-t/RC}$$
$$= 10 + (6-10)e^{-t/RC}$$
$$\boxed{V_c(t) = 10 - 4e^{-160t} \quad V}$$

Phasor Analysis

6 pts Find the voltage across the inductor and express it in ***polar, rectangular, and sinusoidal*** forms.



Current divider:

$$i_L = \frac{3\angle 0 \left(\frac{1}{jwC}\right)}{\frac{1}{jwC} + jwL + R}$$

$$= \frac{3\angle 0 \; (100 \angle -90^\circ)}{-100j + 100j + 100}$$

$$= 3\angle -90 \text{ A}$$

$$V_L = i_L Z_L$$

$$= (3\angle -90)(100\angle 90^\circ)$$

$$\boxed{\begin{aligned} V_L &= 300\angle 0^\circ \text{ V} \\ &= 300 + 0j \text{ V} \\ &= 300 \cos(1000t + 0^\circ) \text{ V} \end{aligned}}$$

$$V_1 = 3\angle -90 \; (100 + 100j)$$

$$= 424.2 \angle -45^\circ$$

$$= 300 - 300j$$

2 pts Find the current through the capacitor and express it in ***polar*** form only.

$$i_C = i - i_L$$

$$= 3\angle 0 - 3\angle -90^\circ$$

$$= 3 + 3j$$

$$\boxed{i_C = 4.243\angle 45^\circ \text{ A}}$$