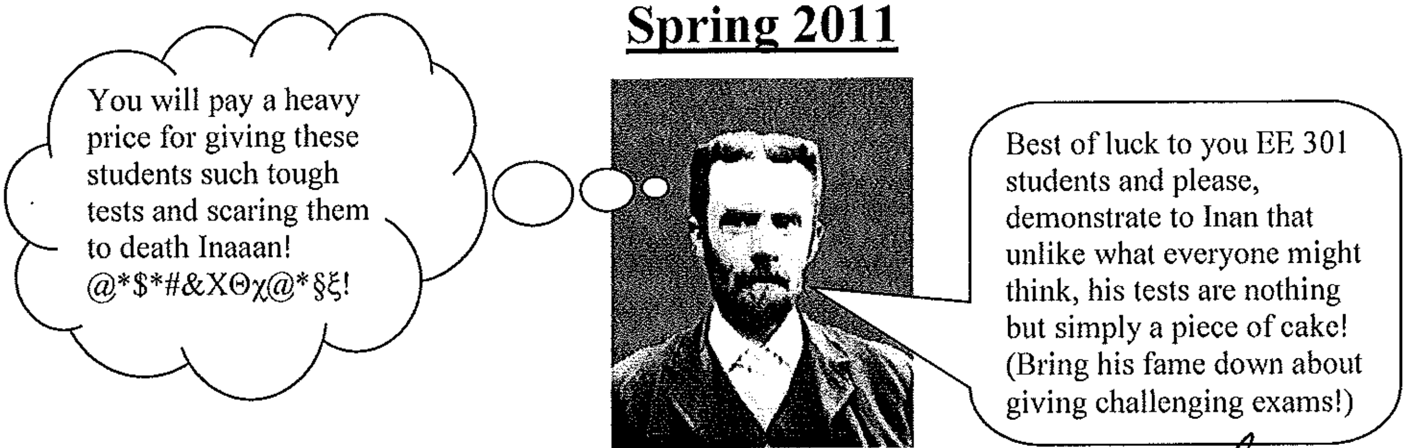
3/4/2011

University of Portland
School of Engineering

EE 301-Electromagnetic Fields-3 cr. hrs.
Spring 2011



Midterm Exam # 1

(Prepared by Professor A. S. Inan)

(Friday, March 4, 2011)
(Closed Book Exam; 1 Formula Sheet Allowed)
(Total Time: 55 mins.)

Name: SOLUTIONS! ☺

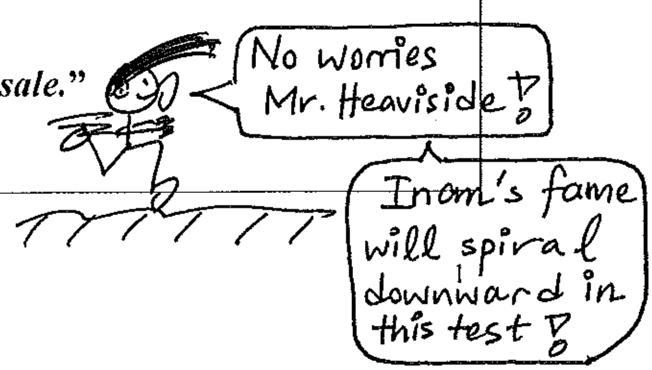
Signature: Solutions ☺

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

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

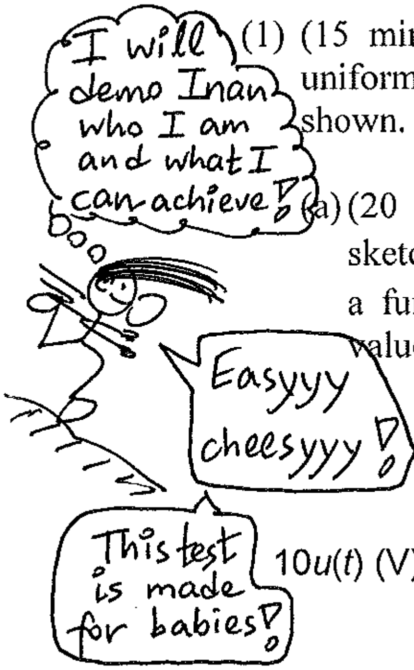
"Honest people are the true winners of the universe."
Anonymous

