ECE 203 Fall 2022
Exam 3

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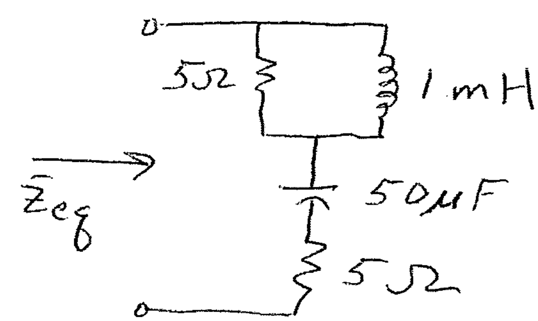
Open notes. No computers or other internet-connected devices including cell phones. You must show your work on each problem in order to get credit for your answer, even if you can do the work in your head. You must show sufficient work to demonstrate that you know how to solve the problem – guesses will not get credit.

ANSWERS

1.	D	6.	D
2.	B	7.	C
3.	A	8.	D
4.	B	9.	C
5.	C	10.	B

1. Find the equivalent impedence $\mathbf{Z}_{eq}$ of this network at f = 1 kHz.

A) 10 + j95.46 Ω B) 5.19 - j19.04 Ω C) 5.19 + j0.96 Ω D) 8.06 – j0.74 Ω



$X_L = 2\pi f L = 2\pi \times 10^3 \times 10^{-3} = 2\pi = 6.283\Omega$

$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 10^3 \times 50 \times 10^{-6}} = 3.183\Omega$

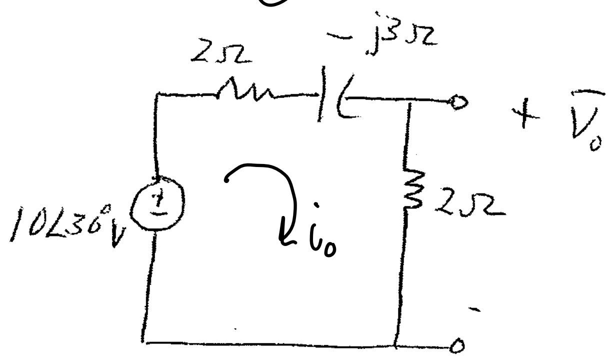
$Z_{eq} = (5 \| jX_L) + 5 - jX_C$

$= \frac{5 \times (j6.283)}{5 + j6.283} + 5 - j3.18$

$Z_{eq} = 8.06 - j0.75$

2. Calculate $\mathbf{V_o}$ in this circuit.

A) $5.55\angle 86.31^\circ$ V B) $4\angle 66.87^\circ$ V C) $5\angle 30^\circ$ V D) $2\angle 66.87^\circ$ V



$$-10\angle 30^\circ + (2 - j3 + 2)i_o = 0$$

$$\sqrt{4^2 + (-3)^2} = \sqrt{25} = 5$$

$$\tan^{-1}\left(\frac{-3}{4}\right) = -36.87^\circ$$

$$i_o = \frac{10\angle 30^\circ}{(4 - j3)}$$

$$i_o = \frac{10\angle 30^\circ}{5\angle -36.87^\circ} = 2\angle 66.87^\circ \text{ A}$$

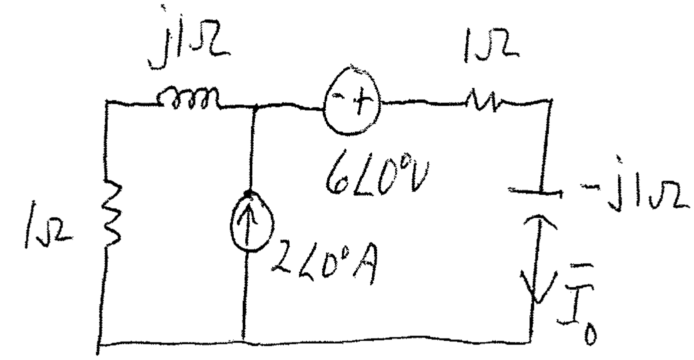
$$V_o = IR$$

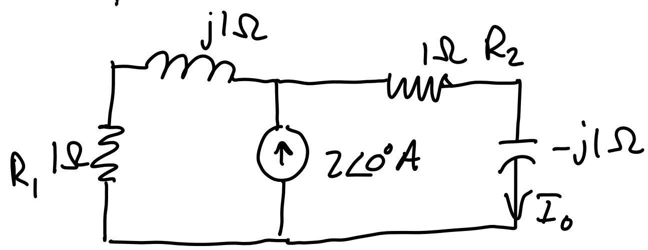
$$V_o = (2\angle 66.87^\circ)(2)$$

$$V_o = 4\angle 66.87^\circ \text{ V}$$

3. You are using superposition to find the current $\mathbf{I_o}$. Find $\mathbf{I_o}$', the current due to the current source alone.

