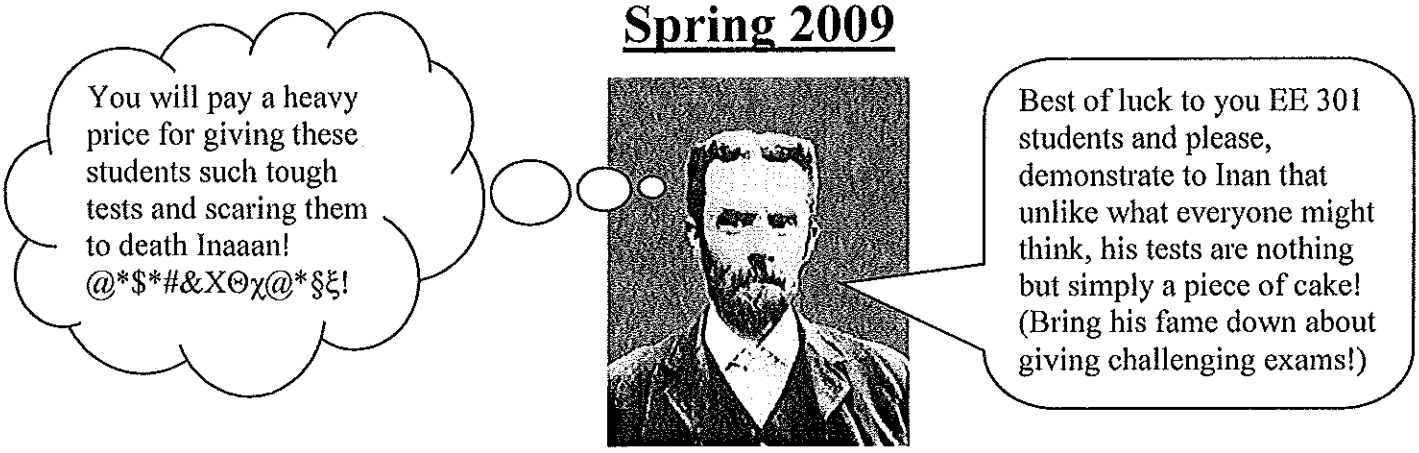
University of Portland
School of Engineering

EE 301-Electromagnetic Fields-3 cr. hrs.
Spring 2009



Midterm Exam # 1

(Prepared by Professor A. S. Inan)

(Friday, February 27, 2009)
(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

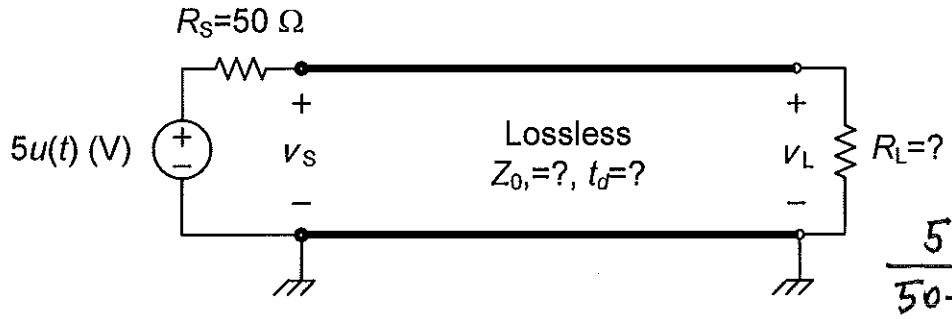
"Honesty is not for sale."
A. Inan

2009
MT #1

(1) (15 mins., Total: 30 points) **TDR characterization.** A TDR experiment is constructed to determine the unknown parameters of a distributed circuit as shown. Based on the source-end voltage waveform given,

