2/27/2004

UNIVERSITY ☺F P☺RTLAND
Sch☺☺l ☺f Engineering

EE 301-Electromagnetic Fields-3 cr. hrs.
Spring 2004

SOLUTIONS TO

Midterm Exam # 1

(Prepared by Professor A. S. Inan)

(Friday, February 27, 2004)
(Closed Book Exam; 1 Formula Sheet Allowed)
(Total Time: 55 mins.)

Name: SOLUTIONS! ☺

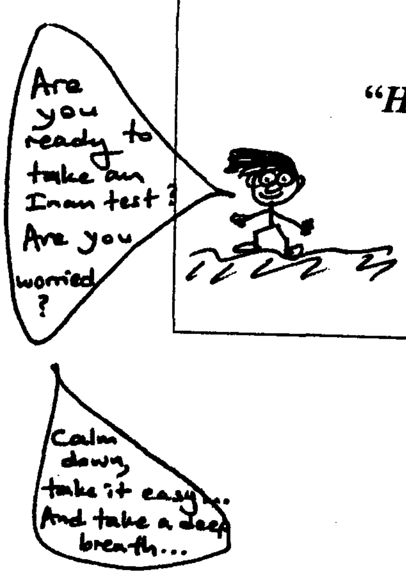
Signature: ☺

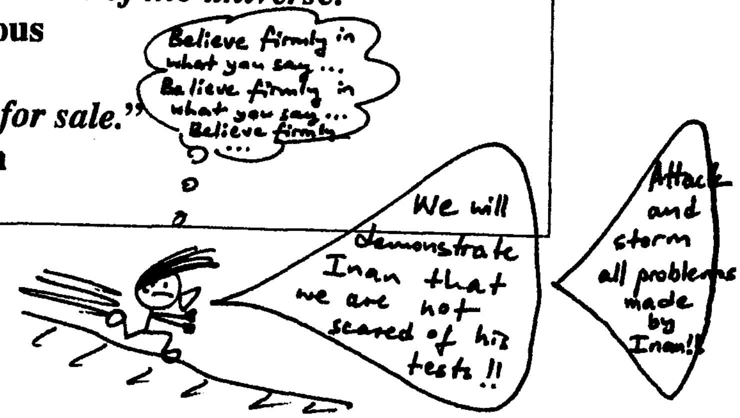
"Honesty is the best policy."
Aesop (~ 620B.C. –?)

"An honest mind possesses a kingdom."
Lucius Annaeus Seneca (4B.C.–65A.D.)

"Honest people are the true winners of the universe."
Anonymous

"Honesty is not for sale."
A. Inan





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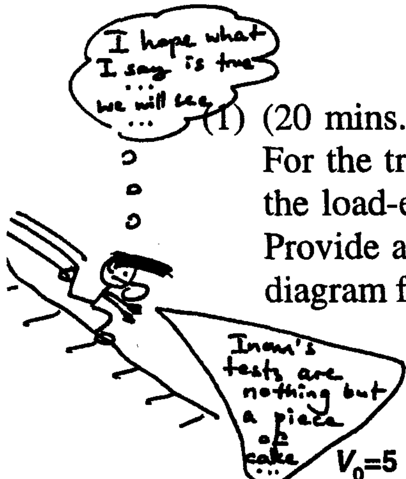
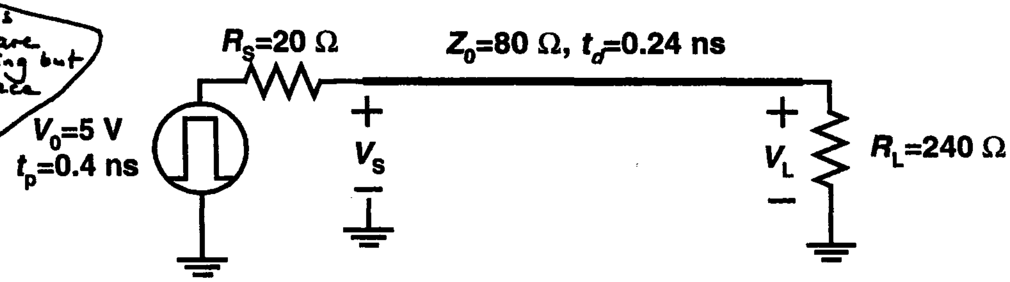