A) 1.41∠45° A   B) 0 ∠-45° A   C) 1.41∠-45° A   D) 2 ∠0° A





$$I_o' = I_s \times \frac{R_1 + j\omega L}{R_1 + j\omega L + R_2 + \frac{1}{j\omega C}}$$

$$= 2\angle 0^\circ \times \frac{1+j1}{1+j1+1-j1}$$

$$= 2 \times \frac{1+j1}{2}$$

$$= 1+j1$$

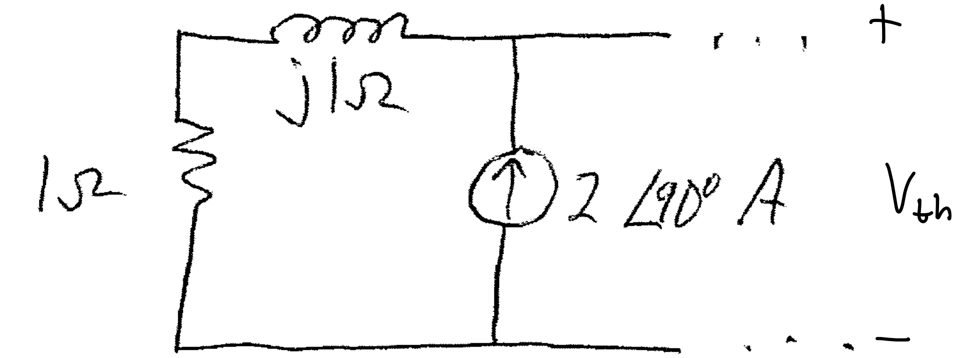
$$\sqrt{1^2+1^2} = \sqrt{2} \approx 1.41$$

$$\tan^{-1}\left(\frac{1}{1}\right) = 45^\circ$$

$$I_o' = 1.41\angle 45^\circ$$

4. Use source exchange to transform the circuit shown into an equivalent circuit with a voltage source in series with an impedance. Which of these is the voltage of the new source?

A) 1+j1 V B) -2 + j2 V C) j2 V D) 1 + j3 V



$$2\angle 90^\circ = 2\,(\cos(90) + j\sin(90))$$

$$= 2j \text{ A}$$

$$V_{th} = IR = (2j)\,(j+1)$$

$$= 2j^2 + 2j$$

$$V_{th} = -2 + 2j \text{ V}$$

5. For a circuit element, the magnitude of the complex power **S** is 15 kVA at a power factor of 0.85. Find the value of the reactive power, Q.

A) 12.75 kVAR B) 17.65 kVAR C) 7.9 kVAR D) 15.00 kVAR

$pf = \cos(\theta) = 0.85 \Rightarrow \theta = \cos^{-1}(0.85)$

$S = 15\times10^3$ VA

$Q = |S| \sin\theta$

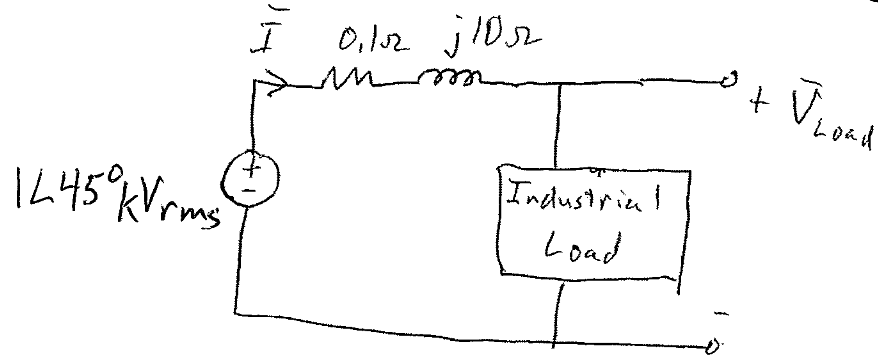
$Q = (15\times10^3) \sin(\cos^{-1}(0.85))$

