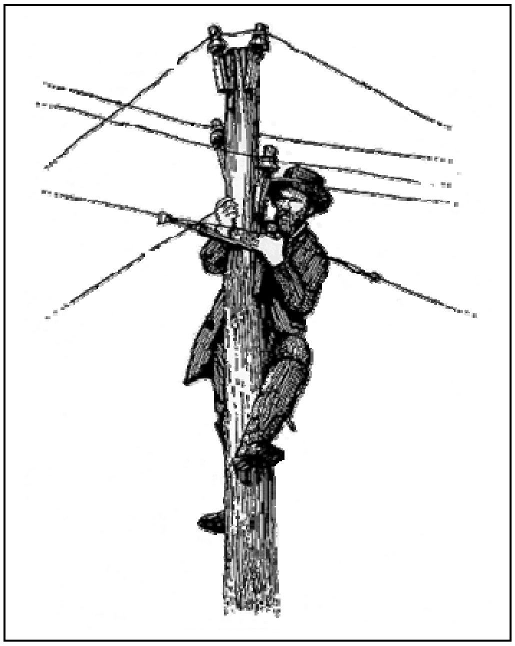
Name ______________________

Section ______________________



Short Answer Questions

1. (18 Pts) ________
2. (15 Pts) ________
3. (12 Pts) ________
4. (5 Pts) ________

Regular Questions

5. (30 Pts) ________
6. (20 Pts) ________

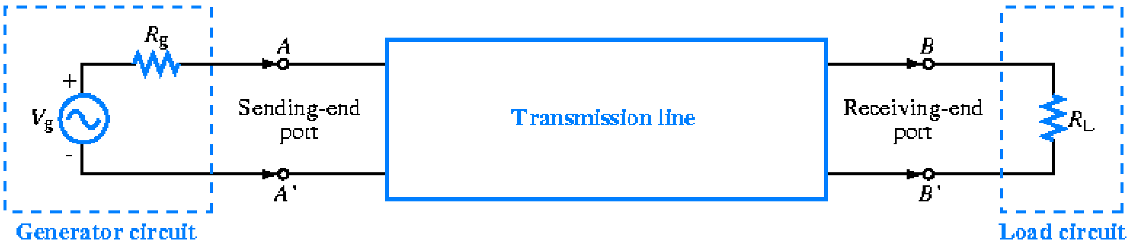
Total

____

Notes:
1. **Please read over all questions before you begin your work. There may be some information in a later question that helps you with an earlier question.**
2. For short answer questions, you may add some comments to justify your answer.
3. Make sure your calculator is set to perform trigonometric functions in radians & not degrees & use 4 significant digits.

MULTIPLE CHOICE AND SHORT ANSWER QUESTIONS

1. Input Impedance of Lossless Transmission Lines (18 points)



Assume a sinusoidal source is connected to a lossless transmission line, as shown.

a. (6 pts) The transmission line load is an open circuit.

  i. For what line lengths will the input impedance observed at the sending point end also be an open circuit? Circle all correct answers.

$0 \quad \lambda/8 \quad \lambda/4 \quad 3\lambda/8 \quad \lambda/2 \quad 5\lambda/8 \quad 3\lambda/4 \quad 7\lambda/8 \quad \lambda \quad 9\lambda/8 \quad 5\lambda/4 \quad 11\lambda/8 \quad 3\lambda/2$

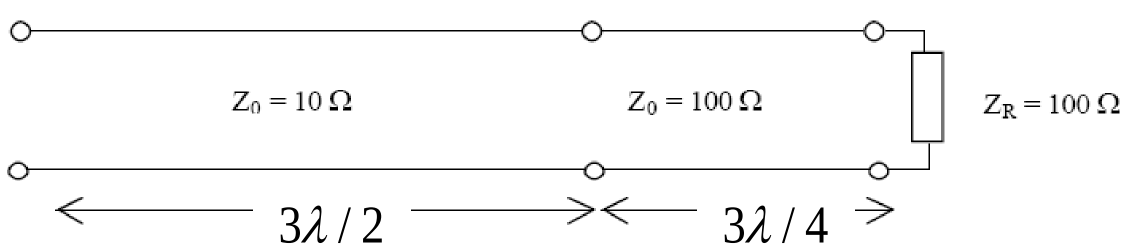
  ii. For what line lengths will the input impedance observed at the sending point end be a short circuit? Circle all correct answers.

