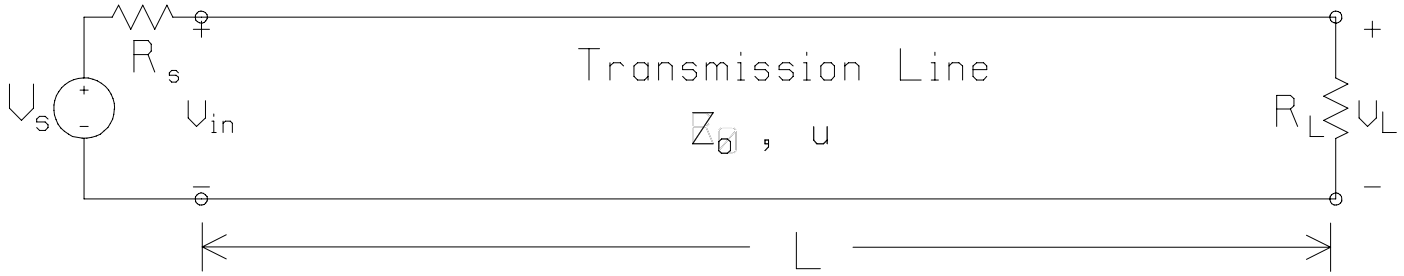
ELEC353 Class Test **Name:_____**

I.D. Number:_____

February 13, 2009

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.



A logic chip has internal resistance $R_s = 15\Omega$ and generates a step-function voltage, that steps up from $V_s = 0$ volts to $V_s = 10$ volt at $t = 0$. The output of the chip is connected to the input of another logic chip by a circuit path that is $L = 25$ cm in length. The interconnect has inductance-per-unit-length $\ell = 0.320$ microHenries/meter and capacitance-per-unit=length $c = 50.0$ picoFarads/meter. The load resistor has value $R_L = 400\ \Omega$.

1.1What is the characteristic resistance $R_c$of the transmission line?

(a) 80 ohms	(b) 25 ohms	(c) 50 ohms	(d) 100 ohms	(e) none of these

1.2What is the speed of travel u of waves on the transmission line?

(a) 25 cm/ns	(b) 15 cm/ns	(c) 8 cm/ns	(d) 30 cm/ns	(e) none of these

1.3What is the voltage at the generator terminals, V_{in}, at $t = 0.1T$, where $T = L/u$?

(a) 9.3 volts	(b) 5.0 volts	(c) 8.4 volts	(d) 1.9 volts	(e) none of these

1.4What is the voltage at the load, V_L, at $t = 1.1T$?

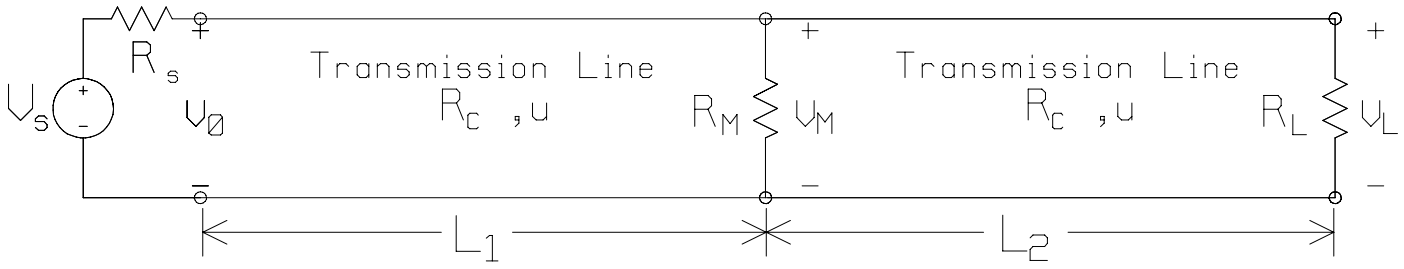
(a) 4.0 volts	(b) 14.0 volts	(c) 6.5 volts	(d) 11.7 volts	(e) none of these

1.5What is the voltage at the generator terminals, V_{in}, at $t = 2.1T$?

(a) 7.8 volts	(b) 9.4 volts	(c) 7.0 volts	(d) 10.3 volts	(e) none of these

1.6What is the final value of the load V_L, as $t \to \infty$?

