

Last Name, First Name

Student No.

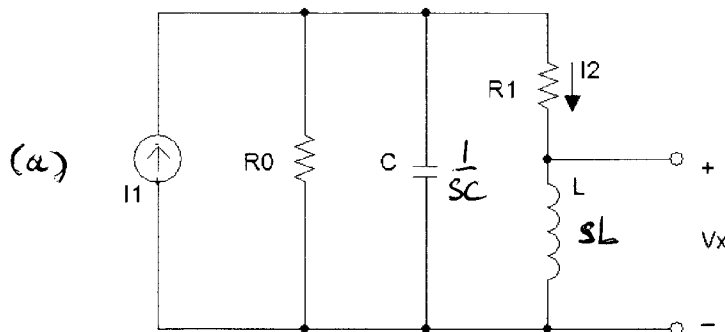
Check your tutorial section (REQUIRED!):

| TUT0101 | TUT0102 | TUT0103 | TUT0104 | TUT0105 | TUT0106 | TUT0107 | TUT0108 |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Thu. 9 am | Thu. 9 am | Thu. 9 am | Thu. 9 am | Mon. 10am | Mon. 10am | Mon. 3 pm | Mon. 3 pm |
| BA2165 | BA2155 | BA2145 | BA2195 | BA2145 | BA2165 | BA2145 | HA410 |
| Claudia | Ahmadreza | Hugo | Isaac | Shuo | Ashwin | Shuo | Farid |

University of Toronto
Department of Electrical & Computer Engineering
ECE212F – Circuit Theory
Quiz 3 – November 25, 2002, 11:00-12:00 AM

Instructions: Non-programmable calculators allowed. No other aids. Answer in the space provided on these sheets. The back sides of these sheets can be used as well. For full marks (25) you must show methods, state UNITS and compute numerical answers when requested. *Please write in pen, NOT IN PENCIL! Quizzes written in pencil can not be considered for mark revision.*

1. **Network Functions.** In the circuit below $R_0=2.5k\Omega$, $R_1=3k\Omega$, $L=15mH$, and $C=1.25\mu F$.
- Transform the circuit into the s-domain. (2 marks)
 - Find the driving-point impedance $Z(s)$ and the transfer function $T(s)=I_2(s)/I_1(s)$. (6 marks)
 - Find all poles and zeroes of $T(s)$ and $Z(s)$. (2 marks)
 - For $i_1(t)=\delta(t)$ find $v_x(t)$. (2 marks)



$$(b) \quad Z(s) = \frac{1}{\frac{1}{R_0} + sC + \frac{1}{sL + R_1}} = \frac{0.5333 \cdot 10^8 (0.015s + 3000)}{(s + 199732.55)(s + 587.45)}$$

$$T(s) = \frac{\frac{1}{\frac{1}{R_0} + sC}}{\frac{1}{\frac{1}{R_0} + sC} + R_1 + sL} = \frac{0.5333 \cdot 10^8}{(s + 199732.55)(s + 587.45)}$$

(c)

$T(s)$ poles: $s = -199732.55, s = -587.45$

$Z(s)$ poles: $s = -199732.55, s = -587.45$

zero: $s = -200000$

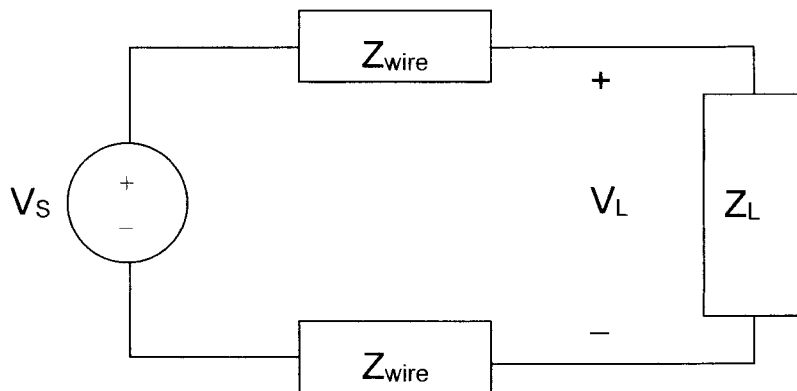
$$(d) V_x(s) = \frac{800000 s}{(s+199732.55)(s+587.45)}$$

$$= \frac{802359.9}{(s+199732.55)} - \frac{23.9}{(s+587.45)}$$

$$v_x(t) = \{ 802359.9 e^{-199732.55t} - 23.9 e^{-587.45t} \} \mu(t)$$

2. Power in the sinusoidal steady state. The load in the circuit below consists of a $1\text{ k}\Omega$ resistor parallel to a 0.5H inductor. The wires have an impedance of $Z_{\text{wire}} = 1 + j5\ \Omega$. The source voltage is 10V (rms) at $1000/(2\pi)$ Hz.

- (a) Calculate the load impedance. (1 mark)
- (b) Find the rms line current. (3 marks)
- (c) Find the complex, average, reactive, and apparent power absorbed by the load, and the power factor. (3 marks)
- (d) Find the complex power supplied by the source. (3 marks)
- (e) Calculate the transmission efficiency. (2 marks)



(a)
 $\omega = 1000$
 $Z_L = 200 + j400$

$$(b) I_{\text{line}}^{\text{rms}} = |V_s^{\text{rms}} / (Z_L + 2 \cdot Z_{\text{wire}})| = 21.9 \text{ mA}$$

$$(c) S = Z_L (I^{\text{rms}})^2 = \underset{\substack{\uparrow \\ \text{avg}}}{0.096} + j \underset{\substack{\uparrow \\ \text{reactive}}}{0.19}$$

$$|S| = 0.214 \quad \text{pf} = 0.45$$

$$(d) S_s = V_s I_{\text{line}}^* = 0.097 + j0.191$$

$$(e) \eta = \frac{\text{Re}(S_L)}{\text{Re}(S_s)} \cdot 100 = 99\%$$