ELEC353 Mid-Term Test

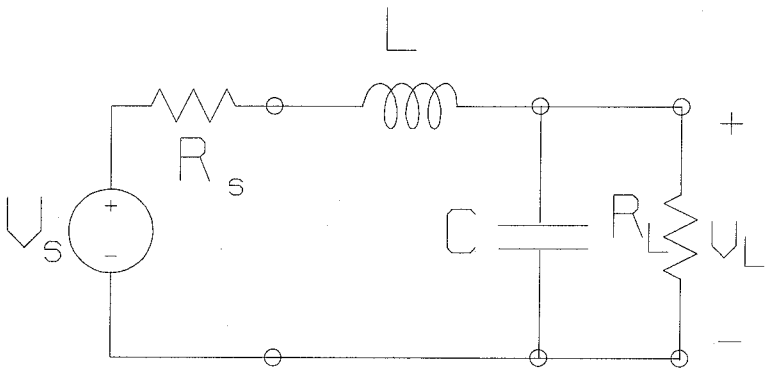
Name:_____

I.D. Number:_____

February 16, 2011

Closed book exam! No books or notes allowed!
Cell phones and other wireless devices are forbidden in examinations. You are not permitted to have a cell phone in your possession, even if it is turned off.
You are permitted to use an ENCS-approved electronic calculator, either the Sharp EL 531 and the Casio FX-300 MS. No other calculator is permitted.

Circle the correct answer directly on the examination paper. The exam booklet is for rough work. If your answer is within 3% of one of the given answers, then choose that answer.



1. The figure shows an equivalent circuit model for a transmission line, in which the line is represented with a series inductor L and a shunt capacitor C. The transmission line has inductance per unit length ℓ = 0.429 microHenries/meter and capacitance per unit length c = 80.6 picoFarads/meter. The length of the line is 14 cm. The generator is sinusoidal with amplitude V_s = 10 volts and frequency 2450 MHz. The internal resistance of the generator is R_s=40 Ω. The load resistance is R_L =120 Ω.

1.1) Find the inductance L for the equivalent circuit.

21.4 nH	60	42.9	429	none of these

1.2) Find the impedance of the capacitor at the operating frequency.

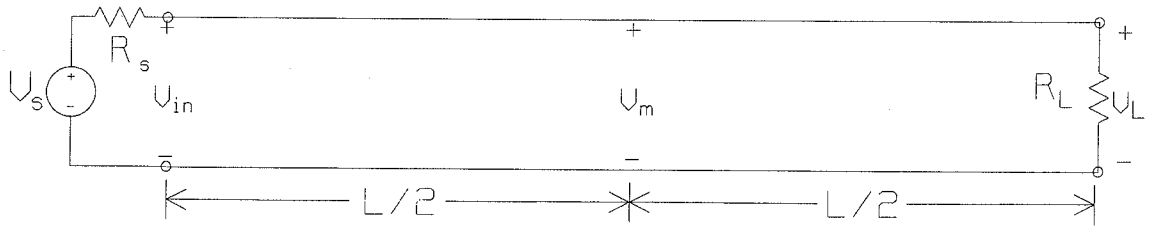
-j5.76 Ω	-j5.04	-j6.41	-j7.05	none of these

1.3) Find the input impedance at the generator terminals.

40.4+j748 Ω	40.3+j919	40.2+j10.51	40.3+j823	none of these

1.4) Find the voltage across the load.

47.8 mV	94.0	62.5	77.6	none of these



2.A transmission line has characteristic resistance 70 ohms and speed of travel 15 cm/ns. The length of the line is L=22 cm. The generator produces a step function starting at $t = 0$ of amplitude $V_s = 5$ volts. The internal resistance of the generator is R_s=2 Ω. The load resistance is R_L =125 Ω.

2.1) Find the voltage V_m at the middle of the transmission line at $t =$ 0.8 ns.

4.38 V	4.86	2.19	4.12	none of these

2.2) Find the voltage V_L at the load at $t =$ 1.6 ns.