(a) 6.3 volts	(b) 7.7 volts	(c) 9.2 volts	(d) 9.7 volts	(e) none of these



2. A transmission line of characteristic resistance $R_c = 40$ ohms and speed-of-travel $u = 14$ cm/ns connects a generator of internal resistance $R_s = 25$ ohms to two different loads. At distance $L_1 = 2$ cm there is a load of resistance $R_M = 12$ ohms and at distance $L_1 + L_2 = 4$ cm there is a load of resistance $R_L = 25$ ohms. The generator produces a pulse voltage that steps up from 0 volts to $V_s = 1$ volt at $t = 0$, and steps down again to 0 volts at t= 0.4 ns.

2.1Find the voltage V_M across the junction at $t = 0.15$ ns.

(a) 0.155 volts	(b) 0.216 volts	(c) 0.231 volts	(d) 0.245 volts	(e) none of these

2.2Find the voltage V_L across the load at $t = 0.30$ ns.

(a) 0.178 volts	(b) 0.144 volts	(c) 0.062 volts	(d) 0.245 volts	(e) none of these

2.3Find the voltage V_M at $t = 0.45$ ns.

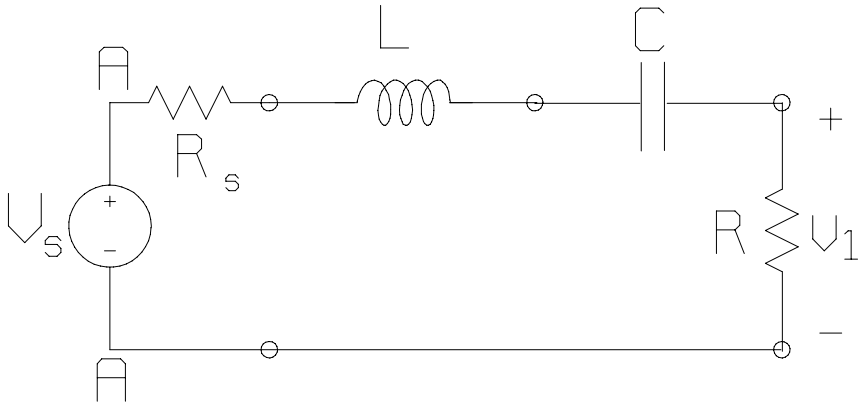
(a) 0.243 volts	(b) -0.241 volts	(c) 0.445 volts	(d) 0.212 volts	(e) none of these

2.4Find the voltage V_0 across the source at $t = 0.45$ ns.

(a) -0.256 volts	(b) -0.379 volts	(c) -0.069 volts	(d) -0.300 volts	(e) none of these

2.5Find the voltage V_M at $t = 0.55$ ns.

(a) 0.013 volts	(b) 0.025 volts	(c) 0.056 volts	(d) 0.000 volts	(e) none of these



3. An A.C. generator at 850 MHz has an open-circuit voltage of 10 volts amplitude, and internal resistance $R_s = 10\,\Omega$. It drives a series RLC circuit, with $L = 2$ nanoHenry, $C = 10$ picoFarads and $R = 5\ \Omega$.

3.1 What is the impedance across the generator terminals A-A?

(a) 15+j115 ohms	(b) 15-j13.4 ohms	(c) 15-j8.04ohms	(d) 15-j2.70 ohms	(e) none of these

3.2 What is the amplitude of the voltage V_1 across the load?

(a) 2.49 volts	(b) 3.28 volts	(c) 2.94 volts	(d) 0.611 volts	(e) none of these

3.3 What is the power delivered to the load resistor R ?

(a) 18.7 mW	(b) 863 mW	(c) 1076 mW	(d) 619 mW	e) none of these

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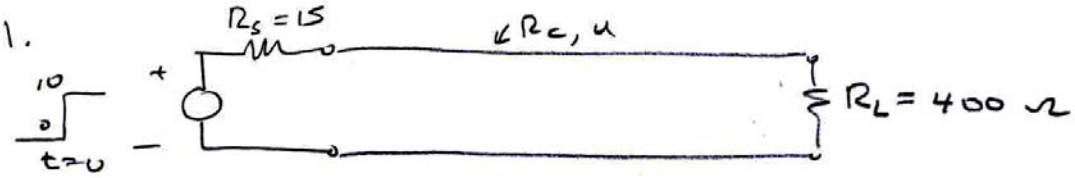
1.