$0 \quad \lambda/8 \quad \lambda/4 \quad 3\lambda/8 \quad \lambda/2 \quad 5\lambda/8 \quad 3\lambda/4 \quad 7\lambda/8 \quad \lambda \quad 9\lambda/8 \quad 5\lambda/4 \quad 11\lambda/8 \quad 3\lambda/2$

b. (6 pts) A transmission line has length $\lambda/4$, characteristic impedance $Z_o = 100\Omega$ and load $Z_L = j100\Omega$. What is the input impedance?

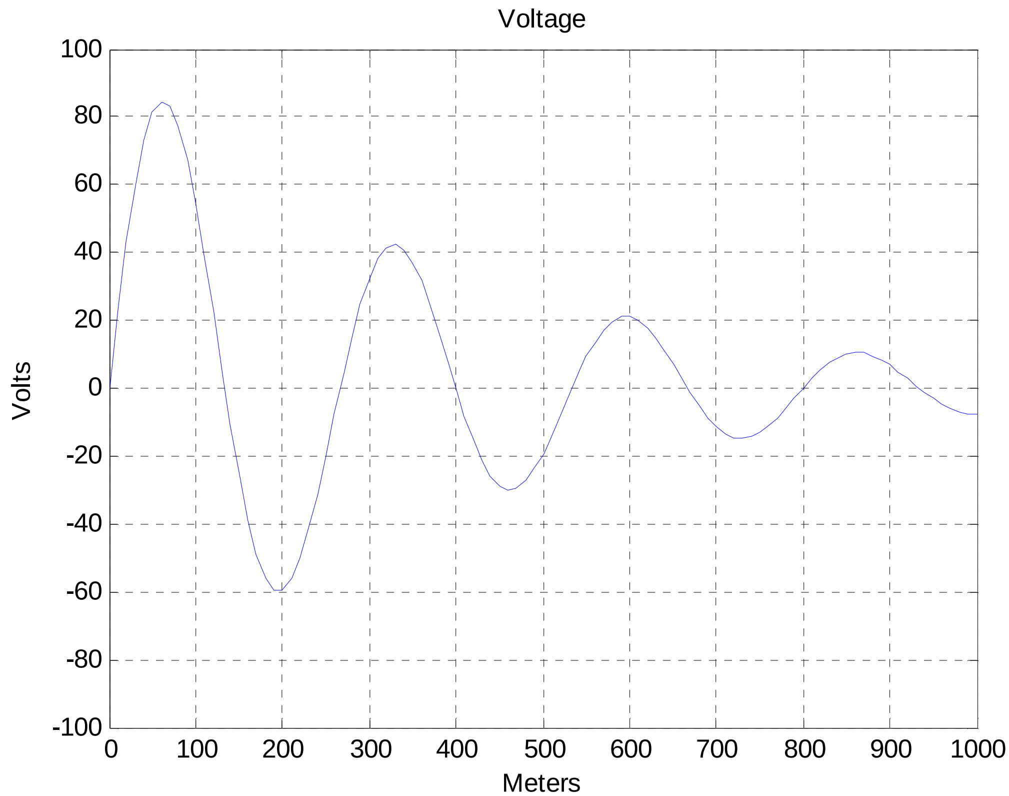
$Z_{IN} =$

c. (6 pts) What is the input impedance of the network below? $Z_{IN} =$



2. **Lossy Transmission Line** (15 points)

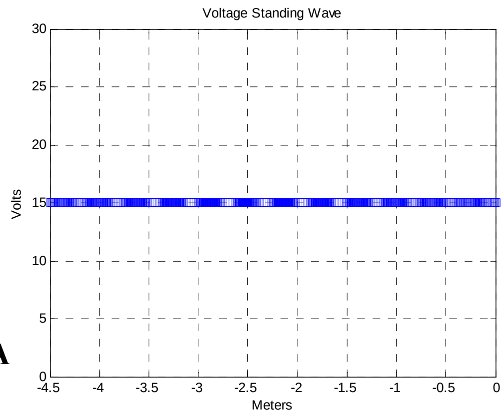
A sinusoidal voltage wave is propagating on a low loss transmission line. The voltage as a function of position appears as shown below. From this plot, determine the damping coefficient $\alpha =$ and the propagation constant $\beta =$