3.42 V	1.03	6.23	6.84	none of these

2.3) Find the voltage V_{in} at the generator terminals at $t =$ 3.2 ns.

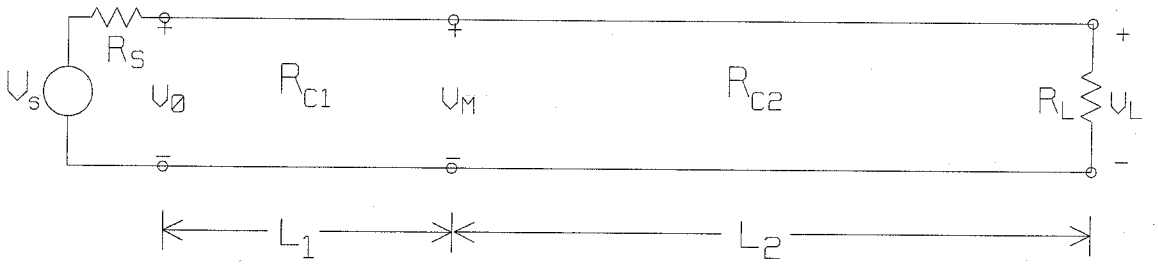
3.02 V	4.98	5.42	4.14	none of these

2.4) Find the voltage V_L at $t =$ 4.8 ns.

3.96 V	1.53	4.57	0.95	none of these

2.5) Find the voltage at the load as $t \to \infty$.

2.00 V	2.50	4.09	4.89	none of these



3.The transmission-line circuit shown above is driven by a step-function generator that switches on at $t = 0$, with $V_s = 10$ volts and R_s = 5 ohms. The two transmission lines have characteristic resistance R_{c1} = 200 ohms and R_{c2} = 400 ohms, and speed-of-travel $u = 20$ cm/ns. Line #1 has length $L_1 = 1$ cm and line #2 has $L_2 = 4$ cm. The circuit is terminated by a load resistor of value R_L = 1000 ohms.

3.1) Find the voltage V_0 across the generator terminals at $t = 0.05$ ns.

9.76 V	3.33	8.00	6.67	none of these

3.2) Find the voltage V_M across the junction at $t = 0.10$ ns.

4.44 V	8.89	13.0	10.7	none of these

3.3) Find the voltage V_0 at $t = 0.12$ ns.

9.07 V	4.81	8.14	9.92	none of these

3.4) Find the voltage V_M across the junction at $t = 0.27$ ns.

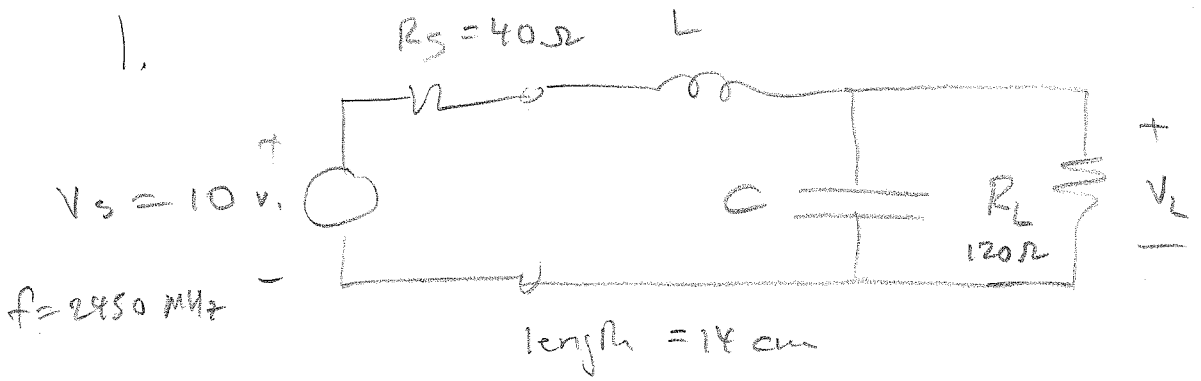
8.01 V	10.2	8.96	4.99	none of these

3.5) Find the voltage V_L across the load at $t = 0.27$ ns.

