MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

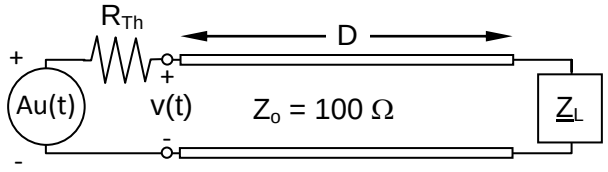
6.013 Electromagnetics and Applications

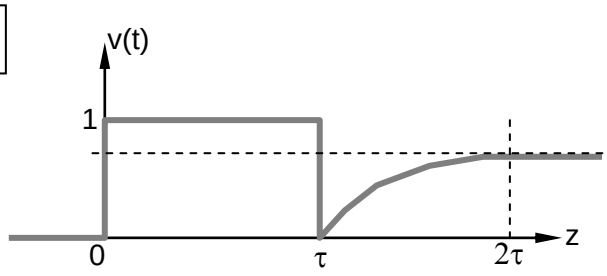
Quiz 2 Closed book, no calculators

*Please note the formulas provided on a separate sheet. There are **4 problems** on two pages. For full credit, please **simplify** all expressions, **circle and dimension your answers**, and present numerical answers to the extent practical without a calculator or tedious computation. You may leave natural constants in symbolic form (π, ε_o, h, e, etc.). You may keep the quiz questions.*

Problem 1. (28/100 points)

The voltage v(t) at the input end of the illustrated lossless air-filled 100-ohm TEM line of length D is illustrated for the case where the Thevenin voltage source is a step function of amplitude A, and the source impedance is R_{Th}.





a) What is the numerical value of R_{Th}? Briefly explain your reasoning (required).

b) What is the line length D?

c) Diagram a simple load at the end of the line that could produce this response; it is not necessary to compute element values. Simply label your components as R, L, or C, as necessary.

Problem 2. (22/100 points)

A certain parallel-plate TEM transmission line is 1 cm wide and 1 mm high, and is filled with a medium characterized by μ_o and $\varepsilon = 9\varepsilon_o$.

a) What is the approximate wavelength λ (numerical value) for a 1-GHz signal on this line?

b) Assume a sinusoidal signal propagates in the +z direction as $|\underline{V}(z)| = V_o e^{-\alpha z}$ and that $\varepsilon = 9\varepsilon_o(1 + 0.01j)$. What are the sign and approximate numerical value of α at 1 GHz?

Problem 3. (22/100 points)

The magnetic field $\underline{\bar{H}}$ for y > 0 in vacuum is $\underline{\bar{H}} = \hat{x}\, H_o e^{-jz\,-\,0.6y}$.

a) Explain completely but very briefly whether this is a TE or TM wave.

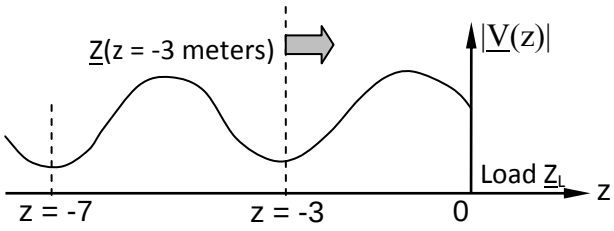
b) What is the approximate angular frequency ω [r/s] of this wave?

Problem 4. (28/100 points)

A vacuum-filled 100-ohm TEM transmission line is terminated with a complex load $\underline{Z}_L$.

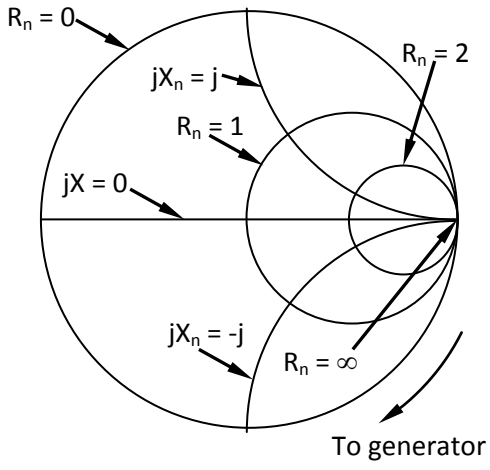
(a) What is the numerical value of the inductance L [Hy/m] for this line?

(b) The magnitude of the voltage $|\underline{V}(z)|$ is measured on this line as illustrated. The VSWR = 3. What fraction F of the power incident upon the load is being reflected?



(c) What is the complex impedance $\underline{Z}(z = -3 \text{ meters})$ seen looking toward the load?

Although a Smith chart is not required for this problem, a small one is provided here as a courtesy.



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