Session 1

Exercise 1: Phase difference

Given are two coherent sources of microwaves with a wavelength 1.5 cm. The sources are positioned in the xy plane at locations $(x_1, y_1) = (0, 15)$ cm and $(x_2, y_2) = (3, 14)$ cm. The sources are in phase. Derive the phase difference of the two sources in the origin $(x_0, y_0) = (0, 0)$ in degrees and in radians.

Hints: Use vector geometry to get $(\triangle x, \triangle y)$ and then derive the phase difference.

Exercise 2: Transversality

Given an electromagnetic plane wave. Show that the vectors $\mathbf{B}$ and $\mathbf{k}$ are perpendicular.

Hints: Use the harmonic plane wave solution for an electromagnetic wave and the 4th Maxwell equation.

Exercise 3: Wave equation

Derive the vector wave equation in homogeneous, linear and isotropic, non-conducting and soucre-free medium from the Maxwell equations. Assume that no currents $\mathbf{J}$ are present.

Hints: Insert the rotation of one Maxwell equation into another and then use the vector identities $\nabla \times a\mathbf{x} = a\ (\nabla \times \mathbf{x}) + (grad\ a) \times \mathbf{x}$ and $\nabla \times \nabla \times \mathbf{x} = grad(\nabla \cdot \mathbf{x}) - \nabla^2\mathbf{x}$. Finally remove terms from the conditions given in the exercise.

Exercise 4: Three-dimensional partial differential vector wave equation

Show that a harmonic plane vector wave is a solution of the vector wave equation.

Hints: Insert the complex exponential equation shown in the course material into the partial differential vector wave equation.