18.6 V	15.2	12.7	6.34	none of these

ELEC 353 MID TERM TEST FEB 2011

1.



1.1) $\ell = 0.429\ \mu H/m = 4.29\ nH/cm$

$c = 80.6\ pF/m$

$L = 4.29\ nH/cm \times 14\ cm = 60.06\ nH$

$C = 80.6 \times 0.14 = 11.28\ pF$

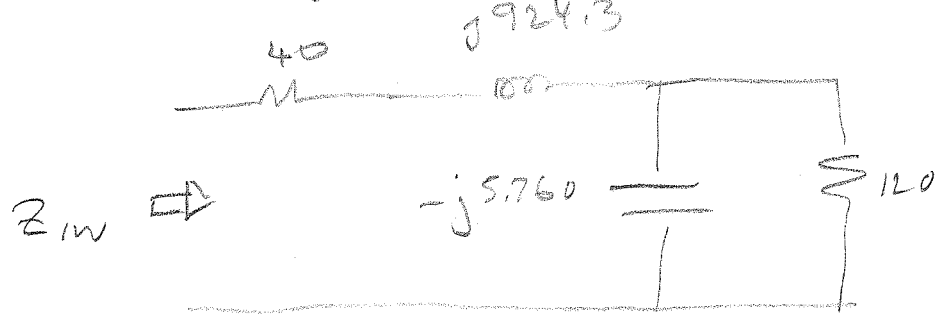
1.2) $Z_c = \dfrac{1}{j\omega C}$ $\quad \omega = 2\pi \times 2450 \times 10^6 = 1.539 \times 10^{10}$

$= -j \dfrac{1}{1.539 \times 10^{10} \times 11.28 \times 10^{-12}}$

$= -j\ 5.760$

1.3) $Z_L = j\omega L = j\ 1.539 \times 10^{10} \times 60.06 \times 10^{-9}$

$= j\ 924.3$

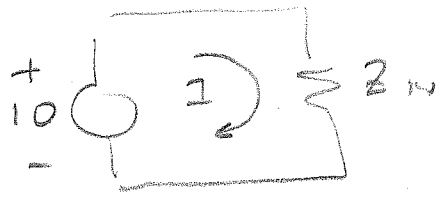


$$Z_p = -j5.760 \parallel 120 = \frac{120 \times (-j5.760)}{120 - j5.760} = 0.2758 - j5.746$$

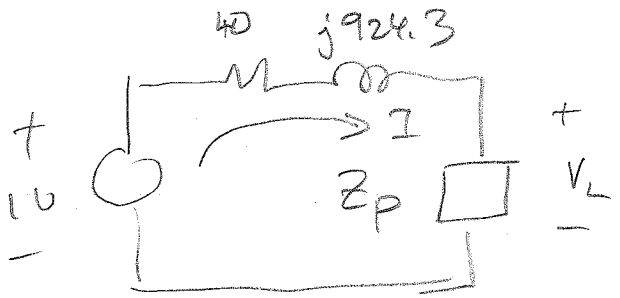
$$Z_{in} = 40 + j924.3 + 0.2758 - j5.746$$

$$= 40.2758 + j918.6$$

1.4)