1.1 $R_c = \sqrt{\frac{e}{c}} = \sqrt{\frac{0.320 \times 10^{-6}}{50 \times 10^{-12}}} = 80\ \Omega$ (a)

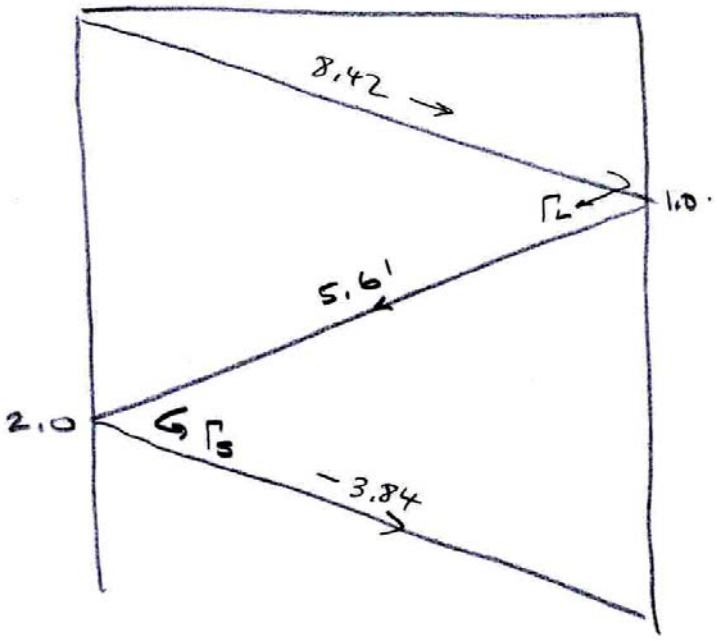
1.2 $u = \frac{1}{\sqrt{ec}} = \frac{1}{\sqrt{0.320 \times 10^{-6} \times 50 \times 10^{-12}}} = 25\ cm/ns$ (a)

1.3 $T = \frac{25}{25} = 1\ ns$

$\Gamma_s = \frac{15 - 80}{15 + 80} = -0.684$

$\Gamma_L = \frac{400 - 80}{400 + 80} = 0.667$

$V_0 = \frac{10 \times 80}{15 + 80} = 8.42$ volts



1.3 V_{in} at 0.1 ns?

$V_{in} = 8.42$ (c)

1.4 V_L at 1.1 ns?

$V_L = 8.42 + 5.61$

$= 14.03$ (b)

1.5 V_{in} at 2.1 ns?

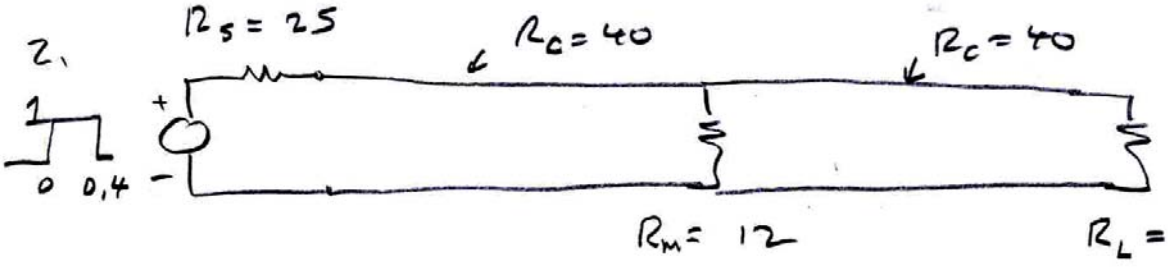
$V_{in} = 8.42 + 5.61 - 3.84$

$= 10.2$ (d)

1.6

$V_L = \frac{10 \times 400}{400 + 15} = 9.64$

2.



(2)

$$V_0 = \frac{40+1}{25+40} = 0,615 \text{ V.}$$

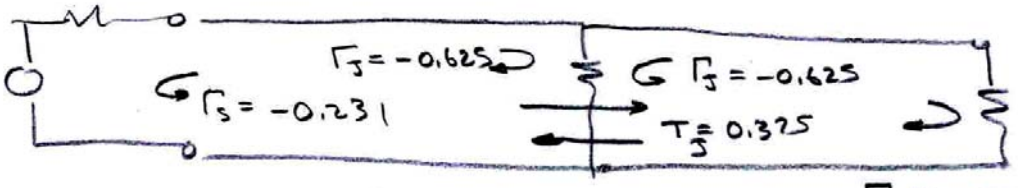
$$\Gamma_s = \frac{R_s - R_c}{R_s + R_c} = \frac{25-40}{25+40} = \frac{-15}{65} = -0,231$$