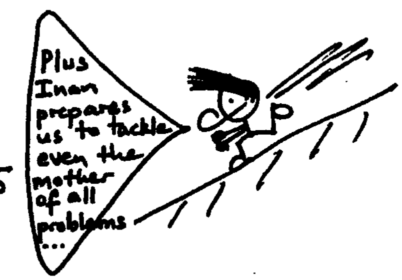
(1) (20 mins., 40 points) **Pulse excitation of a lossless transmission line.** For the transmission line circuit shown, sketch both the source-end and the load-end voltages as a function of time between $t = 0$ and $t = 1$ns. Provide all the relevant values on your sketches. Also provide a bounce diagram for your solution.

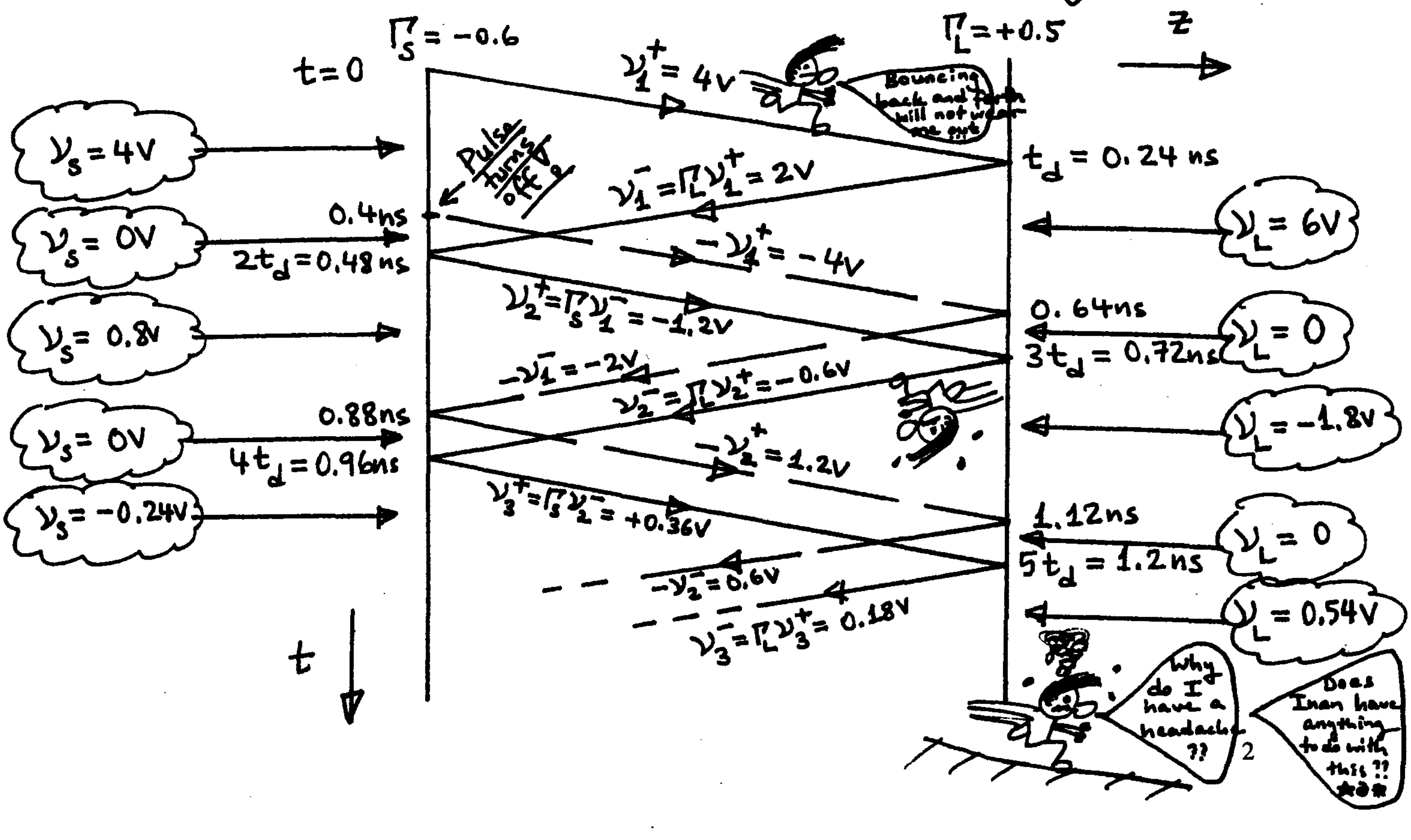


$$\mathcal{V}_1^+ = \frac{Z_0}{R_s + Z_0} V_0 = \frac{80}{20 + 80}(5) = 4\text{V}$$