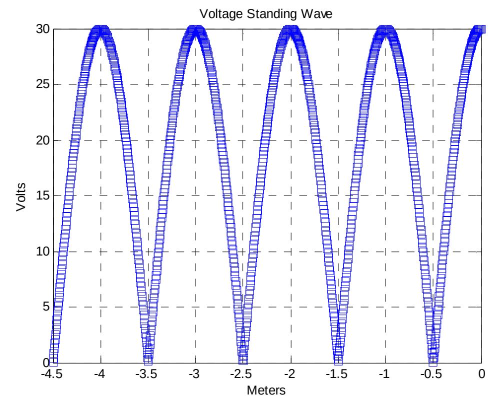
If the measurements above were taken at in a transmission line with a propagation constant of *70%* and capacitance per unit length of *31.75pF/m*, what are the characteristic impedance, the inductance per unit length and the resistance per unit length of the line?

3. **Standing Waves** (12 points)

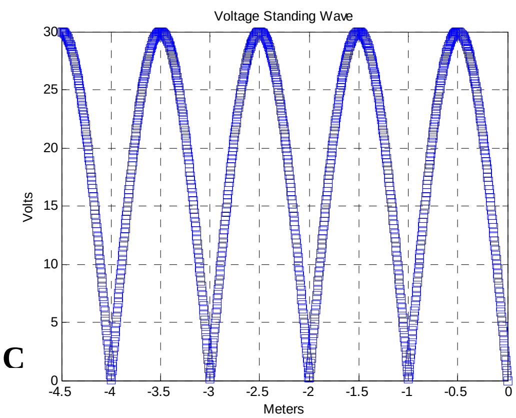
For all of the following questions, assume that a lossless transmission line has a characteristic impedance of $Z_o = 300\Omega$.



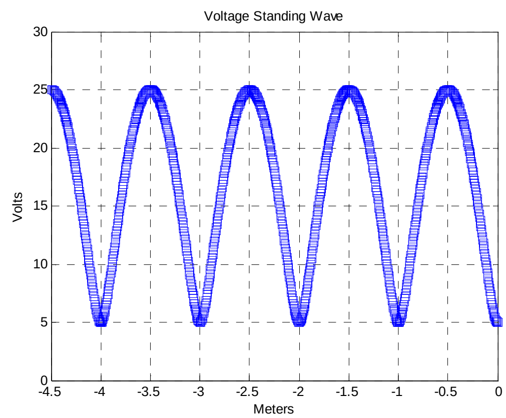
A



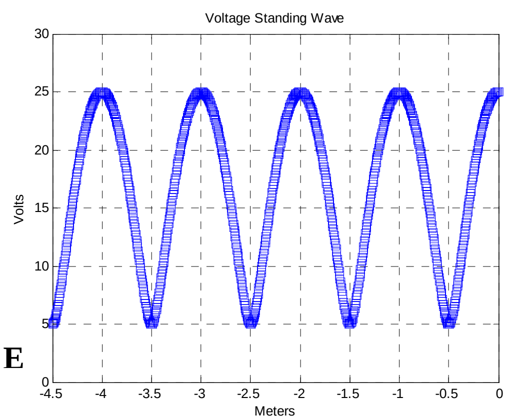
B



C



D



E

	A	**B**	**C**	**D**	**E**
Z_L					
Γ_L					
SWR					

a. (10 pts) For each of the five standing wave plots shown above, determine the load impedance Z_L, the reflection coefficient Γ_L and the standing wave ratio *SWR*. Place the values you determine in the table.

b. (2 pts) Which of the standing wave plots looks like the current standing wave pattern for a short circuit load?

Which of the standing wave plots looks like the current standing wave pattern for an open circuit load?