$Q = (15\times10^3) \sin(31.79)$

$Q = (15\times10^3)(0.527)$

$Q = 7902.11 = 7.9$ KVAR

6. In this circuit, the current **I** is 5∠45° A$_{rms}$. Find **S**$_{Load}$.
A) 50.01 ∠134.43° VA B) 5000 ∠0° VA C) 480 ∠-45° VA D) 5010 ∠-2.86° VA



$$\bar{V}_{Load} = 1000\angle 45^\circ - 5\angle 45^\circ(0.1 + j10)$$

$$= 1000\angle 45^\circ - 5\angle 45^\circ(10\angle 89.43^\circ)$$

$$= 1000\angle 45^\circ - 50\angle 134.43^\circ$$

$$V_{load\,(rms)} = 1002.13\angle 42.14^\circ$$

$$S = V_{Load} \times I_{Load}$$

$$= 1002.13\angle 42.36 \times (5\angle 45)^*$$

$$S = 5010.65\angle -2.64^\circ$$

$$\sqrt{0.1^2 + 10^2} = 10$$

$$\tan^{-1}\left(\frac{10}{0.1}\right) = 89.43$$

$$1000(\cos 45 + j\sin 45) = 707.11 + 707.11j$$

$$50(\cos 134 + j\sin 134) = -34.73 + 35.97j$$

$$707.11 - 34.73 + 707.11j + 35.97j$$

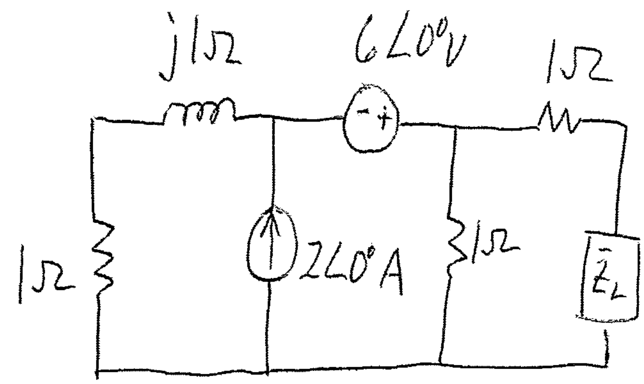
$$672.38 + 743.08j$$

$$\sqrt{672.38^2 + 743.08^2} = 1002.13$$

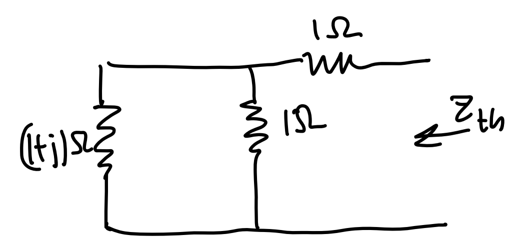
$$\tan^{-1}\left(\frac{672.38}{743.08}\right) = 42.14^\circ$$

7. For this circuit, find the value of load impedance that will maximize power transfer to the load.

A) $1.6 + j0.2\ \Omega$ B) $2\ \Omega$ C) $1.6 - j0.2\ \Omega$ D) $2 - j\ \Omega$