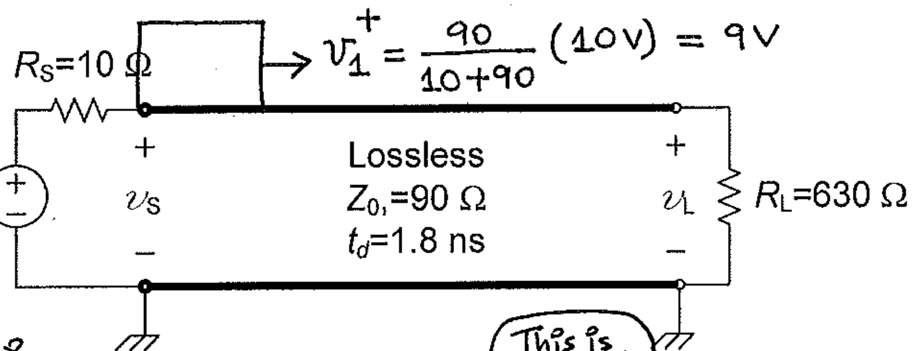
"Honesty is not for sale."
A. Inan



(1) (15 mins., <u>Total:</u> 32.5 points) **Step excitation of a lossless line.** A uniform, lossless transmission line is excited with a step source as shown.

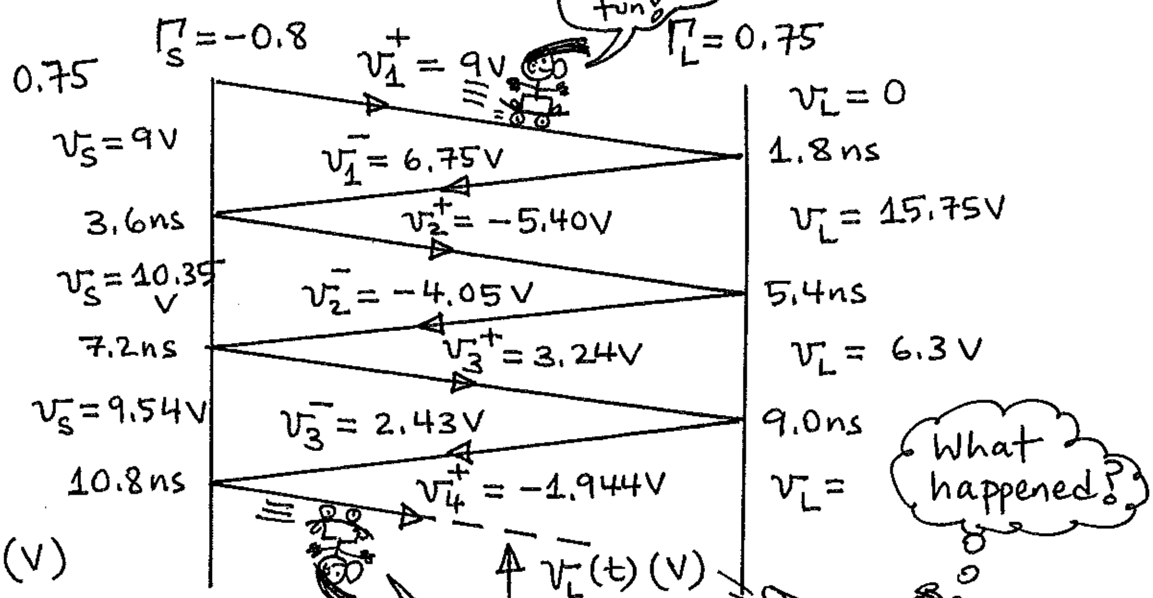
(a) (20 points) Provide an appropriate bounce diagram and use it to sketch both the source-end voltage v_S and the load-end voltage v_L as a function of time between 0 and 10 ns. Provide all the pertinent values on your sketches.

