University of Portland
School of Engineering

EE 301-Electromagnetic Fields-3 cr. hrs.
Spring 2016

Midterm Exam # 2
Sinusoidal Steady-State Waves on Transmission Lines

(Prepared by Professor A. S. Inan)

(Monday, April 11, 2016)
(Closed Book Exam; 2 Formula Sheets Allowed)
(Total Time: 55 mins.)

Name:_____ ☺

Signature:_____ ☺

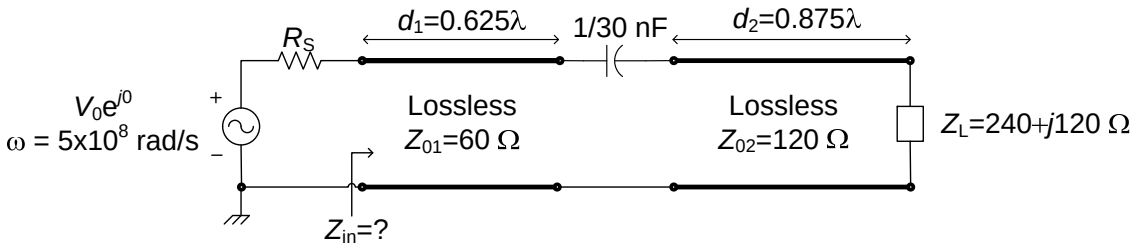
> ***"Honesty is the best policy."***
> **Aesop (~ 620B.C. –?)**
>
> ***"An honest mind possesses a kingdom."***
> **Lucius Annaeus Seneca (4B.C.–65A.D.)**
>
> ***"Honest people are the true winners of the universe."***
> **Anonymous**

Important: Note that Problem (2) is expected to be done fully in class. However, any two of the other three Problems (1), (3) and (4) are expected to be done in class and the third one of your choice is expected to be done as a take-home problem. The take-home problem is due to the next class meeting (Friday, April 15, 2016).

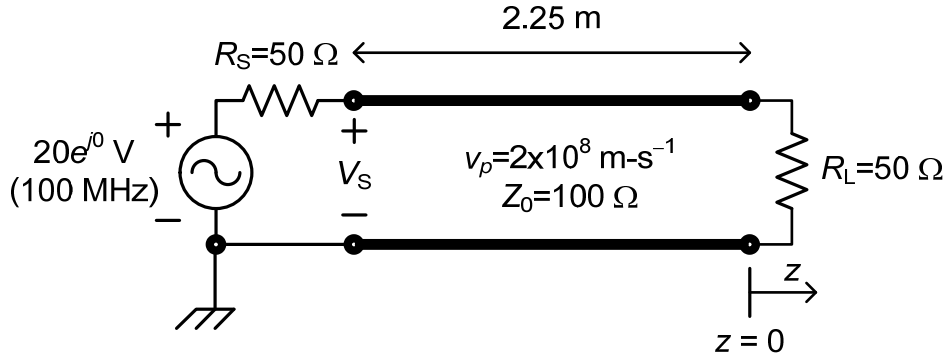
This table will be used by Inan for grading!

Problem #	Points gained
#1	
#2	
#3	
#4	
Total	

(1) (10 mins., 20 points) **Input impedance of a transmission-line circuit.** For the double transmission-line circuit shown, find the input impedance Z_{in} at $\omega = 5\text{x}10^8$ rad-s^{-1}. Note that the capacitor between the two lines is a lumped element.



(2) (15 mins., Total: 40 points) **A lossless transmission line terminated with a complex impedance.** A 2.25 m long, $100\,\Omega$ transmission line with velocity factor 2/3 is terminated with a purely resistive load impedance given by $R_L = 50\,\Omega$ and excited by a sinusoidal voltage source as shown.



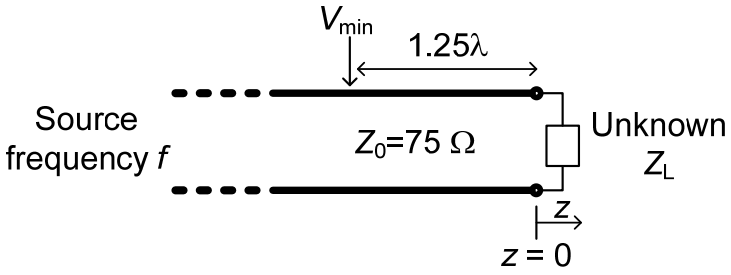
(a) (10 points) Calculate the load reflection coefficient Γ_L. (Provide your answer in polar form.) Show your work!

(b) (5 points) What is the value of the standing wave ratio *S* on the line?

(c) (15 points) Calculate the time-average power delivered to the load.

(d) (10 points) Find all the V_{max} and the V_{min} positions with respect to the load position $z = 0$ on this transmission line. Provide your answers in units of distance.

(3) (10 mins., 20 points) **Unknown load.** The standing wave ratio on a 75 Ω transmission line excited at an operating frequency *f* and terminated with an unknown load Z_L is measured to be 3. If one of the voltage minimum positions on this line is located at a distance of 1.25λ away from the load position, determine the value of the load impedance Z_L. (Note that λ is the wavelength that corresponds to the source frequency *f*.)



(4) (10 mins., 20 points) **Unknown load.** A 50 Ω air transmission line with a standing wave ratio of $S = 5$ has its two voltage maximum and minimum positions nearest to the load at 0.5 m and 1.5 m respectively. Calculate (a) the operating frequency f; and (b) the load impedance Z_L.