ECE 35, Fall 2019
Final – Section B

Sequence
number

Grade

/ 50

Last name

First + middle
name(s)

PID

Instructions:

- Do not look at the questions or start writing until it is announced you can do so.

- Read each problem completely and thoroughly before beginning.

- All calculations must be done in your blue book. It should be clear which question they belong to. Answers without supporting calculations will receive zero credit. If you are using intuition, write a short explanation.

- Write clearly and make sure your answer is structured properly. We will not hunt for your work or answers.

- Write your final answers in the answer boxes on these question pages. Make sure you list units!

- You must follow the Final Exam Procedures that were posted on TritonEd. If you are unsure of anything, ask. As a reminder:

  o Your phone should be turned off and put inside your bag in the front of the room (or on the table in the front). If you are found to have a phone (or other communication device) on you during the exam, your exam will not be graded.
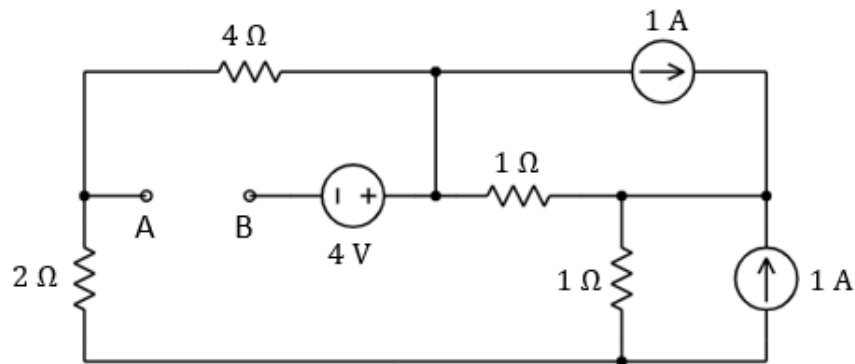 o Calculators are not allowed.
  o This is a closed book exam.

▲

(1) Consider the circuit below.
   (a) Find the Thevenin equivalent model
      between A and B. *(8 points)*

   (b) If we were to place a 2/3 Ω resistor between A and B in
      the circuit below, what is the current i_R through that
      resistor (measured from A to B)? *(1 point)*

i_R

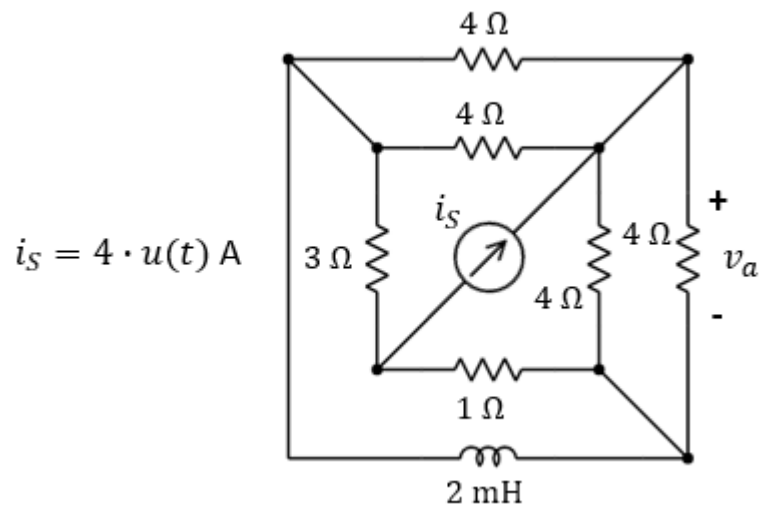**(2)** Consider the circuit below. For $t < 0$ s, you may assume the system has reached steady state.