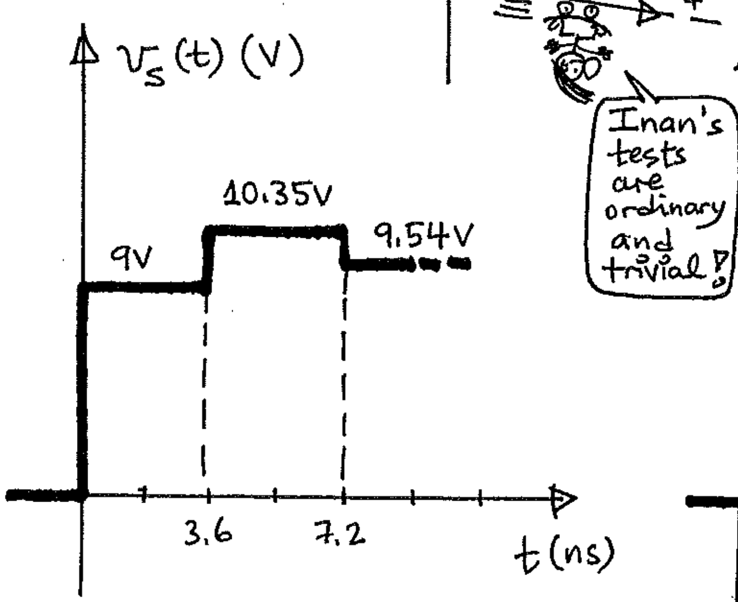


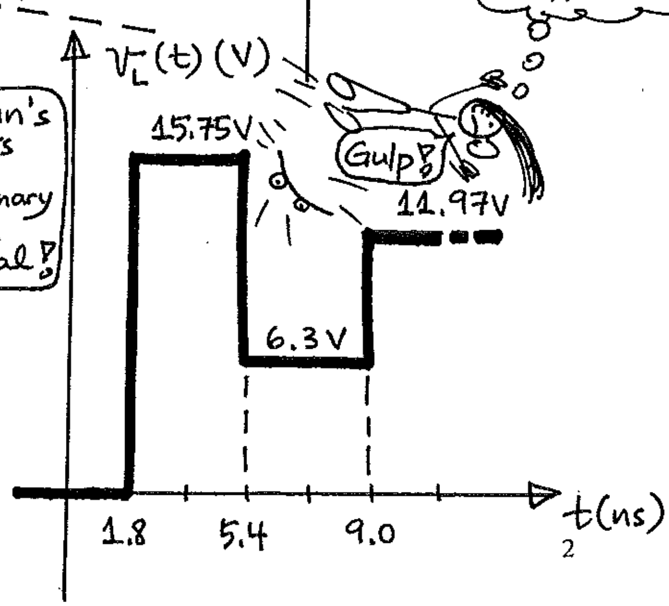


$$\Gamma_S = \frac{10-90}{10+90} = -0.8$$

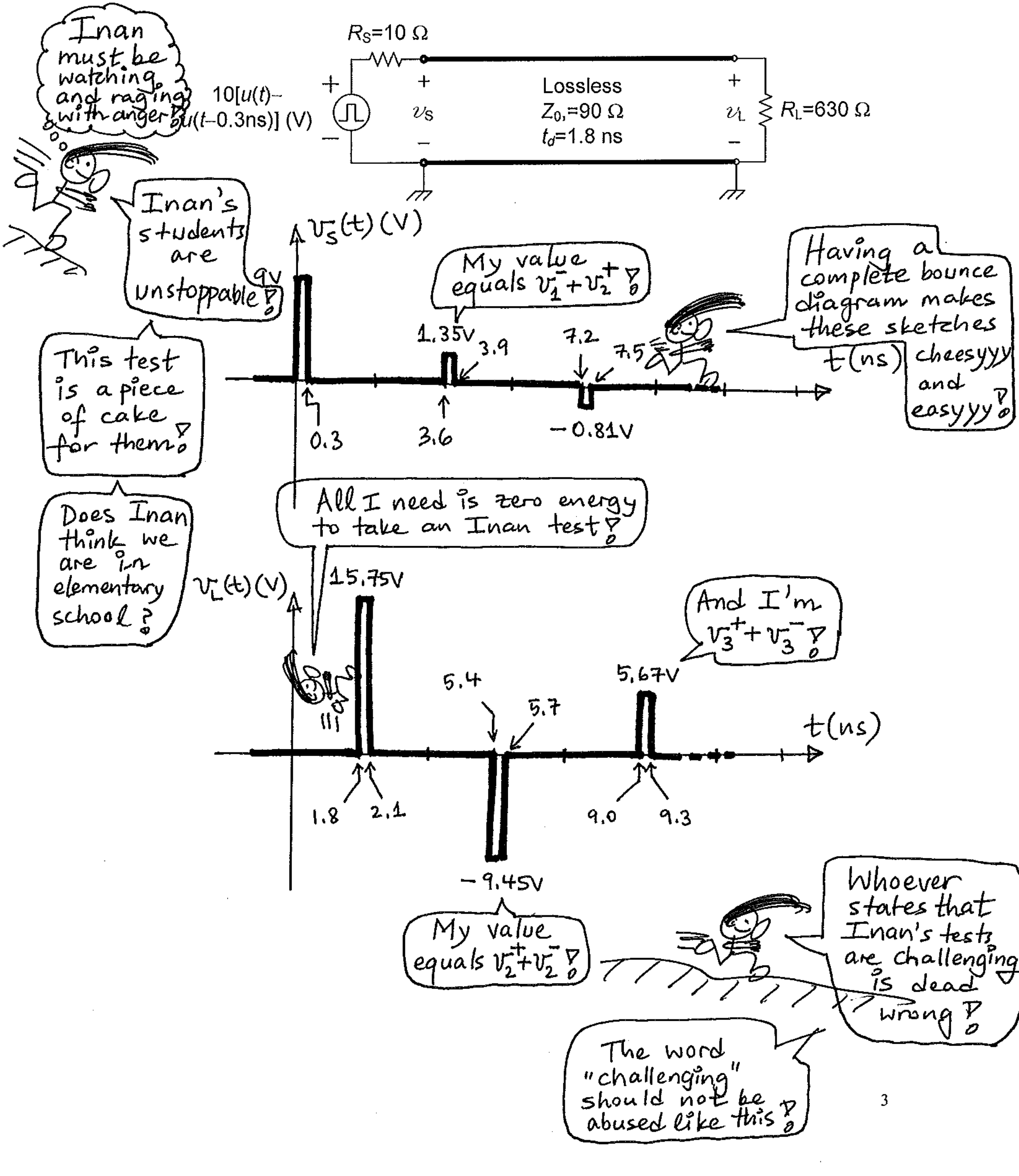
$$\Gamma_L = \frac{630-90}{630+90} = 0.75$$