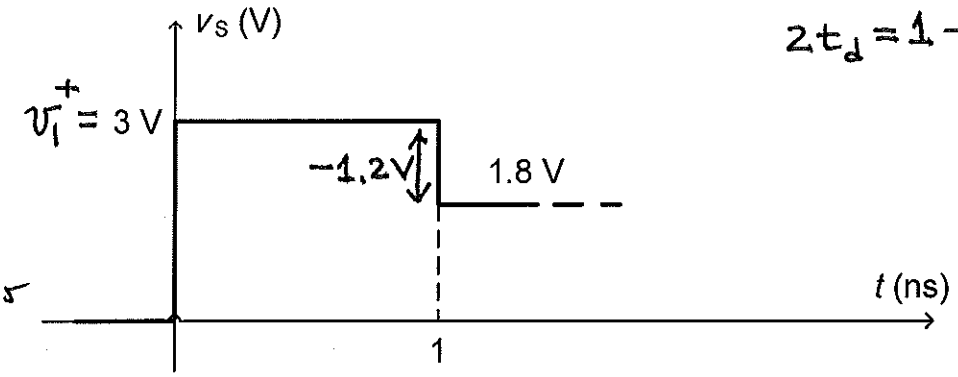
(a) (20 points) Determine the values of Z_0, t_d, and R_L. Show your work clearly. (Use a bounce diagram.)

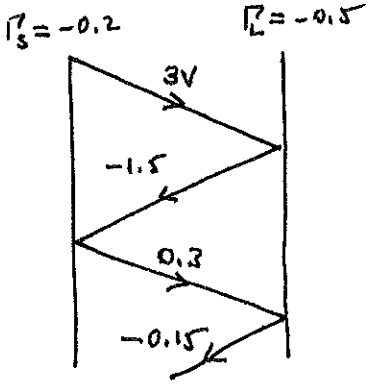
(b) (10 points) Sketch the load-end voltage v_L as a function of time t for the time interval $0 \le t \le 2$ ns.