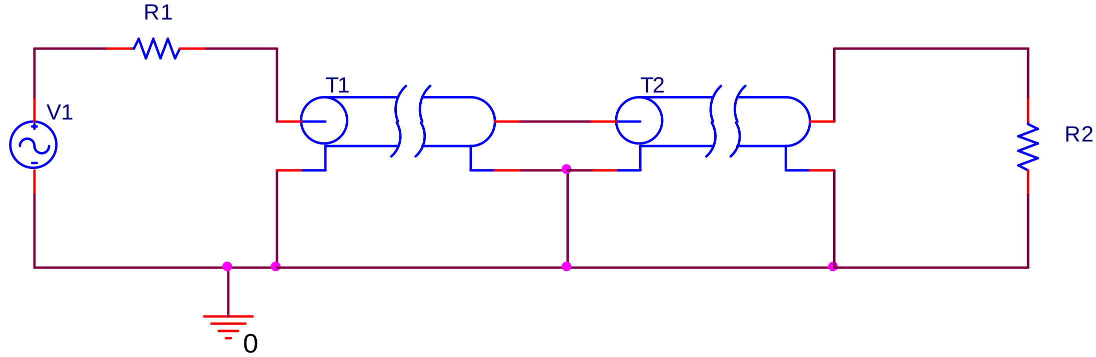
4. Cultural Question (5 points)

What is the name of the organization that awarded the badge shown below for telegraphy in 1925? *Hint: It is not the Boy Scouts.*

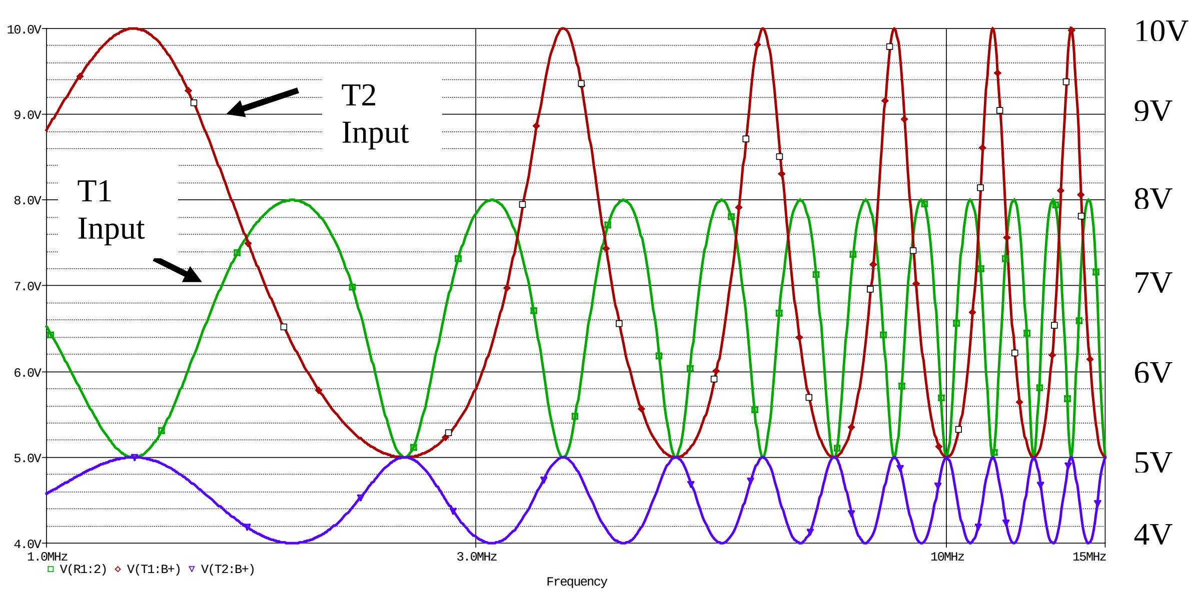
REGULAR QUESTIONS

5. Sinusoidal Voltages on a Lossless Transmission Line (30 points)

Two identical, unidentified lossless transmission lines are connected in series, as shown below. A series of experiments is performed to determine their properties. For these experiments, both *R1* and *R2* are *50 Ohms*.



a. The time delay observed for each of the lines is observed to be *200ns*. The voltage at the input and output of each of the two lines is measured at frequencies from *1MHz* to *15MHz*. In the plot below, the top curve is measured at the input to T2, the middle curve at the input to T1 and the bottom curve at the load. Six peaks (maxima) are observed in the voltage at the input to T2 at the following frequencies: *1.25MHz, 3.75MHz, 6.25MHz, 8.75MHz, 11.25MHz, and 13.75MHz.* Six valleys (minima) are also observed at *2.5MHz, 5MHz, 7.5MHz, 10MHz, 12.5MHz, and 15MHz.* These frequencies and an enlarged voltage scale have been added on the right side of the figure for clarity.