$$\Gamma_S = \frac{R_s - Z_0}{R_s + Z_0} = \frac{20 - 80}{20 + 80} = -0.6$$

$$\Gamma_L = \frac{R_L - Z_0}{R_L + Z_0} = \frac{240 - 80}{240 + 80} = +0.5$$





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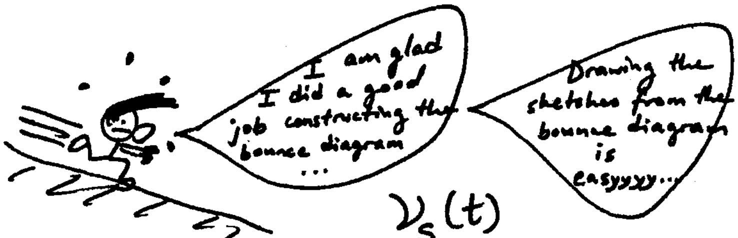
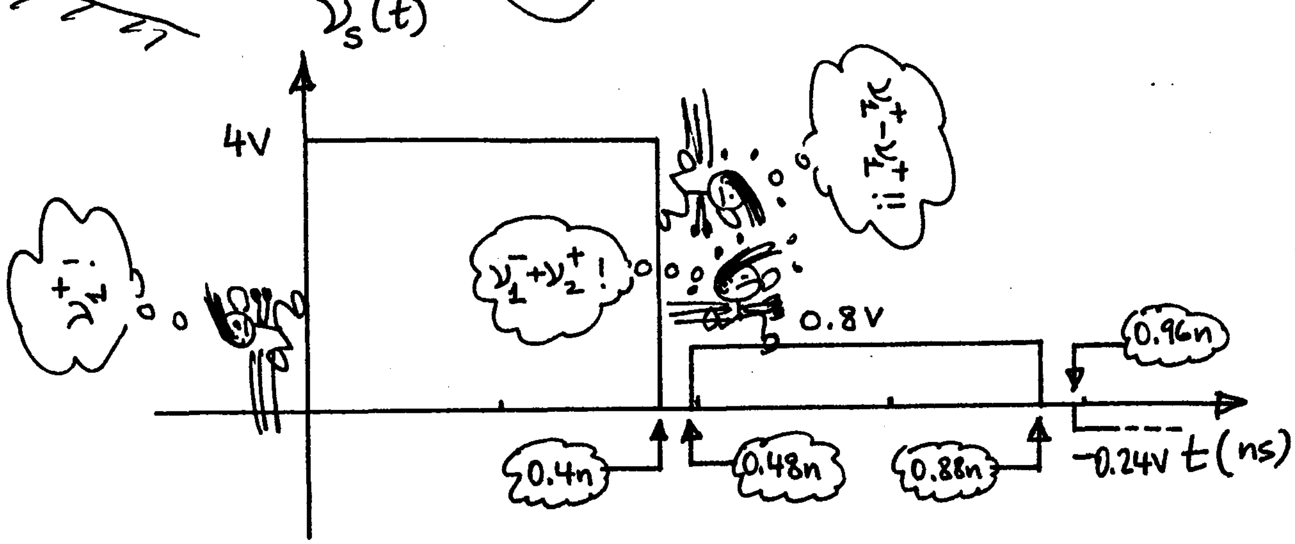
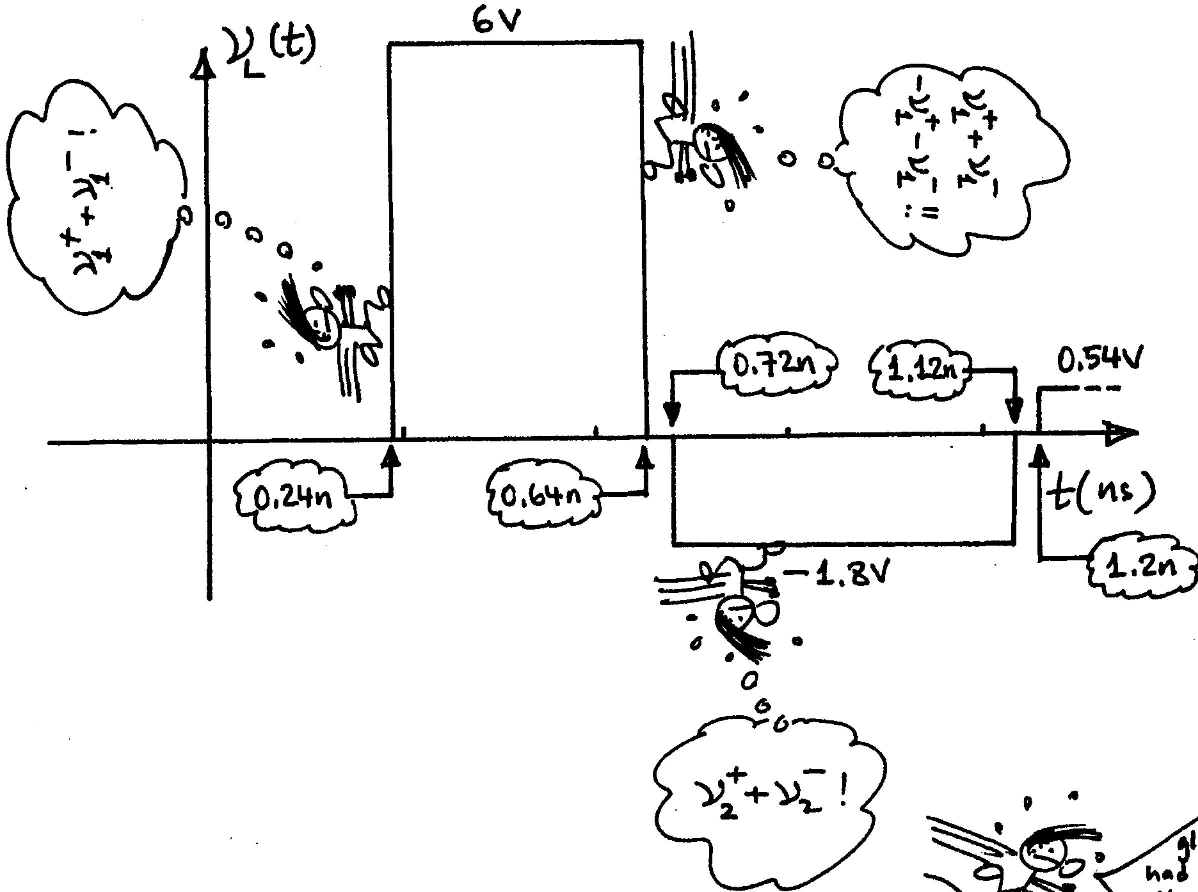
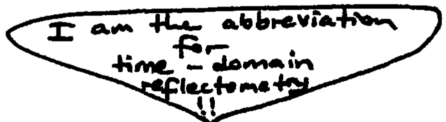

I am glad I did a good job constructing the bounce diagram ...
Drawing the sketches from the bounce diagram is easyyyy...


