Problem 10.1

An air-filled lossless TEM transmission line has capacitance $C$ per meter of $10^{-10}/3$ [Fm$^{-1}$]. Simple numerical answers exist for all parts of this problem.

a) What is the inductance $L$ per meter for this line?

b) What is the characteristic impedance $Z_o$ for this transmission line?

c) What is the complex reflection coefficient $\Gamma_L$ of the load $R_L = 3Z_o$?

d) What is the complex reflection coefficient $\Gamma(z = -\lambda/4)$ seen a quarter-wavelength from the load $R_L = 3Z_o$?

e) What is the normalized impedance $Z_n(z = -\lambda/4)$ corresponding to (d)?

f) What is the actual impedance $Z(z = -\lambda/4)$ corresponding to (d)?

g) Repeat parts (c) - (f) for an inductive load impedance equal to $jZ_o$.

1 Can alternatively be submitted at Friday's recitation after the quiz on November 15 without penalty. Since this set covers a fair amount of important material, it would probably be a good idea to do most of it before the quiz rather than after. The problems were designed to minimize computation because of the quiz.
A voltage standing wave pattern is measured on an air-filled TEM line as illustrated.

a) What is the VSWR on this line?

b) What is the wavelength \( \lambda \)?

c) What is \(|\Gamma(z)|\) on this line?

d) What is \( Z_L/Z_o \)?

e) To what points on the illustrated Smith chart (i.e. A, B, C, D, or E) do the points 1, 2, and 3 on the VSWR plot correspond?

f) We wish to add an impedance \( jX \) in series with this line at some position \( z = -D \) so as to match this load. If \( X > 0 \), where on the Smith chart \( j \) should the normalized impedance of the line-plus-load to the right of \( z = -D \) lie?

g) If the impedance \( jX \) we need to add in series is \( 1.1j \), what is the value of this inductor if \( Z_o = 100 \) ohms? The frequency \( f \) follows from part (b).

h) Is the information available from the VSWR figure plus a value for \( Z_o \) sufficient to design a matching circuit for this load? Explain briefly.