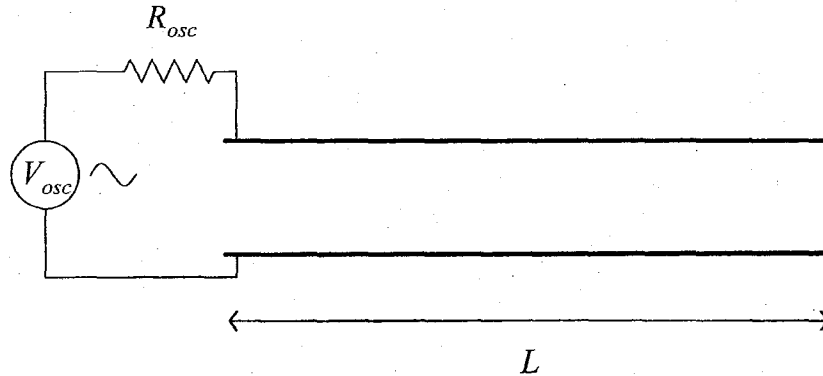


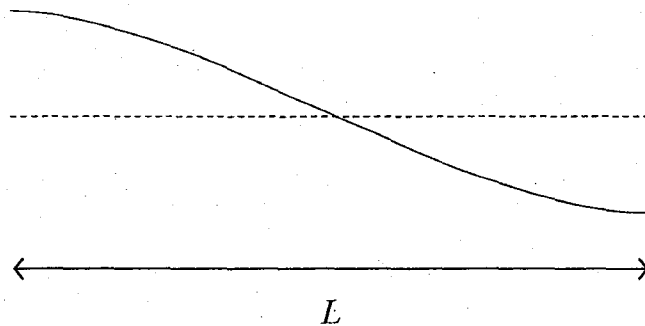
EE Ph.D. Qualifying Exam, January 2006 Solution

(a) For the case where the line has an open circuit at both ends,



(i) what is the lowest frequency at which there is a resonance?

The line will have a standing wave resonance on it with voltage maxima at the ends. The voltage is a maximum at either end because the voltage wave reflects constructively on itself there. The voltage wave looks like



Equivalently, one can say there are zeros in the current at both ends. The lowest frequency for which this can happen is the one for which one half wavelength fits in between one end and the other, i.e.,

$$\frac{\lambda}{2} = L$$

The wavelength is given by

$$\lambda = c / f$$

So the frequency of this first mode is

$$f_1 = c / 2L$$

(ii) what is the next frequency at which there is a resonance?

The next possible resonance is when two half waves fit within the line, i.e., $L = \lambda$ and so the frequency is $2f_1$