PEP 509 Intermediate Waves and Optics
Spring 2018

Meeting Times:	Thursday 3:00-5:30PM
Classroom Location:	McLean 218A
Instructor:	Dr. Rupak Chatterjee
Contact Info:	Burchard 709 (or Babbio 545), rchatte1@stevens.edu, 201-216-3393
Office Hours:	Thursdays 1:00-3:00PM
Prerequisite(s):	Basic Knowledge of Optics, Electromagnetism, and ODEs

COURSE DESCRIPTION

This course will provide a solid theoretical and conceptual foundation for modern classical optics. The course begins with electromagnetic wave propagation starting from the simplest approximation, ray optics, where the foundational aspects are derived through Fermat's Variational principle and short wave asymptotics (the Eikonal equation). Wave aspects are introduced beginning with the scalar version of the wave equation, leading to Wave ('physical'), Beam, and Fourier optics. The fully dual vector field theory of electromagnetic optics is also explored. The course ends with: i) the LIGO (Laser Interferometer Gravitational-Wave Observatory) gravitational wave experiment, which was recently awarded the 2017 Nobel prize in physics, and ii) A brief taste of Quantum Optics

LEARNING OBJECTIVES

- Wave Equations-Scalar, Vector, Dispersion Relations, Phase and Group Velocity,
- Geometric Optics (Ray Optics)-Fermat's Variational Principle, Eikonal Equation, Matrix Optics
- Scalar Wave Phenomena (Physical Optics)-Interference, Diffraction, Gaussian Beams, Fourier Optics
- Vector Wave Phenomena (Full Electromagnetic Optics)-Plane, Spherical, and Gaussian EM Waves, Absorption and Dispersion, Polarization, Fresnel Equations for Reflection and Transmission
- LIGO (Laser Interferometer Gravitational-Wave Observatory -Gravitational Wave Detection)
- Introduction to Quantum Optics

COURSE MATERIALS

Textbook:

Optics, E. Hecht, 5th Edition, Pearson, 2017

Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, Wiley Series in Pure and Applied Optics, 2007.

Other Readings:

Principles of Optics, 7th *(corrected) Edition,* Max Born & Emil Wolf, Cambridge University Press, 2002.

Modern Classical Physics, Kip Thorne & Roger Blandford, Princeton University Press, 2017.

GRADING PROCEDURES

Homework	(60 %)
Take Home Final Exam or Project (presentation and paper)	(40 %)

Tentative Weekly Schedule

Week Starting		Readings	Hwks
January 18th		***Propagation of Light Overview*** (Parts of Hecht Ch 2 & 4) -Ray, Wave, EM, & Quantum Optics approaches -Plane Waves -Transmission, Reflection, Refraction	
January 25th		***Electromagnetic Fields and Wave Equation Review*** **Hecht Ch 3** -Maxwell Equations -EM Wave Equation	**Hwk 1: Hecht** **2.3,** **2.5,** **2.49,** **2.56,** **3.5,** **3.6,** **3.9,** **3.11,** **3.12**
February 1st		***Electromagnetic Waves*** **Hecht Ch 3 & 4** -Polarization -Snell's Law from EM Waves -Poynting Vector -Spherical Waves	
February 8th		***Electromagnetic Waves*** **Hecht Ch 3 & 4** -Scalar and Vector Potentials -Gauge Transformations -Retarded Potentials -Rayleigh Scattering (blue sky)	**Hwk 2: Hecht** **3.15,** **3.16,** **3.18,** **3.21,** **4.2,** **4.39**

February 15th		***Foundations of Geometric Optics*** **Saleh & Teich Ch 1** -Postulates of Ray Optics: Ray Equation -Optical Path Length -Fiber Optics -Matrix Optics	**Hwk 3:** **Saleh-Teich** **Ex 1.1-1,** **1.2-1,** **1.2-6,** **1.3-1,** **1.3-2,** **1.4-4,** **1.4-5**
February 22nd		***Scalar Wave Phenomena-Wave Optics*** **Saleh & Teich Ch 2** -Postulates of Wave Optics -Helmholtz Equation -Paraboloidal and Spherical Waves -Gaussian Beams -Eikonal Equation	**Hwk 4:** **Saleh-Teich** **2.2-1,** **2.2-2,** **Derive eqn 2.3-2**
March 1st		***Scalar Wave Phenomena- Superposition of Waves*** **Saleh & Teich Ch 2, Hecht Chp 7** -Interference -Plane + Spherical -Spherical + Spherical -Bragg Diffraction -Interferometer	
March 8th		***Midsemester REVIEW*** -Hwk 3 reveiw -Ray, Scalar, EM -Final Paper Abstract Discussions	
March 22nd		***Scalar Wave Phenomena- Fourier Optics***	**Hwk 5:**

		Saleh & Teich Ch 4, Appendix A & B, Hecht Chp 7 & 11 -Spectral Analysis -Fourier Series -Fourier Transform	**Hecht** **7.47,** **11.2,** **11.6,** **11.7**
March 29th		***Scalar Wave Phenomena-Diffraction*** **Saleh & Teich Ch 4, Appendix A & B** -Forced Damped Harmonic Oscillator-Fourier Transform Solution -Stationary Phase Approximation -Fraunhofer Diffraction Fourier Transform using a Lens	**Hwk 6:** **Saleh-Teich** **4.1-2,** **4.3-1,** **4.3-2,** **4.3-3,** **4.4-7a)**
April 5th		***Scalar Wave Phenomena- Diffraction*** **Saleh & Teich Ch 4, Appendix A & B** -Forced Damped Harmonic Oscillator-Green's Function Solution -Kirchhoff Diffraction Formula -Fresnel Diffraction	**Hwk 7:** **1) Derive I(x,y) in terms of Fresnel integrals for a rectangular aperture** **2)Fresnel formula for Gaussian Aperture Saleh 4.31-7**
April 12th		**LIGO (Laser Interferometer Gravitational-Wave Observatory)** ***Intro to Quantum Optics*** -Postulates of QM -Harmonic Oscillator	
April 19th		***Intro to Quantum Optics*** -Coherent States -Quantum EM Fields ***5 minute Presentation Practice***	
April 26th		***Final Presentations/Paper or Take-Home Final***	

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. Student Counseling and Disability Services works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, and psychiatric disorders in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from SCDS staff. The SCDS staff will facilitate the provision of accommodations on a case-by-case basis. These academic accommodations are provided at no cost to the student.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the office of Student Counseling, Psychological & Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/sit/counseling/disability-services. If you have any questions please contact:

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Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in education and innovation. Our community represents a rich variety of backgrounds, experiences, demographics and

perspectives and Stevens is committed to fostering a learning environment where every individual is respected and engaged. To facilitate a dynamic and inclusive educational experience, we ask all members of the community to:

- be open to the perspectives of others
- appreciate the uniqueness their colleagues
- take advantage of the opportunity to learn from each other
- exchange experiences, values and beliefs
- communicate in a respectful manner
- be aware of individuals who are marginalized and involve them
- keep confidential discussions private