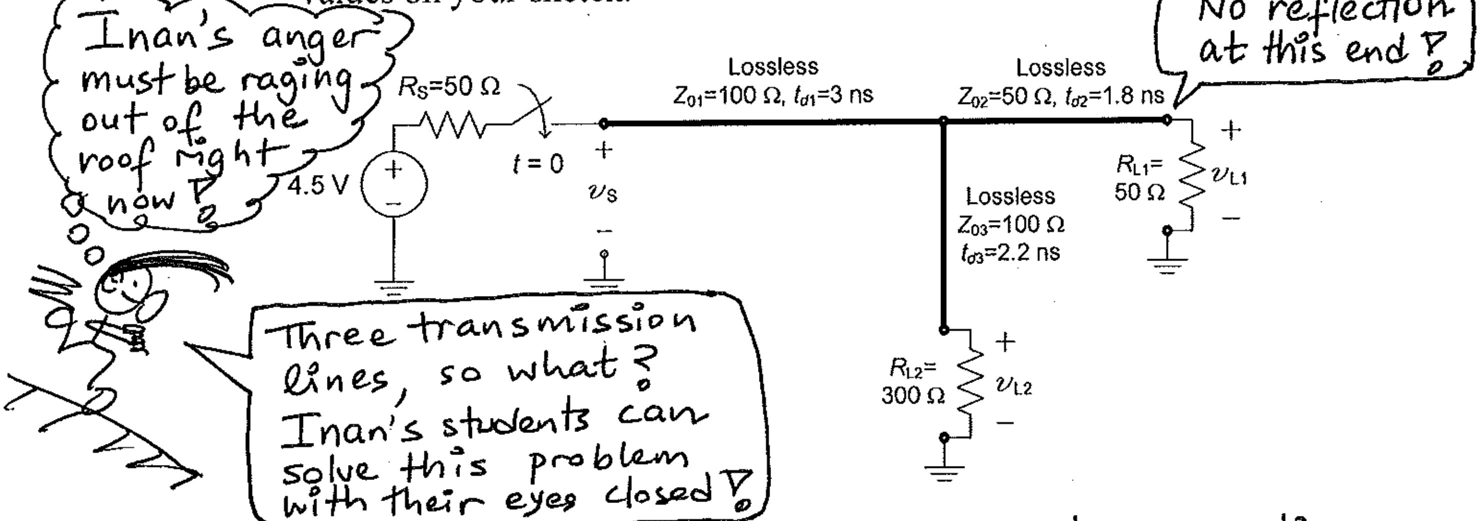




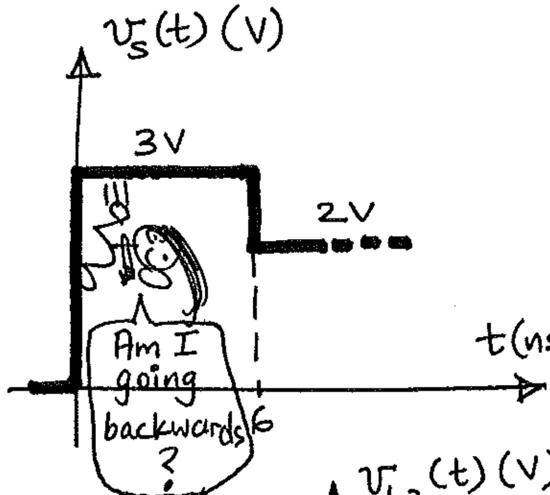
(b) (12.5 points) Redo part (a) if the step source was a pulse source with 0.3 ns pulse width as shown.

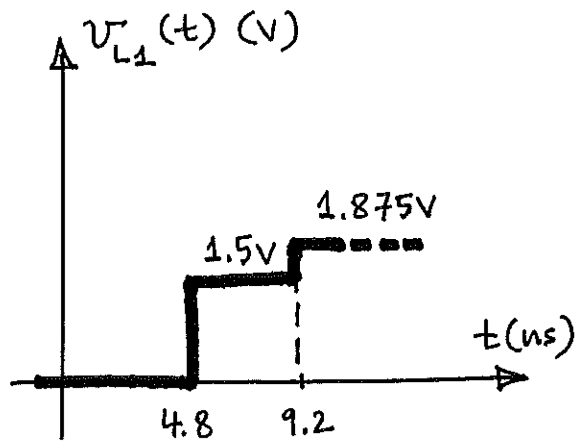


(2) (15 mins., 32.5 points) **Multiple transmission lines.** For the three transmission-line circuit shown, the switch closes at $t = 0$. Assuming all the lines to be uncharged before $t = 0$, sketch voltages v_S, v_{L1} and v_{L2} between $t = 0$ to 10 ns. Use bounce diagram. Provide all the pertinent values on your sketch.

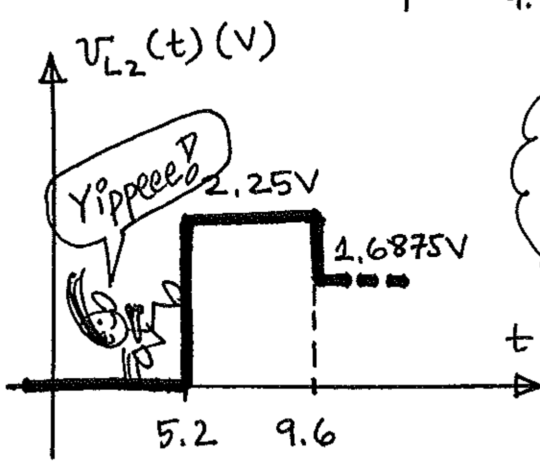


See next page for the bounce diagrams.