From the measurements above, determine the characteristic impedance of the two identical lines and the reflection coefficient at the load Γ_L. (5 pts)

b. Now determine the total capacitance and total inductance for each of the two identical lines. (5 pts)

c. Assume that the one fact that is known about the lines is their insulating material – polyethylene. (See Ref below from Picwire) Using the velocity factor for polyethylene, determine the velocity of propagation and the length of each identical cable. (5 pts)

MATERIAL	ε @ 1.0 GHz	VOP	Delay
Typical Insulation Materials			
Cellular TFE	1.38	85%	1.2
FEP	2.1	69%	1.47
Silicone Rubber	3.6—2.1	53—69%	1.92—1.47
TFE	2.1	69%	1.47
Polyethylene	2.3	66%	1.55
PVC	8.2—3.0	35—58%	2.9—1.75
Nylon	4.5—3.6	47—53%	2.16—1.92
*Non-Typical Insulation Materials**			
Snow (Fresh)	1.2	91%	1.1
Vaseline	2.2	68%	1.49
Beeswax	2.8	60%	1.69
Ice	3.2	56%	1.8
Glass	8.2—3.8	35—51%	2.9—2.0
Water (Distilled)	82	11%	9.2

*Theoretical values, if cables were constructed of these materials

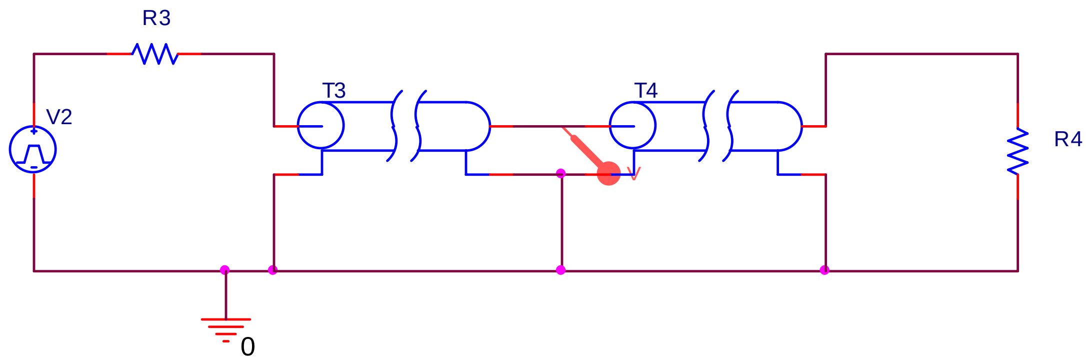
Table 1. Electrical parameters of various materials.

d. Write the general expression for the input impedance seen by the source at the input to T1, simplifying it as much as possible. Then evaluate it at both *f=3.75MHz* and *f=5MHz.* (5 pts)

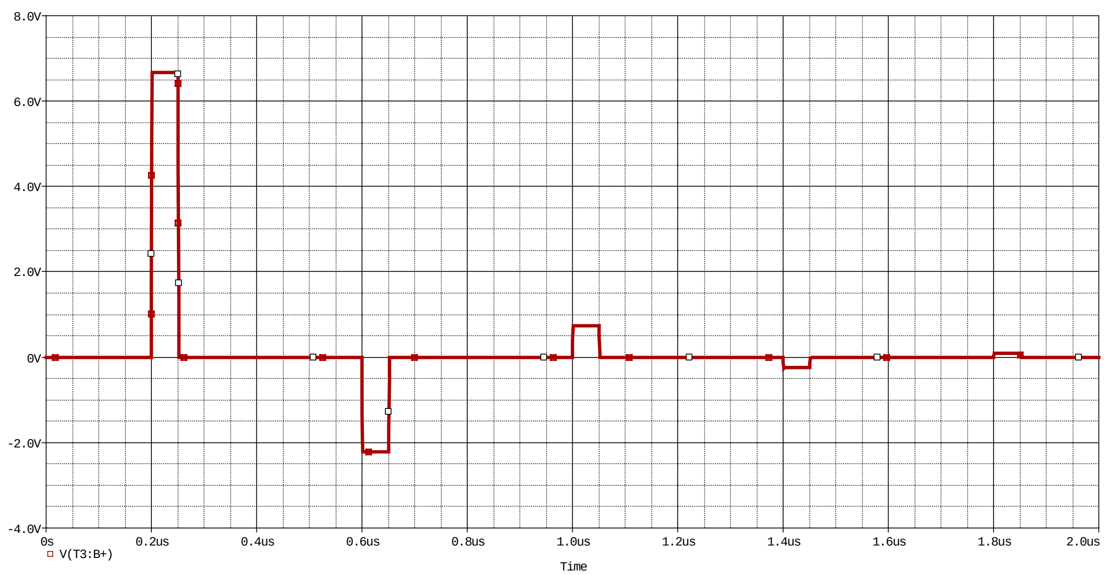
e. What is the voltage at the input to T1 and the output to T2 at these two frequencies? Using this information, determine the average power delivered to the input of T1 and to the load. (5 pts)

