

1. ECE 517 (ECE 581B7): Advanced Optical Imaging
2. 3 credits: 3-50 minute lecture sessions/week
3. Randy Bartels
4. Advanced Optical Imaging Theory. Gu, M. 2000.
5. Course Information
 - a. Engineering design principles of advanced optical imaging techniques and image formation theory
 - b. Prerequisites: ECE 342 or MATH340 or MATH345
 - c. Selected Elective: Electrical Engineering; Computer Engineering; Lasers and Optics Engineering
6. Goals for the Course
 - a. Course Learning Objectives
 - i. Analyze and design high resolution optical imaging systems used in advanced optical imaging systems
 - ii. Examine the fundamentals of optical light scattering and understand the role in image formation
 - iii. Analyze and design high resolution optical imaging systems that capture object information from optical scattering
 - iv. Evaluate, analyze and design optical tomographic imaging systems
 - v. Evaluate, analyze and design single pixel imaging systems
 - vi. Evaluate, analyze and design computational imaging systems
 - b. Student Outcomes
 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
 3. An ability to communicate effectively with a range of audiences
 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. Topics Covered
 - Motivation for optical imaging and open challenges
 - Foundation for light-matter interactions used to form optical images
 - Light propagation and scattering
 - Scattering theory formulation
 - Greens functions for light propagation and dipole scattering
 - Single particle scattering
 - Coherence theory of light applied to optical imaging
 - Introduction to random optical fields
 - Partial optical coherence theory
 - Image formation theory
 - Optical imaging theory with coherent light
 - Optical imaging theory with incoherent light

Image formation with high numerical aperture optical systems
Imaging with coherent light scattering
Holographic imaging
Computed tomography
Optical diffraction imaging
Optical Coherent Tomography (OCT) and Low Coherence Interference (LCI) imaging
Phase contrast imaging
Speckly imaging
Single pixel imaging
Confocal microscopy
Structured light single pixel imaging
Super-resolution imaging
Phase retrieval and ptychography
Analysis of aberrations in imaging systems