Elektrodynamika 1 / Electrodynamics 1
Magister study, winter semester 2020-2021, 2+0
Fields of Study: Photonics, Laser physics and technology
Lecturer: Prof. Ing. Jiří Čtyroký, DrSc, ctyroky@ufe.cz

Syllabus

1. Electromagnetic field in a homogeneous medium. Macroscopic Maxwell equations, vector and scalar potential, Hertz vectors. General time-varying fields in a medium with sources. Time harmonic fields, complex formalism. Time harmonic electromagnetic field in a medium without sources – number of independent quantities.

2. Gauss and Stokes laws, physical meaning of the operators of divergence and rotor (curl). "Physical derivation of differential operators in curvilinear orthogonal systems of coordinates. Cylindrical and spherical coordinates.

3. Plane electromagnetic waves. Uniform and non-uniform plane waves, plane waves with a complex wave vector, their properties in lossless and lossy media.

4. Cylindrical waves. Solution of a homogeneous scalar Helmholtz equation in cylindrical coordinates. Cylindrical functions (Bessel, Neumann, Hankel functions, modified Bessel functions). Hertz vectors and cylindrical electromagnetic waves.

5. Spherical waves. Solution of a homogeneous scalar Helmholtz equation in spherical coordinates. Legendre polynomials and associated Legendre functions, spherical harmonics. Spherical Bessel functions. Spherical electromagnetic waves.

6. Field of a point source, Laplace equation, scalar Green's function. Radiation of electromagnetic field from time-harmonic sources. Tensor Green's function General time dependence – retarded potentials, their limitation.

7. Electromagnetic field of time-harmonic elementary electric and magnetic dipole.

8. General character of electromagnetic field radiated from a general distribution of time-harmonic sources in the far-field zone.

9. Multipole expansion of a far-field. Electric and magnetic multipoles, their physical interpretation. Electric and magnetic dipole, electric quadrupole of distributed sources, their definitions and radiation diagrams.

Recommended literature:

[1] R. A. Stratton, Teorie elektromagnetického pole. 1961, Praha: SNTL (Electromagnetic Theory, McGraw-Hill, 1941).
[2] R. E. Collin, Field theory of guided waves. second ed. 1991, New York: IEEE Press.
[3] Bo Thidé, Electromagnetic field theory, Second edition. 2009, Uppsala, Sweden.
[4] J. D. Jackson, Classical Electrodynamics, John Wiley, New York 1962
[5] G. Crabbe: Classical multipole theory, www.oup.com/pdf/13/9780198567271.pdf
[6] J. Wheeler, http://www.physics.usu.edu/Wheeler/EM/EMMultipoleRadiation.pdf
Presentations at www.ufe.cz/cs/fjfi, Section Elektrodynamika 1

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