EC 565: Introduction to Electromagnetics and Photonics

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Course information, handouts, homework assignments, etc. available at https://learn.bu.edu/ (access available for students registered for credit or audit)

Background & Content: EC 565 is mezzanine level course for advanced undergraduate and starting graduate students intending to familiarize the student with fundamental concepts in electromagnetics and photonics that govern the generation, propagation and reception of fields and waves in the optical and radio-frequency domains. There will be a strong emphasis in connecting covered theoretical concepts to current and emerging applications and technologies.

Prerequisites: Electricity and Magnetism; Vector Calculus; Fourier Analysis (co-req.).

Topics to be covered:

- Maxwell's Equations: 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.
- Propagation in Space: 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 & Multilayers: Reflection & refraction at interfaces, propagation matrix, Fresnel coefficients, critical angle and Brewster's angle, total internal reflection, thin-film stacks, Bragg Mirrors, photonic bandgaps, surface waves, surface plasmon resonances.
- Waveguides: TEM, TE, TM & Hybrid – HE & EH modes, hollow metallic waveguides, dielectric slab waveguides, fibers and nanowires.
- Radiation and Scattering & Antennas: Scalar and vector potentials, gauge transformation, Green's functions, radiation from electric and magnetic dipoles, extinction theorem, EM Wave Transmission using antennas, applications of antennas.
- Radiation from Apertures (time, interest permitting): Diffraction of EM Fields from apertures, field equivalence principle, Huygens' diffraction from apertures, vector diffraction theory.

Textbook and References:

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

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

Homework & Exams:

Two exams. Homeworks will uploaded every ~2 weeks, and solutions will be posted ~2 weeks thereafter. *They will not be graded*, and they exist primarily for your self-assessment, learning & preparation (for exams!).

Grading Policy: 10% Class participation; 45% mid-term exam; 45% final exam