ENG EC 565: Electromagnetic Fundamentals

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Time and Location: Tuesdays and Thursdays, 1:30 to 3:15 pm, PHO 404/428

EC 565 is an advanced course dealing with the propagation of electromagnetic (EM) waves in different types of optical media. It uses Maxwell's equations as a starting point and retains the vector nature of the electromagnetic field throughout the semester. Lectures and problem sets cover the following topics.

Maxwell's Equations: Historical introduction, permittivity, permeability, and refractive index, energy, power, and momentum of EM fields, boundary conditions, Lorentz and Drude models, Kramers-Kronig relations, phase and group velocities

Simple Solutions: EM waves in dispersive media, Fourier method for solving the Helmholtz equation, plane waves and their properties, state of polarization, negative-index media,

Dispersive media: Pulse propagation in dispersive media, chromatic dispersion, broadening of Gaussian pulses, slow and fast light, front velocity and causality, exact impulse response

Anisotropic Media: Uniaxial and biaxial crystals, linear and circular birefringence, optically active chiral media, gyroelectric and gyromagnetic media, Faraday rotation and optical isolators, linear and circular dichroism, plane-wave propagation in birefringent media.

Dielectric Interfaces: Reflection and refraction at a dielectric interface, propagation matrix, single dielectric slab, antireflection coatings, Fresnel reflection coefficients, Critical angle and Brewster angle, total internal reflection

Multilayer Structures: Multiple dielectric slabs, thin-film stacks, Bragg Mirrors, photonic band gaps, surface waves, surface plasmon resonance, negative-index media, birefringent media.

Waveguides: TEM, TE and TM modes, hollow metallic waveguides, dielectric slab waveguides.

Radiation and Scattering: Scalar and vector potentials, gauge transformation, Green's function, radiation from electric and magnetic dipoles, extinction theorem

Antenna theory: Directivity and gain, transmitting and receiving antennas, Hertzian dipole, half-wave and quarter-wave antennas, loop antennas.

Course Textbook: S. J. Orfanidis, *Electromagnetic Waves and Antennas*, free e-book available at http://eceweb1.rutgers.edu/~orfanidi/ewa/

Reference books: C. A. Balanis, *Advanced Engineering Electromagnetics*, Wiley 2012;
J. D. Jackson, *Classical Electrodynamics*, 3rd ed., Wiley, 1999.

Grading Scheme: Homework 30%, Midterm Exam 30%, Final Exam or Project 40%