$$\Gamma_L = \frac{R_L - R_c}{R_L + R_c} = \frac{25-40}{25+40} = -0,231$$

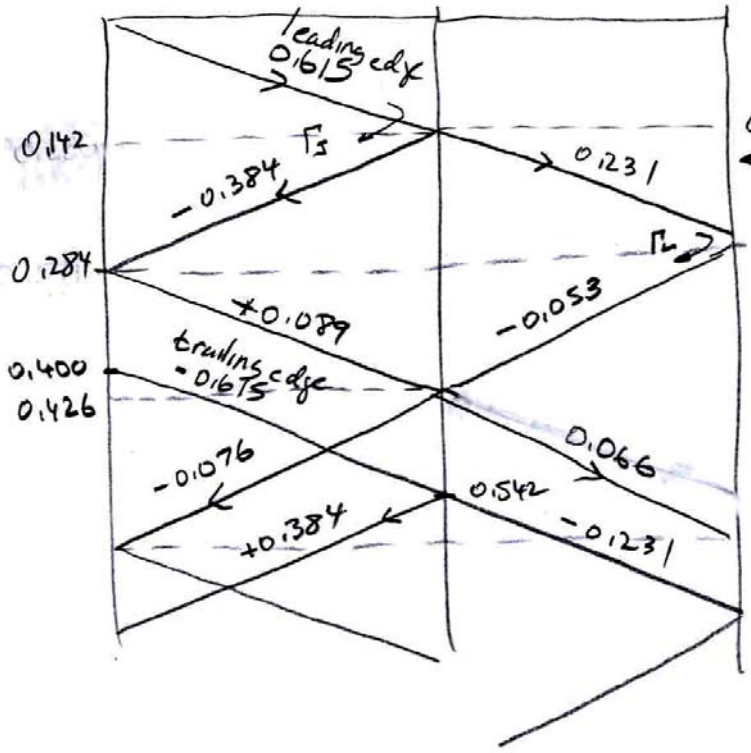
$$R_p = R_M \,||\, R_c = \frac{12 * 40}{12+40} = 9,23$$

$$\Gamma_J = \frac{R_p - R_c}{R_p + R_c} = \frac{9,23-40}{9,23+40} = -0,625$$

$$T_J = \frac{2R_p}{R_p + R_c} = \frac{2 \times 9,23}{9,23+40} = 0,375$$



$$T_1 = \frac{L}{u} = \frac{2}{14} = 0,142 \text{ ns} \qquad T_2 = \frac{2}{14} = 0,142 \text{ ns}$$



2.1 V_m at 0.15 ns

$V_m = 0.615 - 0.384$

$= 0.231$ V. (c)

2.2 V_L at 0.30

$V_L = 0.231 - 0.053$

$= 0.178$ V. (a)

