7)

It says on a coaxial cable that it is a 50 Ω cable.

a) What kind of impedance is the 50 Ω?

b) Why is it important to know this value?

8)

Assume that you use a signal generator in the lab. You measure the amplitude of a time-harmonic signal from the generator with an oscilloskope and find that the peak amplitude is 10 V. After that you hook up a 50 Ω resistor to the generator and measure the voltage over the resistor with the oscilloskope.

a) What peak value will the measured signal probably have?

b) What is the reason to the amplitude in a)?

9)

Assume that you hook up a capacitor with capacitance 1 μF to one end of a 50 Ω coaxial cable. In the other end you send in a time-harmonic signal with frequency 1 GHz and with amplitude 2 V. What is the amplitude of the reflected signal? You are not allowed to use any formulas!

10)

The TE_{10} mode in a rectangular waveguide with cross section $0 < x < a$, $0 < y < b$ $(a > b)$, filled with air, has the complex electric field

$$\boldsymbol{E}(x, y, z) = E_0 \sin \frac{\pi x}{a} e^{-\mathrm{j}k_z z} \hat{\boldsymbol{y}}$$

where $k_z = \sqrt{k^2 - (\pi/a)^2}$ is the $z-$component of the wave vector and $k = \omega/c$ is the wavenumber.

a) What is the time-domain electric field $\boldsymbol{E}(x, y, z, t)$?

b) Below a certain frequency (the cut-off frequency) the wave will attenuate with increasing z. What is this frequency?

c) What is the phase speed in the $z-$direction?

d) Is the phase speed larger or smaller than the speed of light? Is there a contradiction with the theory of special relativity?

e) Assume that you like to feed the TE_{10} in the waveguide by a coaxial cable. You let the inner conductor of the coaxial cable extend straight into the waveguide. Where is it best to attach the coaxial cable? Give the value of (x, y).