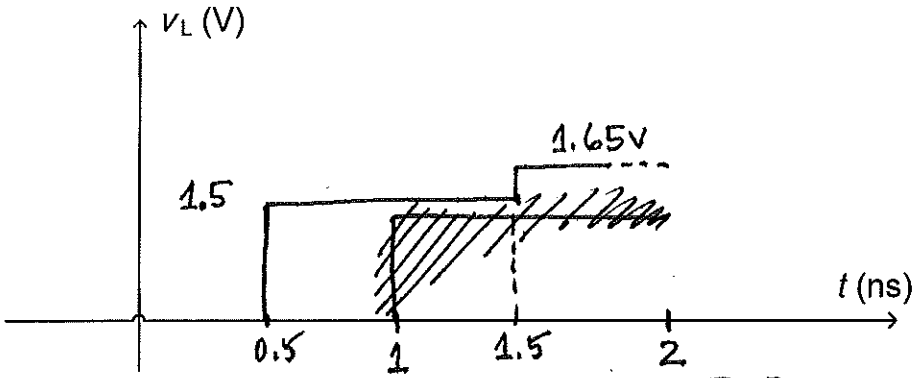


$\frac{5Z_0}{50+Z_0} = 3 \rightarrow \boxed{Z_0 = 75\Omega}$

$2t_d = 1 \rightarrow \boxed{t_d = 0.5\text{ns}}$





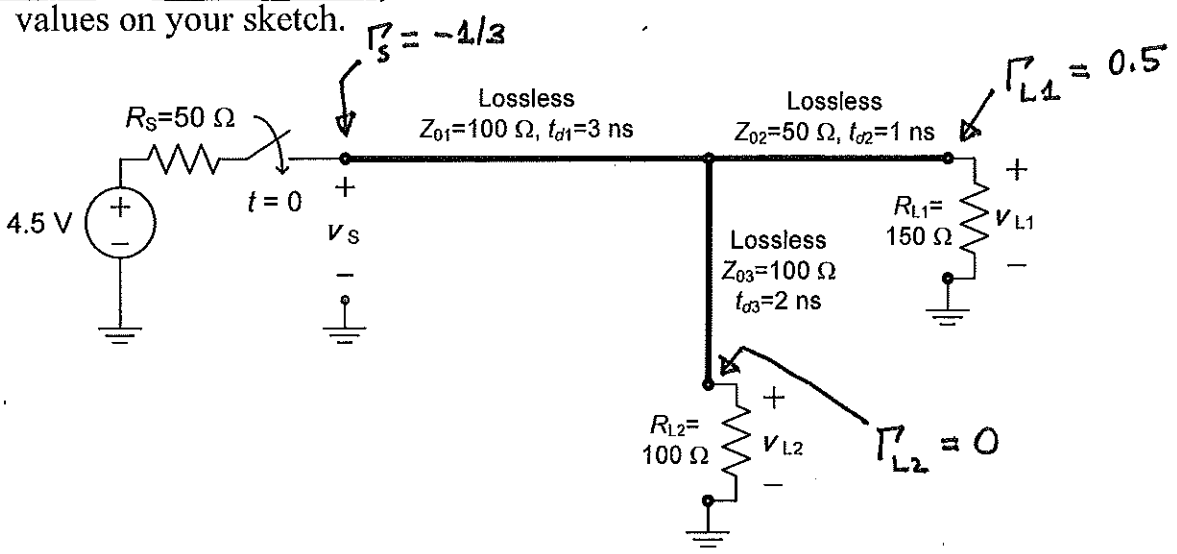


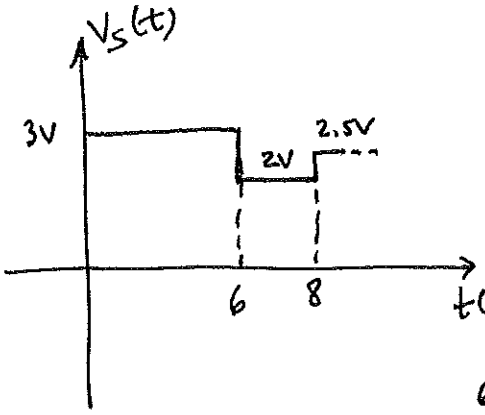
3V ↓+ ↓ $\frac{50-75}{50+75} = -0.2$

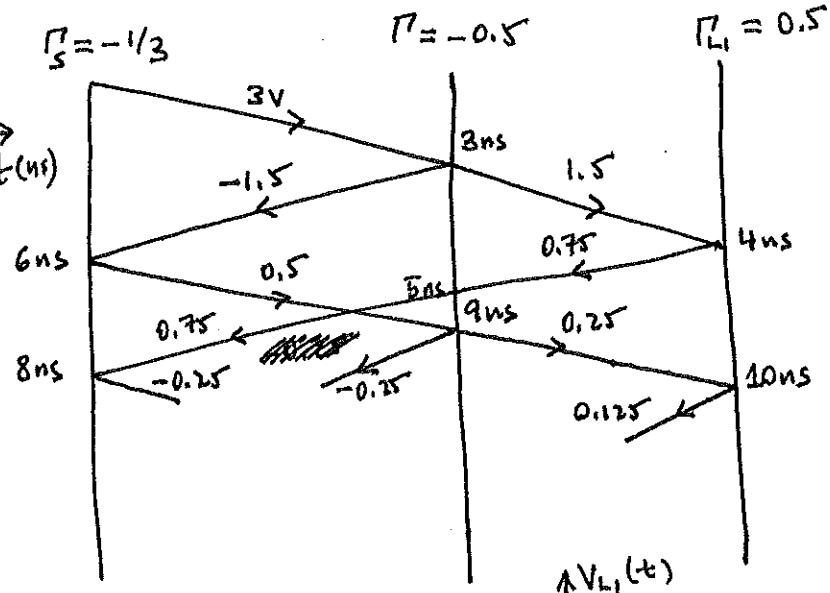
$v_1^- + v_2^+ = \Gamma_L v_1^+ + \Gamma_S \Gamma_L v_1^+ = \Gamma_L v_1^+ (1+\Gamma_S) = -1.2$

