ECE 209 — Final Exam

Estimated time for completion: <75 minutes
13 December 2016

Rules of the Exam

Rule 1: The examination period begins at 12:15pm on Tuesday 13 Decemberr 2016 and ends at 2:15pm on Tuesday 13 December 2016.

Rule 2: There are three problems plus an additional bonus problem.

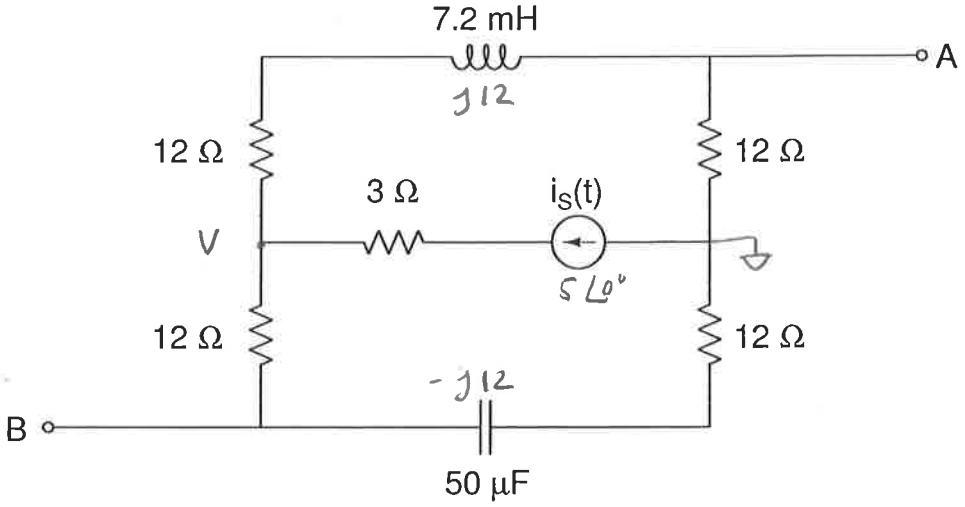
Rule 3: Show all work and state all assumptions. Make sure to include the units along with a numerical answer. Answers without support when needed will not receive credit.

Rule 4: The exam is closed book and closed notes. You may have an 8.5" x 11" sheet of paper with notes. You may use a calculator.

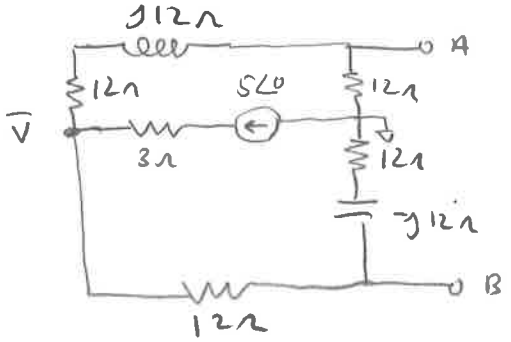
Answer Key
Name

Problem 1 (30 points)

In the circuit below $i_s(t) = 5\cos(1667t)$.



Part A: Draw the Phasor (frequency domain) representation of the circuit.



Part B: Draw the Thévenin Equivalent Circuit with respect to terminals A and B.

$Z_{Th} = (24-j12) \| (24+j12) = 15\Omega$

$V_{AB} = V_A - V_B = -15V$

KCL @ V: $-5 + \frac{V}{24+j12} + \frac{V}{24-j12} = 0$

$V = 75V$

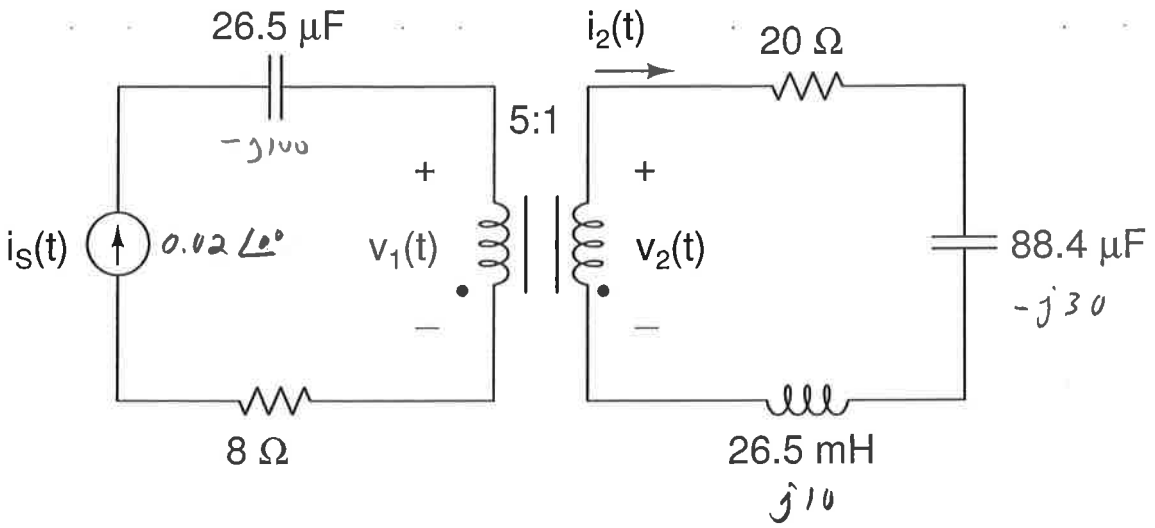
$V_B = V\left(\frac{12-j12}{24-j12}\right) = 45-j15$ $\quad V_A = \frac{V\ 12}{24+j12} = 30-j15$

Part C: If a load impedance Z_L is placed between terminals A and B:
What value of Z_L produces the maximum power transfer to the load? 15Ω

What is the power dissipated by this value of Z_L? $\frac{V_{rms}^2}{4Z_L} = \frac{15^2}{8\times15} = 1.875W$

Problem 2 (40 points)

In the circuit below, the transformer is ideal and $i_s(t) = 20\cos(377t)$ mA.