f. Find the propagation constant β and wavelength λ for the two frequencies. (5 pts)

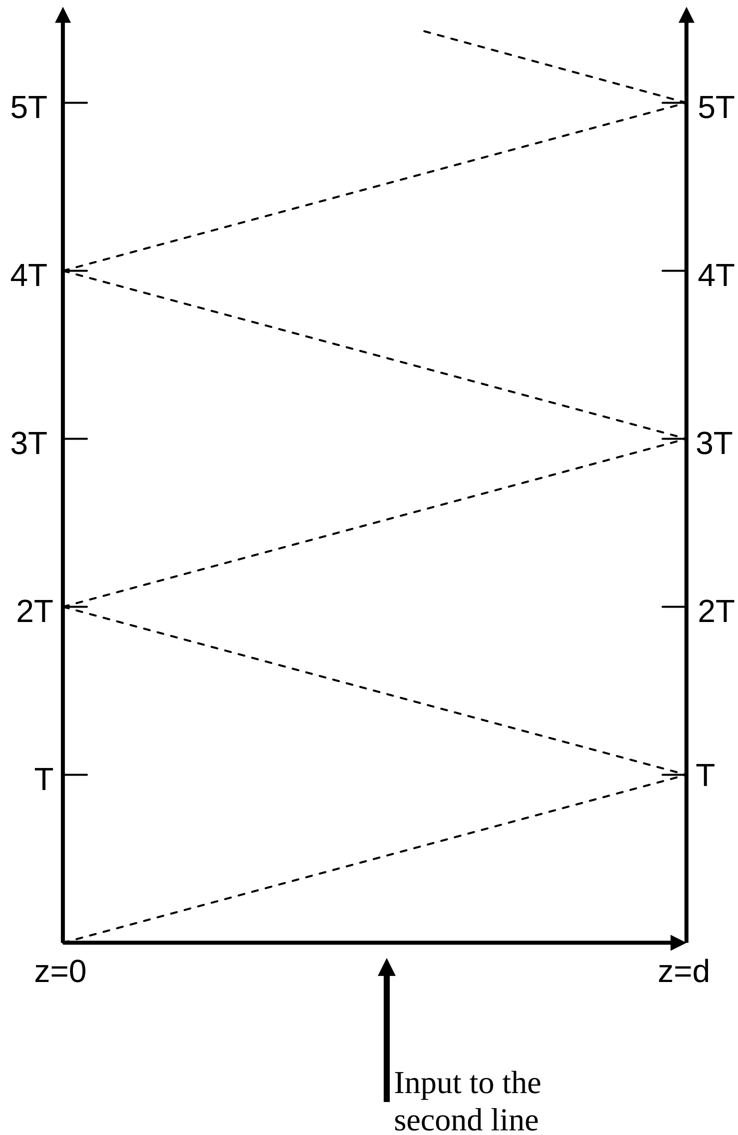
6. **Pulses on Transmission Lines** (20 pts)



Using the same configuration as in the previous problem, a *10V, 50ns* pulse was input to line *T3* and measured at the input to *T4*, with the result shown below. (These are the same lines as in the previous problem, but have different names to keep PSpice happy.) Also, *R3* and *R4* are the same.



a. Using the information in this plot, determine the characteristic impedance of the two identical lines and then fill in the bounce diagram for the complete configuration. Use the information on the velocity of propagation from the previous problem. (10 pts)



a. Determine and plot the voltages at the input to *T3* and at the load, as functions of time. (10 pts)