$$I = \frac{10}{Z_{in}} = 4.764 \times 10^{-4} - j\,0.01086$$



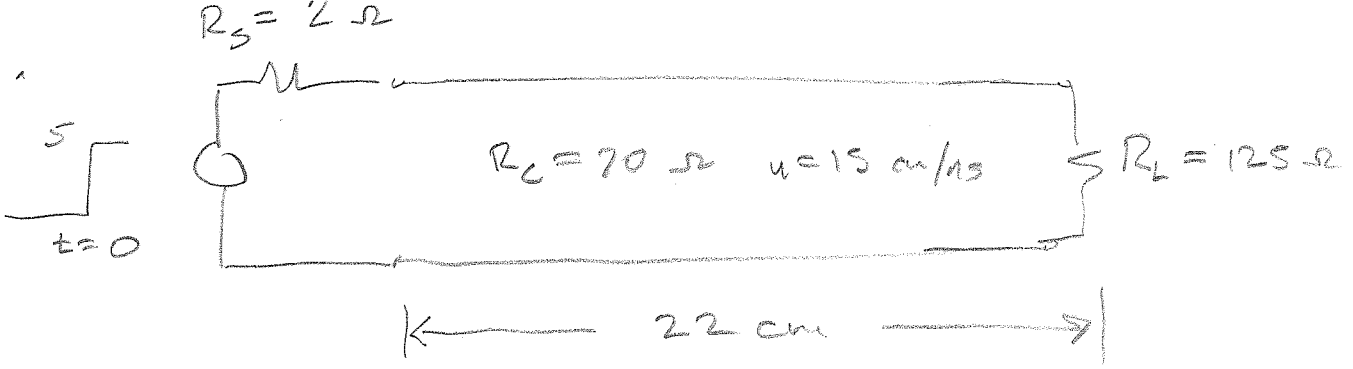
$$V_L = Z_p I = (0.2758 - j5.746)(4.764 \times 10^{-4} - j\,0.01086)$$

$$= -0.06227 - j\,5.733 \times 10^{-3}$$

$$= 0.06253 \angle -1747 \text{ volts}$$

Hence the amplitude is 62.5 mV.

2.

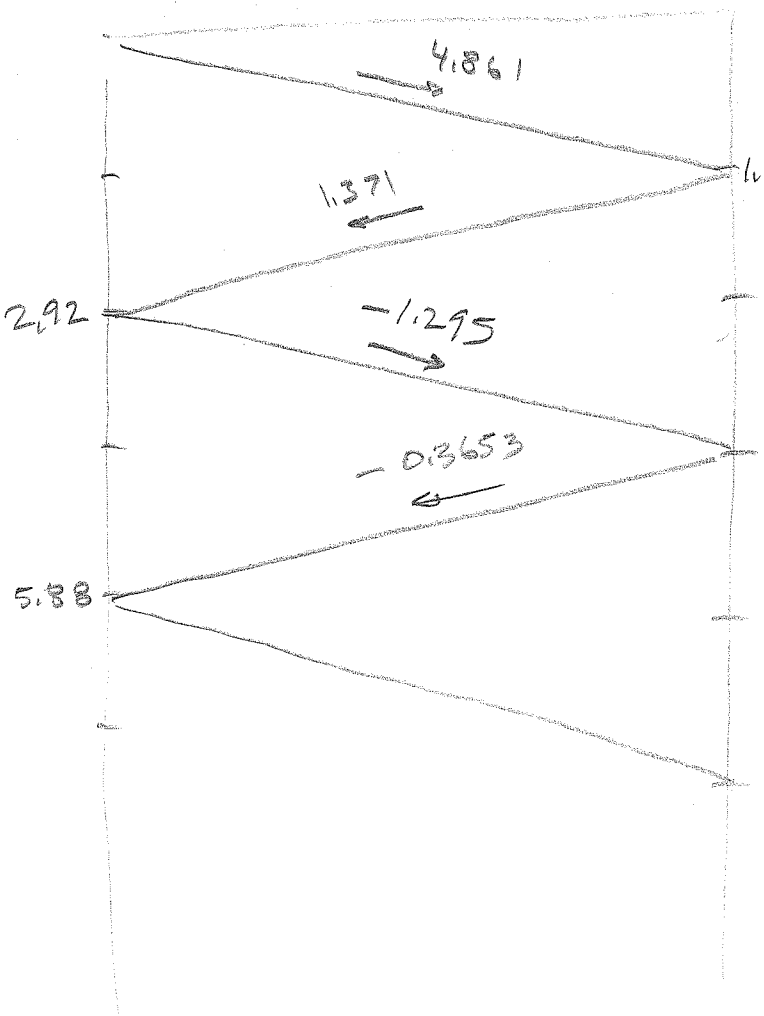


$$T = \frac{L}{u} = \frac{22}{15} = 1.47\ ns$$

$$V(0) = \frac{V_S \times R_C}{R_S + R_C} = \frac{5 \times 70}{2+70} = 4.861\ V$$