$v_S(t)$
4V
$v_1^- + v_2^+$!
0.8V
0.96n
0.4n
0.48n
0.88n
−0.24V
t (ns)


$v_L(t)$
6V
0.72n
1.12n
0.54V
0.24n
0.64n
t (ns)
1.2n
−1.8V
$v_2^+ + v_2^-$!


I am glad I had to stop after 1ns! Raaats!!
Inan trains his students to become fearless fighters!!



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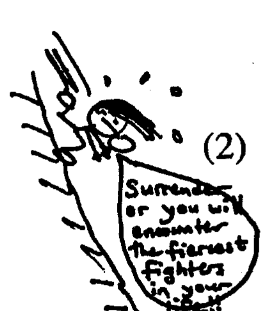
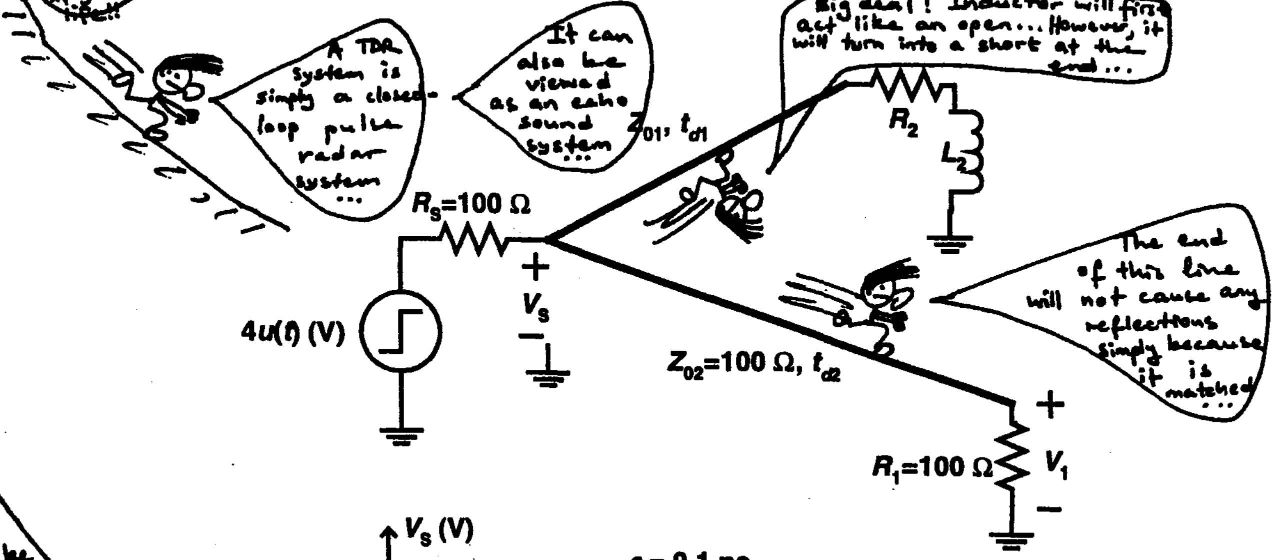
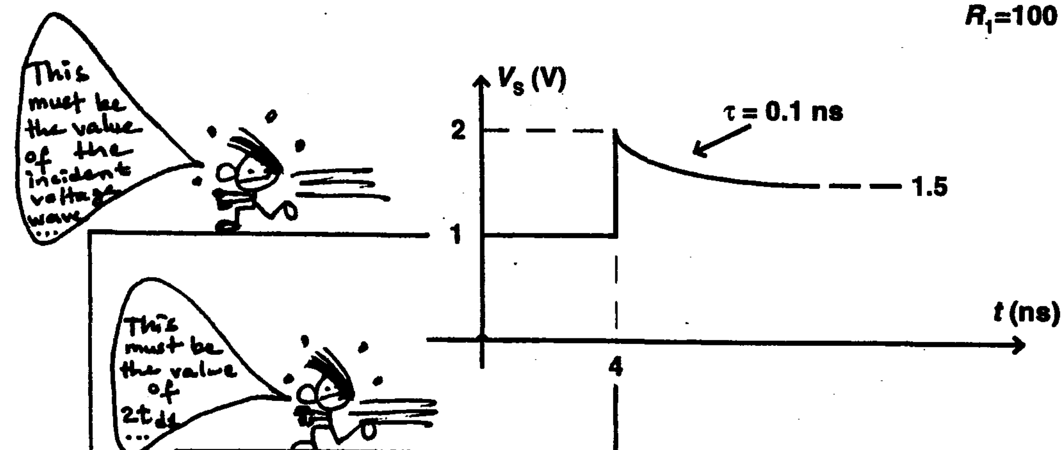