$I_2(20 - j20) = V_2$

$V_2 = 2 - j2 = 2\sqrt{2}\angle -45^\circ = 2.83\angle -45^\circ$

$\frac{V_1}{5} = \frac{V_2}{1} \Rightarrow V_1 = 5V_2$

$V_1 = 10\sqrt{2}\angle -45^\circ = 14.14\angle -45^\circ$

$5I_1 = I_2 \Rightarrow I_2 = 0.1$

What is $v_1(t)$? $14.14\cos(377t - 45^\circ)$ V

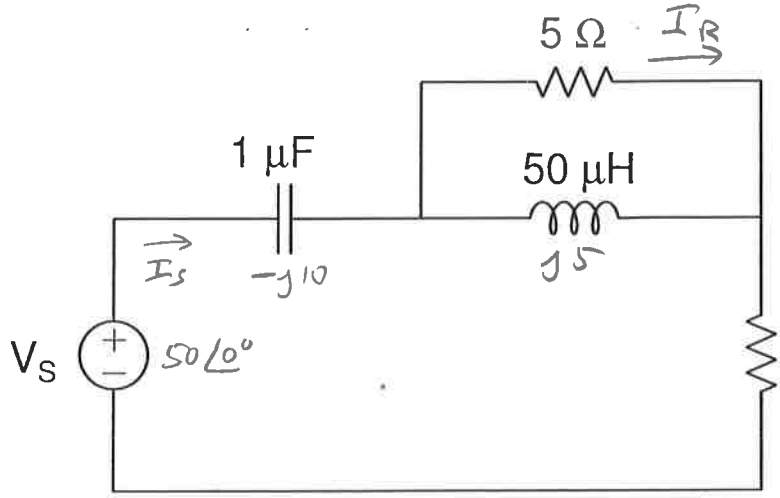
What is $v_2(t)$? $2.83\cos(377t - 45^\circ)$ V

What is $i_2(t)$? $100\cos(377t)$ mA

Whatis the frequency of $i_2(t)$ in Hertz? 60 Hz

Problem 3 (30 points)

For the circuit below the voltage source $v_s(t) = 50\cos(10^5 t)$ V



Power = $7.5|I_s|^2 \frac{1}{2}$

$= \frac{7.5}{2}(3.2+j2.4)(3.2-j2.4)$

$= 60$ W

What is the average power associated with the voltage source? −80 W

What is the reactive power associated with the voltage source? 60 VAR

What is the apparent power associated with the voltage source? 100 VA

Does the voltage source absorb or deliver power? Delivers

What is the average power power associated with the 5Ω resistor? 20 W

What is the reactive power associated with the 5Ω resistor? 0 VAR

$$I_s = \frac{50}{7.5-j10+(5\|j5)} = \frac{50}{10-j7.5} = 3.2+j2.4$$

$$|S| = -\bar{V}_{s_{rms}}\bar{I}^*_{s_{rms}} = \frac{50}{2}(3.2-j2.4) = -80+j60 = 100\angle 143.13°$$

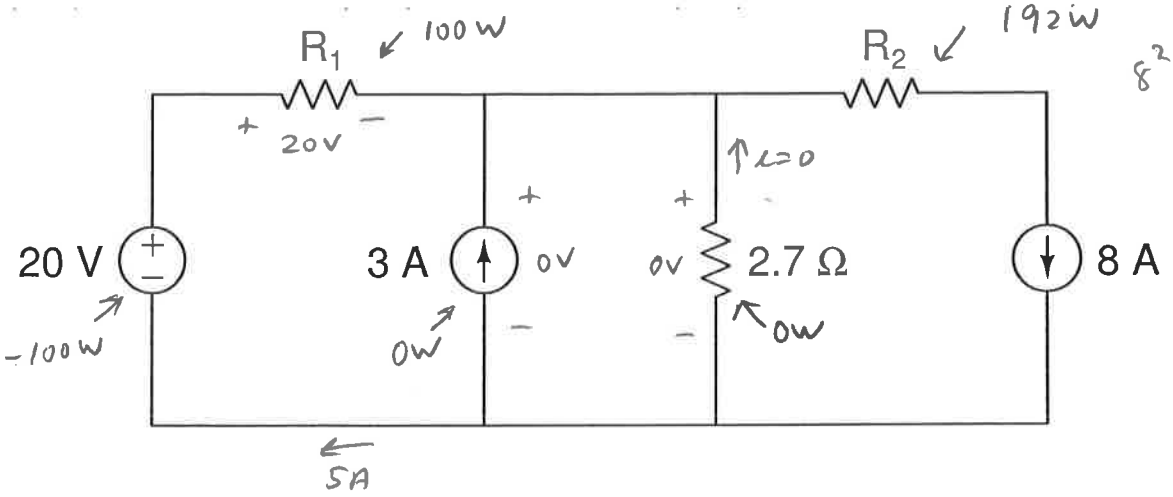
↗ Power associated with the voltage source

$$I_R = I_s\frac{j5}{5+j5} = 0.4+j2.8$$

$$P = \frac{1}{2}|I_R|^2 R = \frac{1}{2}(0.4+j2.8)(0.4-j2.8)5 = 20\text{W}$$

Bonus Problem (20 points) (All, half or nothing)

In the circuit below, the 3A current source absorbs no power and delivers no power. The total power dissipated in the circuit is 292 W.



$8^2 R_2 = 192$

$R_2 = 3\,\Omega$

What is the value of R_1? 4Ω

What is the value of R_2? 3Ω

Name: _____

Name: _____