for Z_{th}



$$\therefore\ Z_{th} = 1 + ((1+j) \| 1)$$

$$= 1 + \frac{(1+j) \times 1}{1 + j + 1}$$

$$= 1 + \frac{(1+j)}{(2+j)}$$

$$= \frac{(2+j) + (1+j)}{2+j}$$

$$= \frac{3+2j}{2+j} \times \frac{2-j}{2-j}$$

$$= \frac{(3+2j)(2-j)}{5}$$

$$= \frac{6 - 3j + 4j + 2}{5}$$

$$= \frac{8+j}{5}$$

$(2+j)(2-j)$

$4 - 2j + 2j - (-1)$

$4+1$

5

$$Z_{th} = \frac{8+j}{5}$$

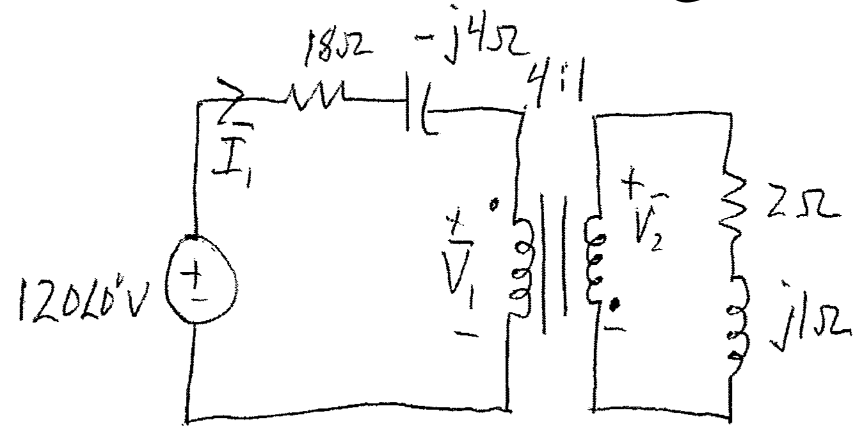
$$Z_{th} = 1.6 + j0.2$$

$$Z_L = Z_{th}^* = (1.6 + j0.2)^*$$

$$Z_L = 1.6 - j0.2\ \Omega$$

8. For this circuit, find the current $\mathbf{I}_1$.

A) 5.87 + j0.88 A B) 6.35 + j1.41 A C) -48 + j24 A D) 2.27 + j0.54 A



$Z_1 = (18 - j4)\Omega,\ Z_2 = (2 + j1)\Omega$

$18 - j4 + 0.25 + j0.125$

$17.75 - 3.875j$

$Z'_2 = (4^2)(2+j1) = 32 + j16$

$$I_1 = \frac{120\angle 0^\circ}{Z_1 + Z_2'} = \frac{120\angle 0^\circ}{(18-j4)+(32+j16)}$$

$$= \frac{120\angle 0^\circ}{50+j12}$$

$120 + 0j$

$\sqrt{50^2+12^2} = 51.41$

$\tan^{-1}\left(\frac{50}{12}\right) = 13.5^\circ$

$$= \frac{120\angle 0^\circ}{51.41\angle 13.5^\circ}$$

$$= 2.33\angle -13.5^\circ$$

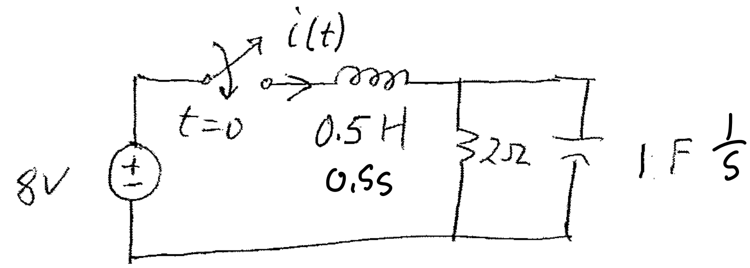
$2.33(\cos(-13.5) + j\sin(13.5))$

$$= 2.27 - j0.54$$

$2.27 - j0.54$

my answer has a signed switch but since i have the same numbers I am going w/ d

Probs. 9 and 10 refer to the following circuit.



9. Which of the following is the correct form of the expression for i(t) for t > 0?

A) $i(t) = K_1 e^{-s_1 t} + K_2 e^{-s_2 t}$

B) $i(t) = B_1 t e^{-st} + B_2 e^{-st}$

C) $i(t) = e^{-\sigma t}\left(A_1 \cos\omega_d t + A_2 \sin\omega_d t\right)$

Since parallel $\alpha = \frac{1}{2RC} = \frac{1}{2(2)1} = 0.25$

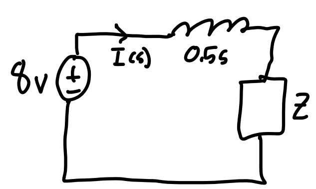
$\omega_0 = \sqrt{\frac{1}{LC}} = \sqrt{\frac{1}{(0.5)(1)}} = \sqrt{2} \approx 1.41$

$\alpha^2 = 0.0625 \quad \omega^2 = 2$

under damped

10. i(∞) equals:

A) 0 A B) 4 A C) 8 A D) 3.33 A



$Z = \frac{\frac{2}{s}}{2+\frac{1}{s}} = \frac{2}{2s+1}$

$I(s) = 8 \times \frac{1}{0.5s + \frac{2}{2s+1}} = 8 \times \frac{2s+1}{s^2+0.5s+2}$

$i(\infty) = \lim_{s\to 0} I(s)$

$= \lim_{s\to 0}\left[8 \times \frac{2s+1}{(s^2+0.5s+2)}\right]$

$i(\infty) = \frac{8\times 1}{2} = 4A$