(2) (25 mins., Total: 60 points) **TDR waveform of a loss-less transmission line system having an inductive termination.** The TDR waveform for the source-end voltage provided below applies to the transmission line circuit shown.





(a) (40 points) Use the TDR waveform provided to calculate the values of the circuit parameters Z_{01}, t_{d1}, R_2 and L_2.

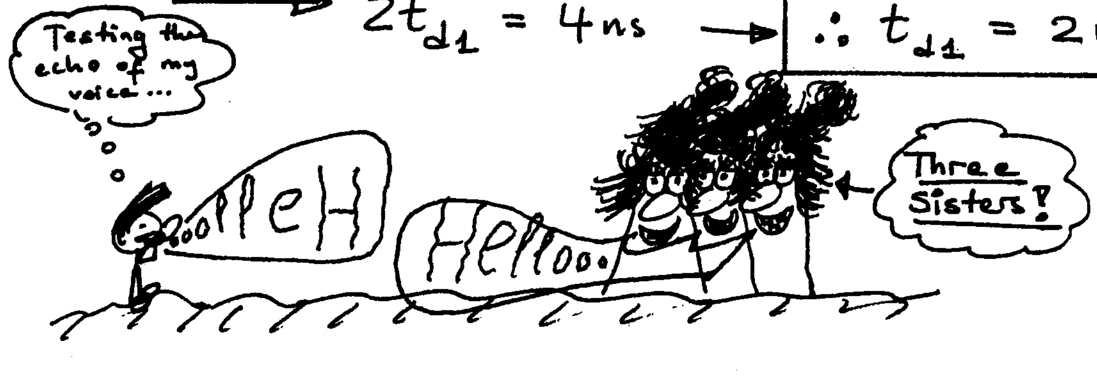
$$V_S(t=0^+) = V_1^+ = \frac{(Z_{01} \,//\, Z_{02})}{R_S + (Z_{01} \,//\, Z_{02})} V_0 = 1\text{V}$$

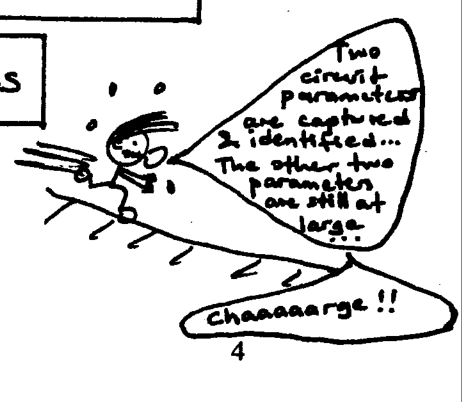
(R_S: 100Ω! ; V_0: 4V!)