$$\Gamma_L = \frac{R_L - R_C}{R_L + R_C} = \frac{125-70}{125+70} = 0.2821$$

$$\Gamma_S = \frac{R_S - R_C}{R_S + R_C} = \frac{2-70}{2+70} = -0.9444$$



2.1) V_m @ 0.8 ns

$V_m = 4.861\ V$

2.2) V_L @ 1.6 ns

$V_L = 4.861 + 1.371$

$= 6.232$

2.3) V_m @ 3.2

$V_m = 4.861 + 1.371 - 1.295$

$= 4.937$

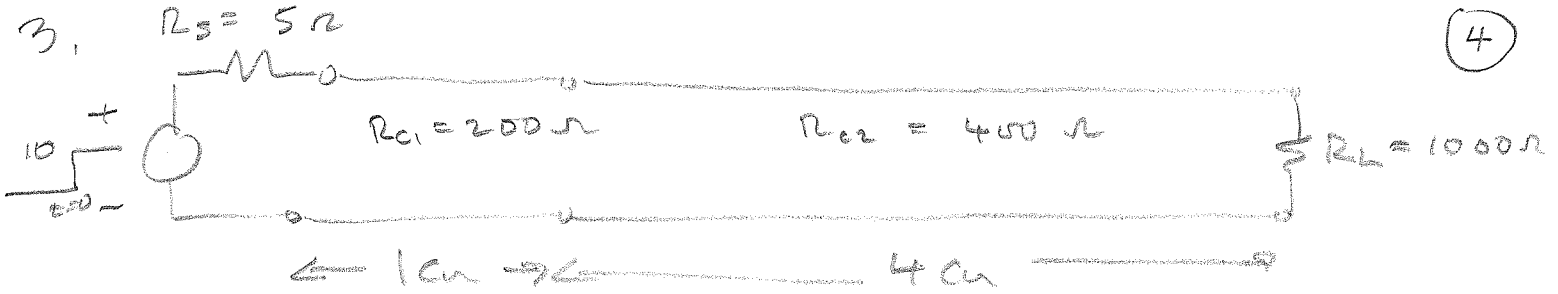
2.4) V_L @ 4.8

$V_L = 6.232 - 1.295 - 0.3653 = 4.572$

Final Value

$$V_L = \frac{125 \times 5}{2+125} = 4.921\ V$$

3.

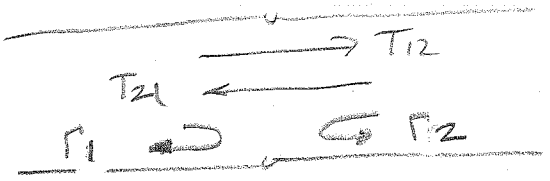


$u = 20\ cm/ns \qquad T_1 = \frac{1}{20} = 0.05\ ns \qquad T_2 = \frac{4}{20} = 0.20\ ns$

$$V(0) = \frac{V_s R_{c1}}{R_s + R_{c1}} = \frac{10 \times 200}{5 + 200} = 9.756$$

$$\Gamma_s = \frac{R_s - R_{c1}}{R_s + R_{c1}} = \frac{5 - 200}{5 + 200} = \frac{-195}{205} = -0.9512$$

$$\Gamma_L = \frac{R_L - R_{c2}}{R_L + R_{c2}} = \frac{1000 - 400}{1000 + 400} = 0.4286$$