(a) Find $v_a(t)$ for $t > 0$ s.
   (8 points)

$v_a(t)$

(b) Sketch the waveform $v_a(t)$ for $t > 0$ s. Include where you can observe the time constant.
   (2 points)

$$i_s = 4 \cdot u(t) \text{ A} \quad 3\,\Omega$$

4 Ω

4 Ω

i_s

4 Ω

4 Ω

+

v_a

–

1 Ω

2 mH

(3) Consider the circuit below. The system is in steady state. Find $i_a(t)$. *(9 points)*

$i_a(t)$
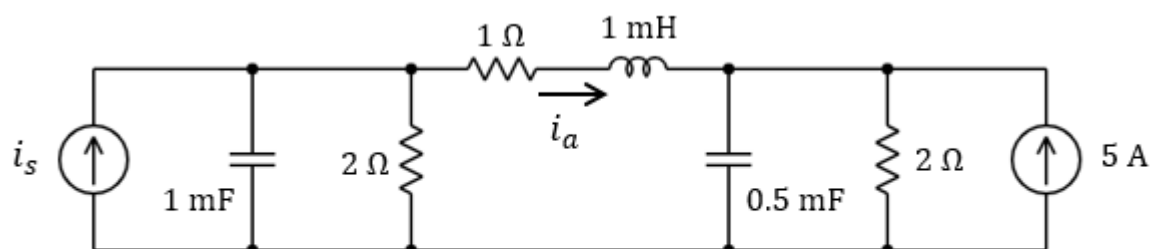
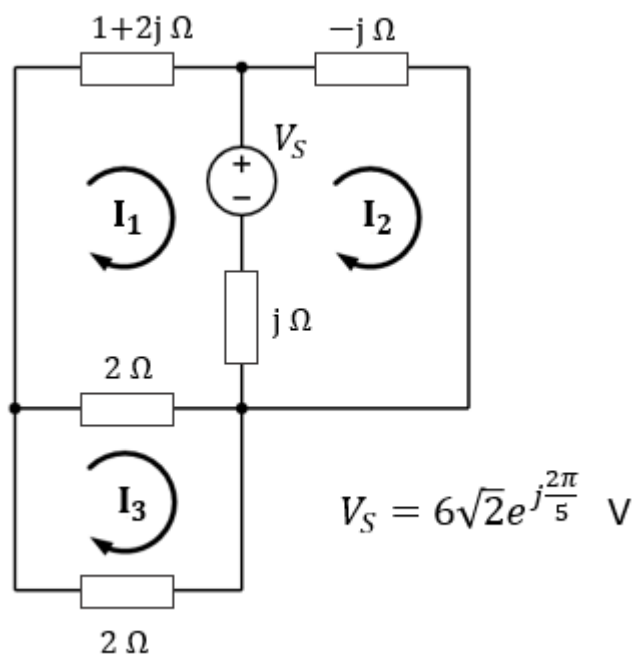$$i_s = 20 \cos\left(1000t - \frac{\pi}{2}\right) \text{ A}$$

(4) Consider the circuit below. The system is in steady state and represented in phasor form.
(a) Find the mesh currents I_1, I_2 and I_3 (expressed in polar form). *(8 points)*

I_1 I_2 I_3

(b) Find the complex power <u>supplied</u> by V_S. *(2 points)*

S

$1+2j\,\Omega$ $-j\,\Omega$

V_S

I_1 I_2

$j\,\Omega$

$2\,\Omega$

I_3

$V_S = 6\sqrt{2}e^{j\frac{2\pi}{5}}\ \text{V}$

$2\,\Omega$

(5) Consider the circuit below. The system is in steady state and represented in phasor form. The ammeter and volt-meter are both ideal.

(a) Assume the load $Z_L = -j\ \Omega$. What is the reading X of the ammeter and the reading Y of the volt-meter? *(8 points)*

X
(ammeter reading)

