Name:_____
(Last name, first name)

Student ID:_____

ECE 391

TRANSMISSION LINES

Spring Term 2017

Midterm II

Exam is closed book, closed notes; **one** sheet (2 pages) of notes and formulas allowed; 50 minutes. Show all work on the pages provided. No extra pages (use back if necessary**). Read each question very carefully**.

Box your final answer and include units where appropriate. Number of points for each problem is given in parenthesis (40 points total).

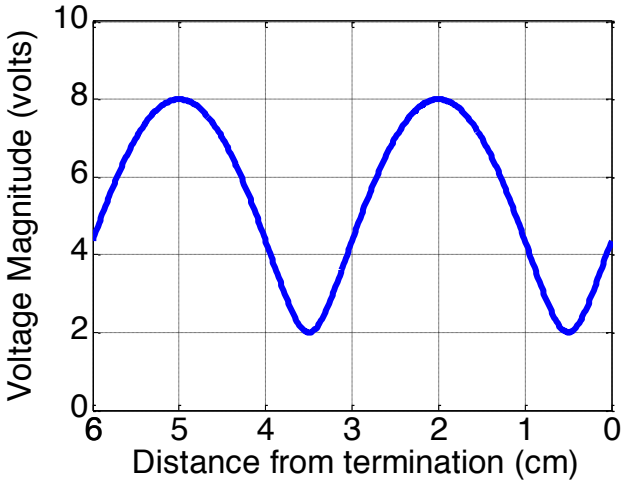
Problem 1 (18 pts.) _____

Problem 2 (12 pts.) _____

Problem 3 (10 pts.) _____

Total (40 pts.) _____

1. (18 pts.) A transmission line of characteristic impedance $Z_0 = 50\Omega$ is terminated in an **unknown** load impedance Z_L. The voltage standing-wave pattern along the transmission line as function of distance from the termination is shown below.



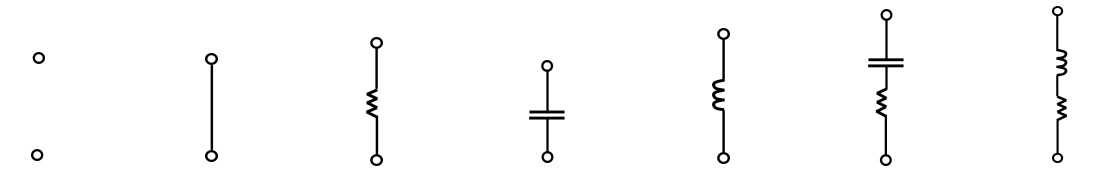
(a) What is the standing-wave ratio on the line terminated in the unknown load impedance Z_L?

(b) Determine the wavelength on the line.

(c) Determine the voltage magnitude of the outgoing wave, $|V_0^+|$.

(d) Determine the reflection coefficient at the termination in **magnitude** and **phase**.

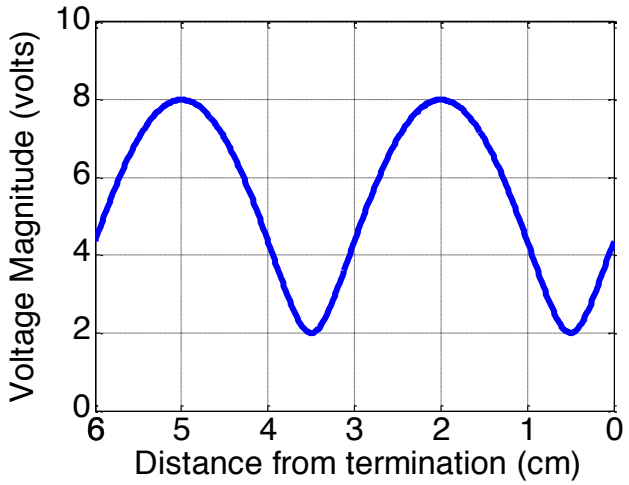
(e) Indicate the type of termination from the list shown below that produces the standing-wave pattern shown above.



open	short	R	C	L	RC	RL
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)

(f) Determine $|I|_{max}$ and $|I|_{min}$ on the line.

(g) Sketch the corresponding current standing-wave plot in the graph below.



2. (12 pts.) A low-loss 50Ω transmission line of 100m length is found to attenuate a sinusoidal wave traveling from one end to the other by 6dB. It is known that dielectric loss is negligible.

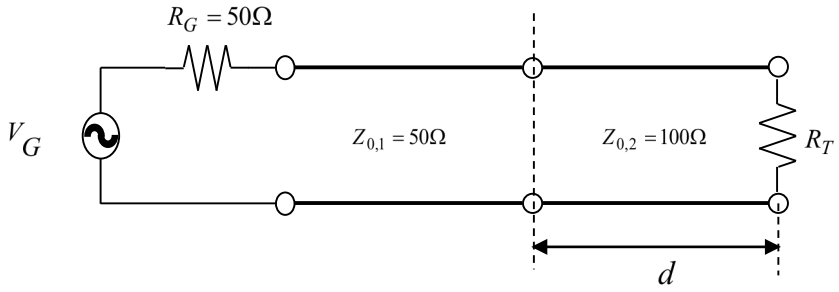
   (a) What is the voltage magnitude across a matched load if the magnitude of the voltage across the input terminals of the line is 10V?

   (b) Determine the attenuation constant in Np/m.

   (c) Applying the low-loss approximation, determine the resistance per-unit-length, *R*, of the transmission line in ohms/meter.

   (d) Applying the low-loss approximation, determine the remaining per-unit-length parameters *L, C,* and *G* (don't forget to specify the proper units). Assume a phase velocity of $v_p = 20$ cm/ns.

3. (10 pts.) An unknown resistive load R_T is connected through a transmission line section of length d and characteristic impedance $Z_{0,2} = 100\Omega$ to a $Z_{0,1} = 50\Omega$ transmission line, as shown below. At frequency f_0, line length d corresponds to a quarter-wavelength ($d = \lambda/4$).



(a) What is the physical length of the 100Ω line if $f = f_0 = 200\,\text{MHz}$ and the effective dielectric constant of the transmission line is $\varepsilon_{r,eff} = 4$?

(b) Determine R_T if at $f = f_0$ the voltage standing-wave ratio on the 50Ω line is $VSWR = 1$.

(c) What is the voltage standing-wave ratio on the 50Ω line (with R_T from part b) if the frequency is doubled ($f = 2f_0$)?

(d) What is the voltage standing-wave ratio on the 50Ω line if the load resistor R_T is replaced with an inductor $L = 4\,\text{nH}$ and the frequency is $f = f_0 = 200\,\text{MHz}$?