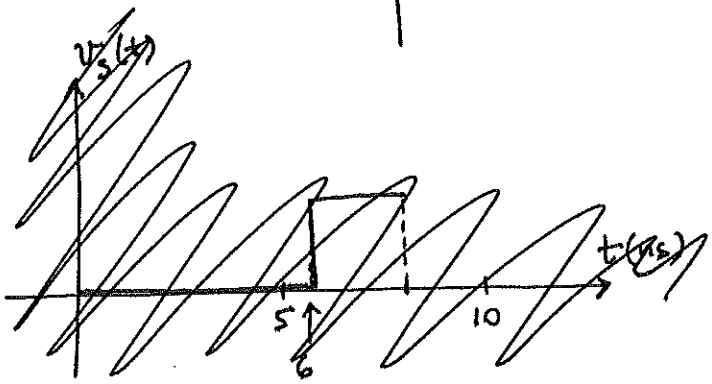
$\rightarrow \Gamma_L = -0.5 \rightarrow \boxed{R_L = 25\Omega}$

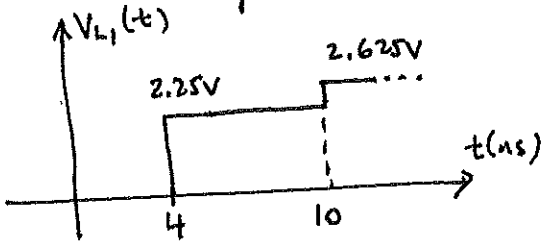
(2) (15 mins., 35 points) **Multiple transmission lines.** For the three transmission-line circuit shown, the switch closes at $t = 0$. Assuming all the lines to be uncharged before $t = 0$, sketch voltages v_S, v_{L1} and v_{L2} between $t = 0$ to 10 ns. Use bounce diagram. Provide all the pertinent values on your sketch.