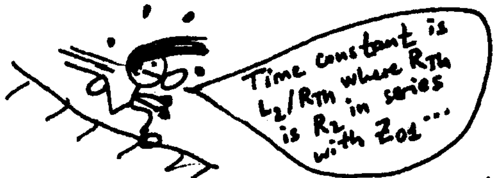
$$\therefore Z_{01} \,//\, Z_{02} = \frac{100}{3}\,\Omega \rightarrow \boxed{\therefore Z_{01} = 50\,\Omega}$$

(Z_{02}: 100Ω!)

$$2t_{d1} = 4\,\text{ns} \rightarrow \boxed{\therefore t_{d1} = 2\,\text{ns}}$$







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The time constant is given by

$$\tau = \frac{L_2}{R_2 + Z_{01}} = \frac{L_2}{R_2 + 50} = 0.1\,\text{ns} \leftarrow \text{From the TDR waveform!}$$

When the circuit reaches steady state, we have

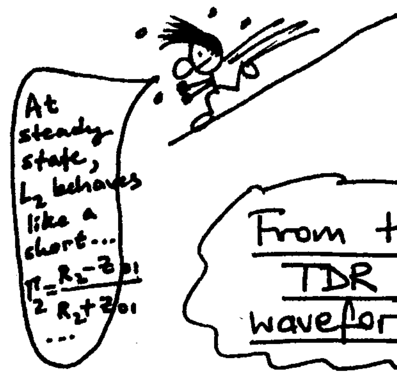
$$v_s(t \to \infty) = v_1^+ + v_1^-(t \to \infty)$$

$$= v_1^+ + \Gamma_2(t \to \infty) v_1^+$$

$$= v_1^+ + \frac{R_2 - Z_{01}}{R_2 + Z_{01}} v_1^+$$

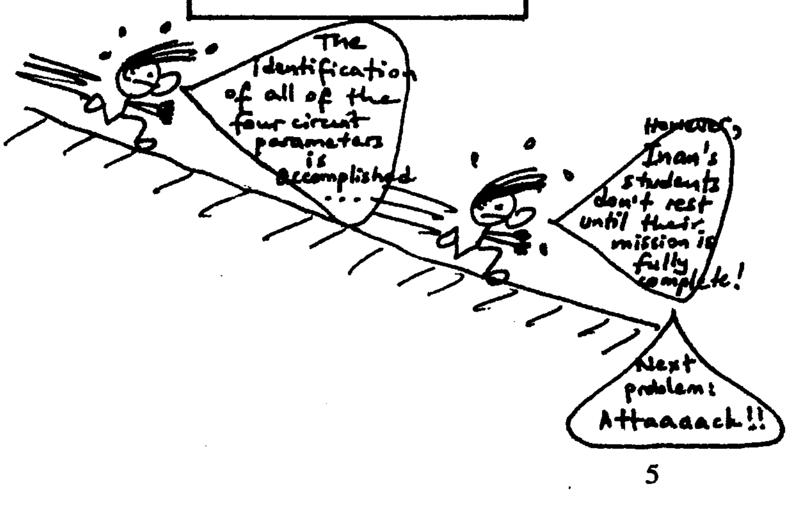
$$= v_1^+ \left[1 + \frac{R_2 - Z_{01}}{R_2 + Z_{01}}\right] = (1)\left[1 + \frac{R_2 - 50}{R_2 + 50}\right] = 1.5\text{V}$$

From the TDR waveform!



Solving, $\boxed{R_2 = 150\,\Omega}$. Substituting the value of R_2 into the time constant equation yields

$$\frac{L_2}{150 + 50} = 0.1\,\text{n} \longrightarrow \boxed{L_2 = 20\,\text{nH}}$$



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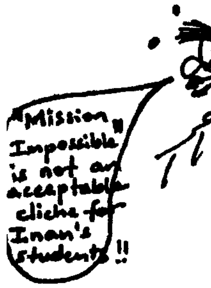

(b) (20 points) Assuming t_{d2}=4 ns, sketch the voltage $V_1(t)$ across the 100 Ω termination at the end of line # 2. Present all the relevant values on your sketch.