

EE Ph.D. Qualifying Exam, January 2013 Question

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Waves and transmission lines

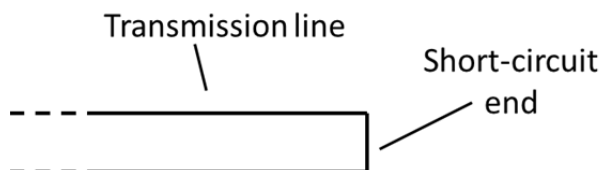
Notes: There may not be single “correct” answer to parts of this question. The goal of this question is to see how you think about it. The answers are mostly qualitative, and little or no algebra should be required for them. If you finish the question on this sheet, subsequent questions will be asked.

Question:

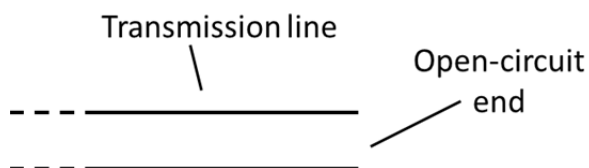
Consider a transmission line – that is, a two-conductor electrical line with some well-defined impedance (for example, $50\ \Omega$). Presume for simplicity that the line has no loss (e.g., perfectly conducting wires) and that the wave propagation velocity on the line is c , the velocity of light in free space. A monochromatic (i.e., single-frequency) wave of frequency f has been launched onto the line from some source on the far left.

a) Sketch the form of the voltage on the line near the right end at some specific time for the two cases below, in both cases indicating any characteristic length involved and giving its magnitude.

(i) a line that is short-circuited at its right end, as shown in the diagram below



(ii) a line that is open-circuited at its right end, as shown in the diagram below



b) Sketch the form of the time-averaged electrostatic energy density in the line (which you can take to be proportional to the square of the voltage from your answers above) for both cases above.

c) Suppose that, instead of an open circuit at the right, we connect to another, lower impedance (for example, $25\ \Omega$) line. Sketch the form of the energy density (i.e., the square of the voltage) in the line to the left of this connection (you need not calculate any numbers, but you should show the qualitative behavior).