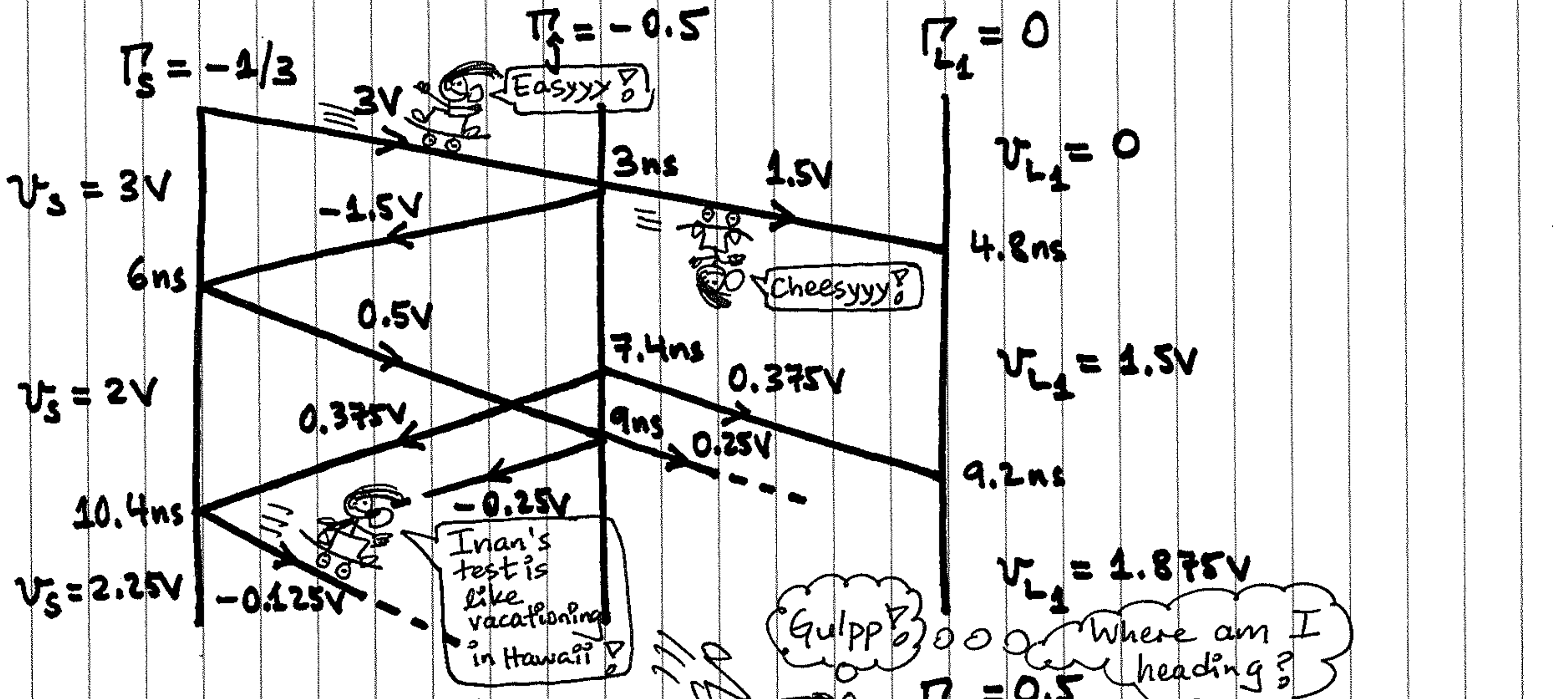


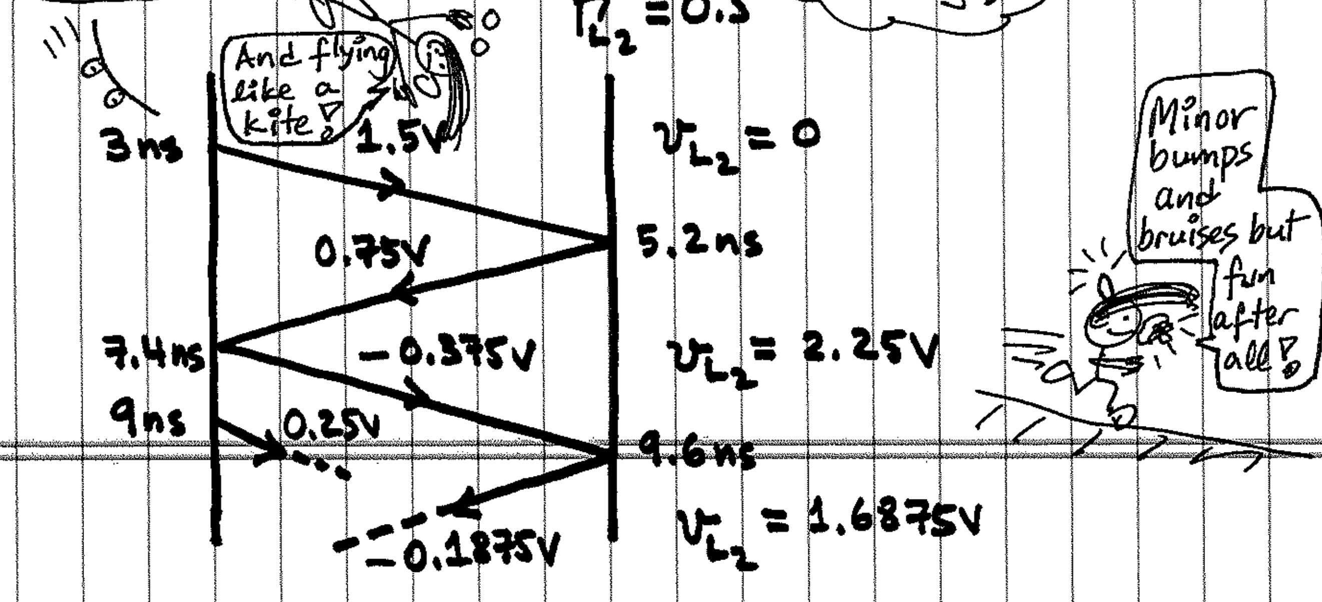


(Note that the changes in these graphs after t=10ns are not included.)



(#2)





$$\Gamma_s = \frac{50-100}{50+100} = -\frac{1}{3}$$

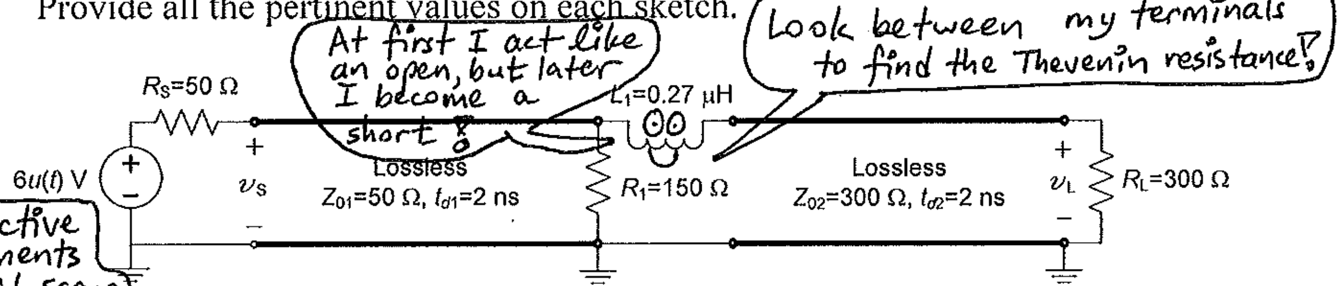
$$\Gamma_j = \frac{(50//100)-100}{(50//100)+100} = -0.5$$

$$\Gamma_{L1} = 0$$

$$\Gamma_{L2} = \frac{300-100}{300+100} = 0.5$$

$$\Gamma_{j_{2\to 1,3}} = 0$$

(3) (15 mins., 35 points) **Reactive element at the junction.** In the transmission-line circuit shown, 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.



They are easy to tackle for Inan students and don't pose any difficulty!

$$\Gamma_S = 0, \quad \Gamma_L = 0, \quad v_1^+ = \frac{50}{100}(6V) = 3V$$

$$\Gamma_J(t = t_{d1}) = \frac{150 - 50}{150 + 50} = 0.5$$

$$\Gamma_J(t \to \infty) = \frac{(150//300) - 50}{(150//300) + 50} = 1/3$$

$$v_1^-(t = t_{d1}) = \Gamma_J(t = t_{d1})\, v_1^+ = 1.5V$$

I'm the initial value of the reflected voltage wave!

$$v_1^-(t \to \infty) = \Gamma_J(t \to \infty)\, v_1^+ = 1V$$

I'm the final value!

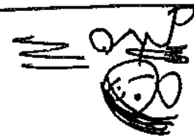
I determine how fast the inductor charges up!

$$\tau = L/R_T = \frac{0.27\mu H}{(150//50) + 300} = 0.8 \text{ ns}$$

I'm the Thevenin resistance!

$$\therefore v_S(t) = 3u(t) + \left[1.5 e^{-(t-4ns)/0.8ns} + \left(1 - e^{-(t-4ns)/0.8ns}\right)\right] u(t-4ns)$$

$$= \boxed{3u(t) + u(t-4ns) + 0.5 e^{-(t-4ns)/0.8ns} \cdot u(t-4ns)}$$



Inan himself brought his fame down by providing us all the tools and skills we need to tackle these type of problems!

Why I am left out?

$$v_L(t) = 4\left(1 - e^{-(t-4\text{ns})/0.8\text{ns}}\right) u(t - 4\text{ns})$$