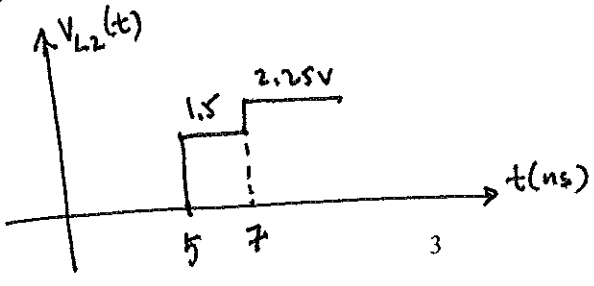








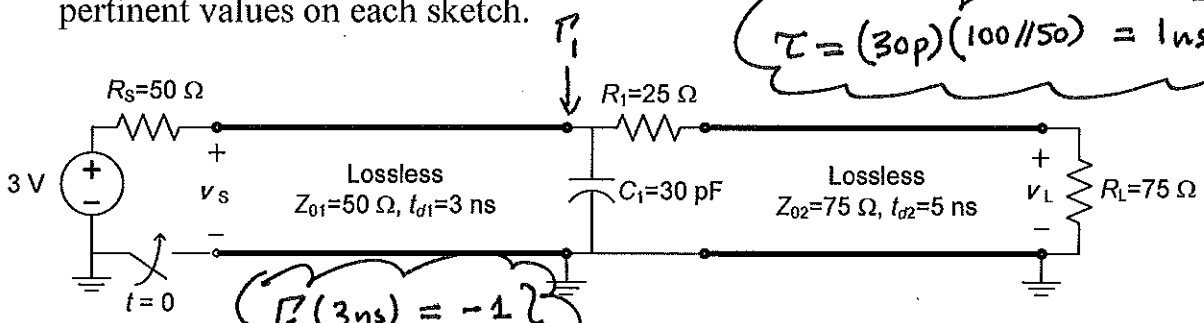




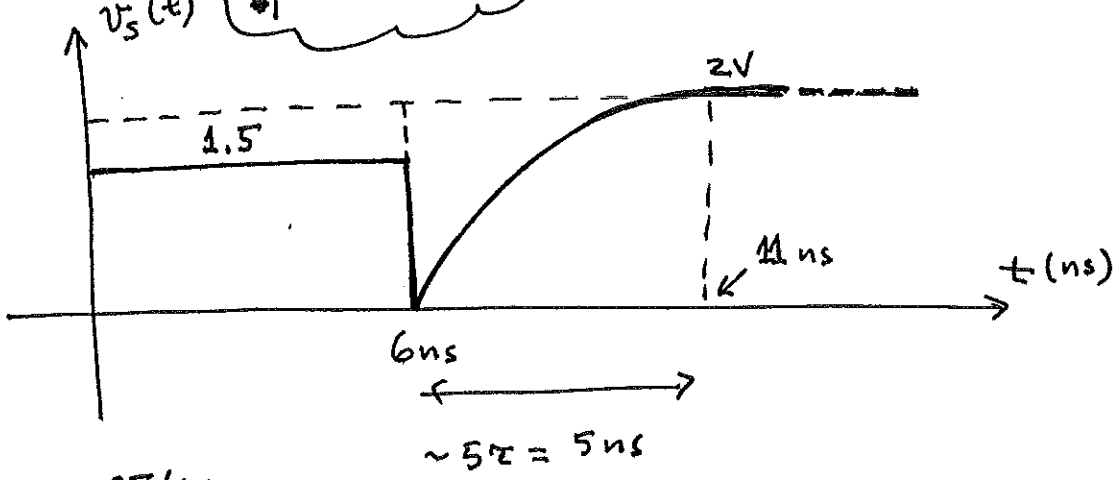
(3)

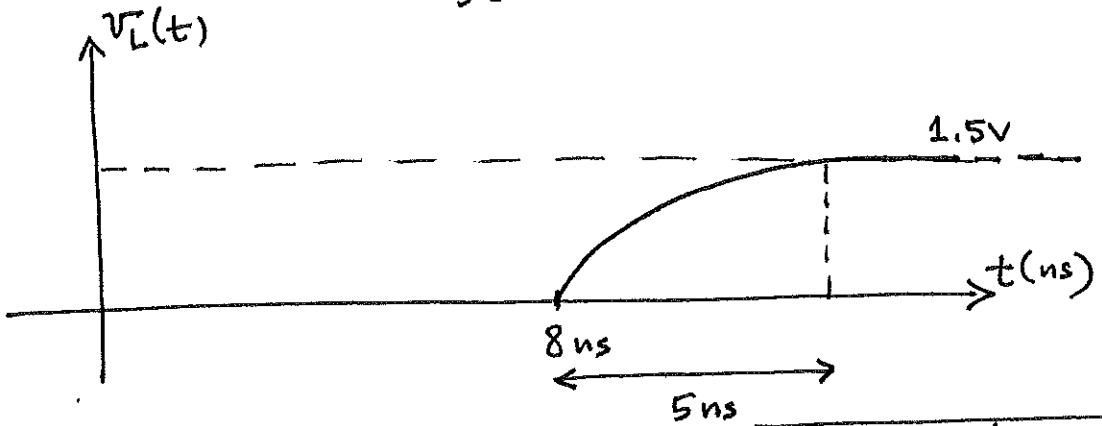
(c) (15 mins., 35 points) **Reactive termination.** In the transmission-line circuit shown, the switch closes at $t = 0$, after being open for a long time. Find the complete mathematical expressions and sketch both the source-end voltage v_S and the load-end voltage v_L as a function of time. Sketch the two waveforms separately. Provide all the pertinent values on each sketch.

$\tau = (30p)(100 // 50) = 1ns$



$\Gamma_1(3ns) = -1$
$\Gamma_1(\infty) = 1/3$





$$v_S(t) = 1.5\,[u(t) - u(t-6ns)] + 2\left(1 - e^{-(t-6ns)/1ns}\right) u(t-6ns)$$

$$= 1.5\,u(t) + 0.5\,u(t-6ns) - 2e^{-(t-6ns)/1ns}\,u(t-6ns)$$

$$v_L(t) = 1.5\left(1 - e^{-(t-8ns)/1ns}\right) u(t-8ns)$$