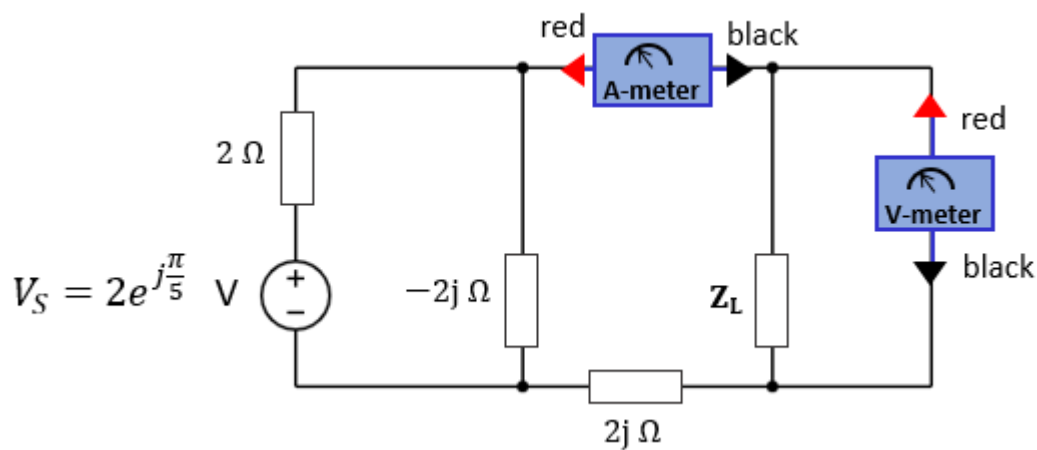Y
(voltmeter reading)

(b) We now replace the load Z_L with a new value such that the average power received by this load is maximized. What is this new value of Z_L? *(2 points)*

Z_L

(c) Find the average power <u>received</u> by the load calculated in part (b). *(2 points)*

P

red   black
A-meter
red
V-meter
black

$2\ \Omega$

$V_S = 2e^{j\frac{\pi}{5}}\ V$

$-2j\ \Omega$

Z_L

$2j\ \Omega$

ECE35 Equation Sheet

Basics:
$$i \triangleq \frac{dq}{dt} \qquad v_{ab} \triangleq \frac{dw}{dq} \qquad R = \rho \frac{l}{A}$$

Capacitors:
$$C = \epsilon \cdot \frac{A}{d} \qquad Q = C \cdot v \qquad w_C = \frac{1}{2} C v^2$$

Inductors:
$$L = \mu \cdot \frac{N^2 A}{l} \qquad B \sim i \qquad w_L = \frac{1}{2} L i^2$$

AC power:
$$p(t) = \frac{1}{2} V_m I_m \cdot \cos(\theta_v - \theta_i) + \frac{1}{2} V_m I_m \cdot \cos(2\omega t + \theta_v + \theta_i)$$

$$P = \frac{1}{2} V_m I_m \cos(\theta_v - \theta_i) \qquad Q = \frac{1}{2} V_m I_m \sin(\theta_v - \theta_i) \qquad X_{rms} = \sqrt{\frac{1}{T} \int_0^T x(t)^2 dt}$$

Trigonometry:

$$\sin(-\alpha) = -\sin(\alpha) \qquad\qquad \cos(-\alpha) = \cos(\alpha)$$

$$\sin(\pi - \alpha) = \sin(\alpha) \qquad\qquad \cos(\pi - \alpha) = -\cos(\alpha)$$

$$\sin\left(\frac{\pi}{2} - \alpha\right) = \cos(\alpha) \qquad\qquad \cos\left(\frac{\pi}{2} - \alpha\right) = \sin(\alpha)$$

$$\sin\left(\alpha - \frac{\pi}{2}\right) = -\cos(\alpha) \qquad\qquad \cos\left(\alpha - \frac{\pi}{2}\right) = \sin(\alpha)$$

$$\sin(2\alpha) = 2\sin(\alpha)\cos(\alpha) \qquad\qquad \cos(2\alpha) = \cos^2(\alpha) - \sin^2(\alpha)$$

$$\sin(\alpha \pm \beta) = \sin(\alpha)\cos(\beta) \pm \cos(\alpha)\sin(\beta)$$

$$\cos(\alpha \pm \beta) = \cos(\alpha)\cos(\beta) \mp \sin(\alpha)\sin(\beta)$$

$$\sin(\alpha)\sin(\beta) = 0.5 \cdot (\cos(\alpha - \beta) - \cos(\alpha + \beta))$$

$$\cos(\alpha)\cos(\beta) = 0.5 \cdot (\cos(\alpha - \beta) + \cos(\alpha + \beta))$$

$$\sin(\alpha)\cos(\beta) = 0.5 \cdot (\sin(\alpha - \beta) + \sin(\alpha + \beta))$$

α:	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin(\alpha)$:	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\tan(\alpha)$:	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	∞