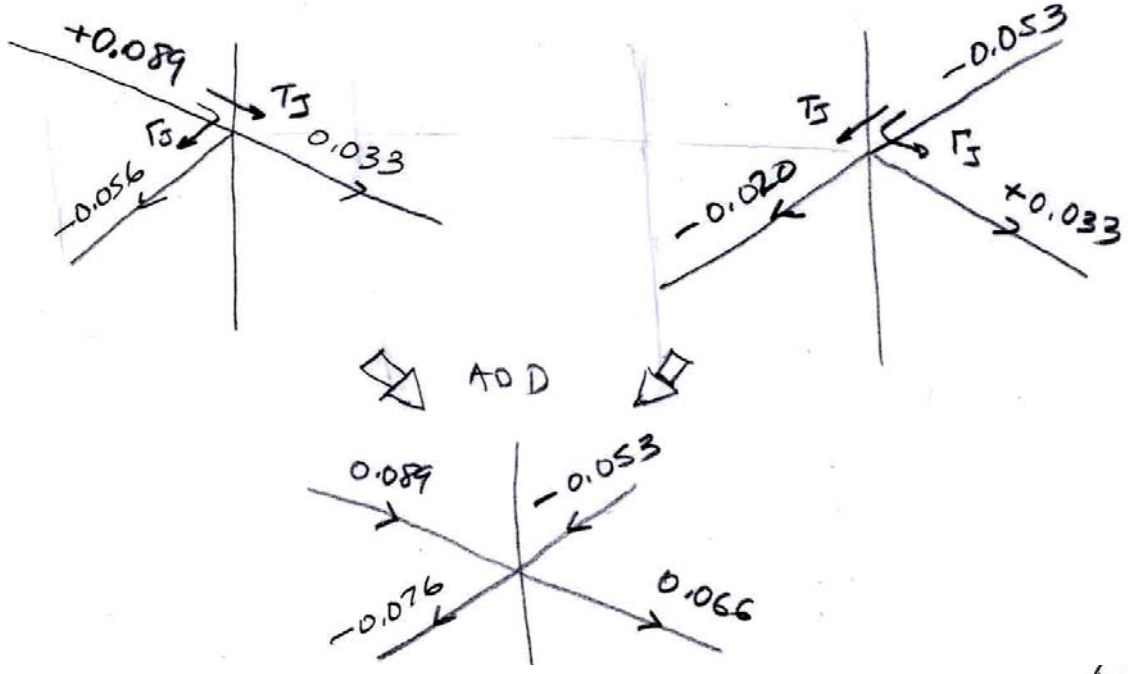
2.3 V_m at 0.45 ns

$V_m = 0.231 + 0.089 - 0.076$

$= 0244$

or $V_m = 0.231 - 0.053 + 0.066$

$= 0.244$ (a)



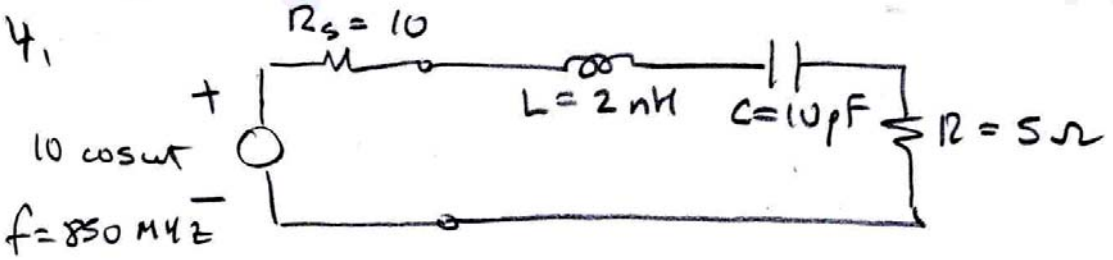
2.4 V_0 at 0.45 ns (4)

$V_0 = +0.615 - 0.384 + 0.089 - 0.615$

$= -0.295$ (d)

2.5 V_m at 0.55 ns

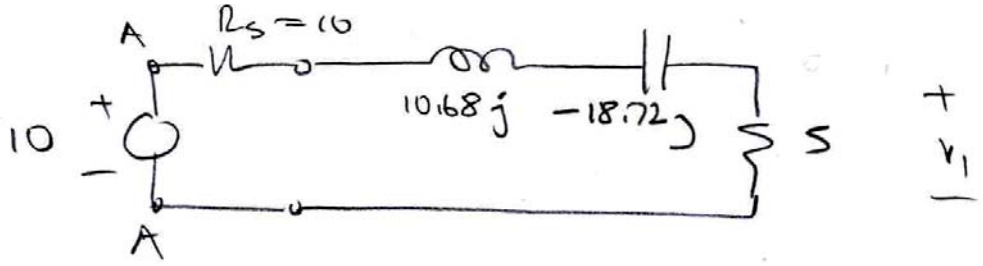
$V_m = 0.244 - 0.231 = 0.013$ (a)

4. 

(6)

$$Z_L = j\omega L = j\ \underbrace{2\pi \times 850 \times 10^6}_{5.34 \times 10^9} \times 2 \times 10^{-9} = 10.68j\ \Omega$$

$$Z_C = \frac{1}{j\omega C} = \frac{1}{j \times 5.34 \times 10^9 \times 10 \times 10^{-12}} = -j18.72\ \Omega$$



4.1 $Z_{AA} = 10 + 10.68j - 18.72j + 5 = 15 - j8.04\ \Omega$ (c)

4.2 $V_1 = 5I = 5 \times \frac{10}{15 - j8.04} = 2.59 + 1.39j$

Amplitude $= |V_1| = 2.94$ volts (c)

$$I = \frac{10}{15 - j8.04} = 0.518 + j0.278$$

$$P = \frac{1}{2} Re(V_1 I^*) = \frac{1}{2} Re((2.59 + 1.39j) \times (0.518 - j0.278))$$

$$= Re(0.864 + 0j)$$

$$= 864\ mW$$ (b)