From the left

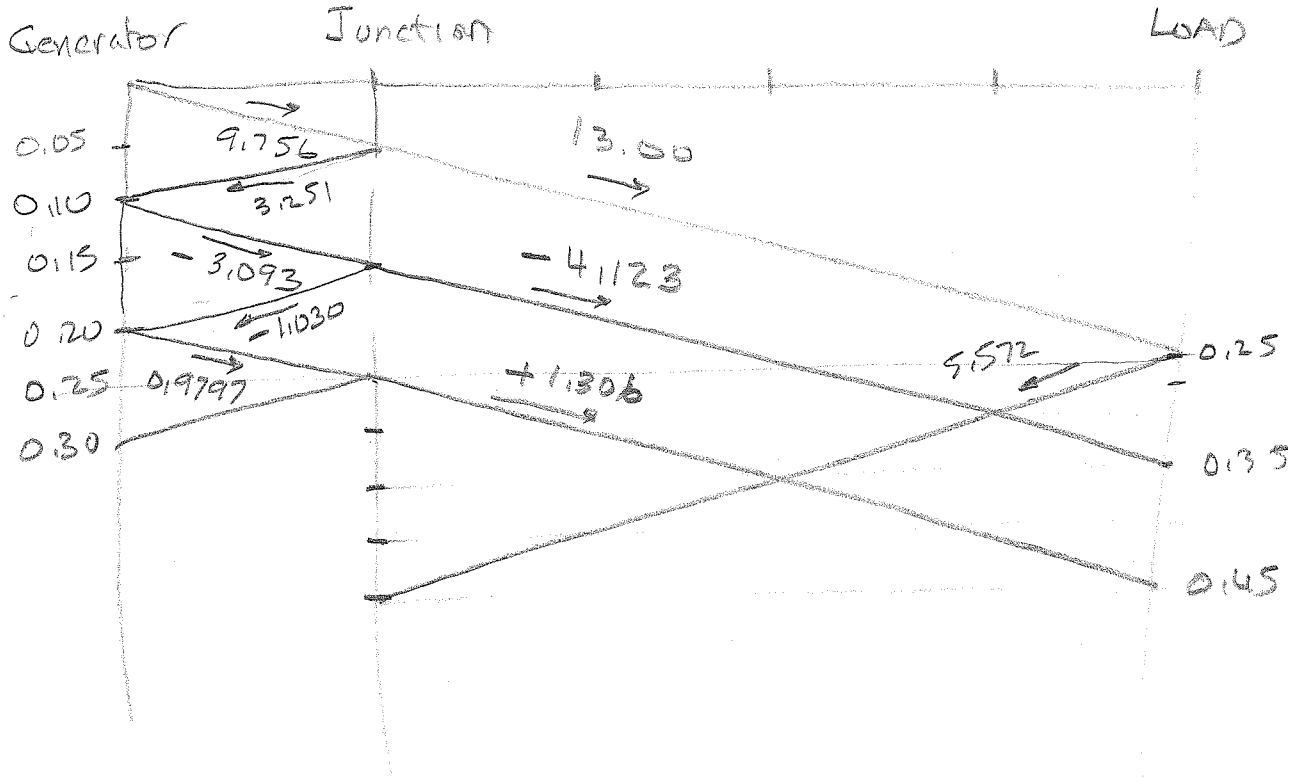
$$\Gamma_1 = \frac{R_{c2} - R_{c1}}{R_{c2} + R_{c1}} = \frac{400 - 200}{400 + 200} = 0.3333$$

$$T_{12} = \frac{2R_{c2}}{R_{c1} + R_{c2}} = \frac{2 \times 400}{400 + 200} = 1.333$$

From the right

$$\Gamma_2 = \frac{R_{c1} - R_{c2}}{R_{c1} + R_{c2}} = -0.3333$$

$$T_{21} = \frac{2R_{c1}}{R_{c1} + R_{c2}} = \frac{2 \times 200}{400 + 200} = 0.6667$$



3.1) V_S @ $t = 0.05$ ns $\quad V_S = 9.756$ V.

3.2) V_M @ $t = 0.10$ ns $\quad V_M = 13.00$ V

3.3) V_S @ $t = 0.12$ ns

$V_S = 9.756 + 3.251 - 3.093 = 9.914$

3.4) V_M @ 0.27 ns

$V_M = 13.00 - 4.123 + 1.306 = 10.18$ V.

3.5) V_L @ 0.27 ns

$V_L = 13.06 + 5.57 = 18.57$ volts