Problem 10.1

A lossless air-filled 100-ohm TEM line one meter long is open-circuited at both ends.

a) What are its resonant frequencies \( f_n \) (Hz)?

b) If one microjoule is stored in this resonator at any non-zero resonant frequency, what is the peak voltage \( v(z,t) \) across the line?

c) If a 10-k\( \Omega \) resistor is placed across one end of the line at the lowest non-zero resonant frequency, what is the Q of this resonator?

Problem 10.2

A parallel-plate waveguide has a plate separation of one centimeter and is filled with dielectric having \( \varepsilon = 4\varepsilon_0 \).

a) What are the cut-off frequencies \( f_{co} \) for the TM\(_1\), TM\(_2\), and TE\(_2\) modes?

b) What is the waveguide wavelength \( \lambda_g \) of the TM\(_1\) mode at twice its cutoff frequency?

c) For the wave of part (b), what is the group velocity of that wave?