Department	Electrical and Computer Engineering
Course Number	**EELE 481**
Course Title	Optical Design
Total Credit Hours and Format	3 Credits. (3 Lec) S alternate years
Catalog Description	PREREQUISITE: EELE 482 or PHSX 327 Optical design using geometric optics and computer ray-tracing software. Introduces ray and wave front aberrations, control of aberrations in optical systems, designing for system requirements, and analytic tools including the moducation transfer function.
Faculty Coordinator	Joe Shaw
Course Designation	Elective
Textbook	Introduction to lens design with practical Zemax examples, J. M. Geary, 2002; Zemax Optics Studio optical design code
Course Learning Outcomes	At the conclusion of EELE 481, students are expected to be able to: 1) Use geometric optics for first-order layout of an optical system; 2) Calculate the locations of focal points, principal points, and nodal points in an optical system, and use these as parameters in the design of optical systems; 3) Calculate the locations and sizes of pupils and stops and understand their use in analyzing and designing optical systems; 4) Understand the meaning of 3rd-order ray and 4^{th}-order wave aberrations; 5) Use diagnostics such as spot diagrams, ray fans, and MTF curves to assess resolution and contrast in an optical image; 6) Use modern computer ray-trace codes to predict ray and wave aberrations in optical systems ranging from single lens elements to multiple-element lenses, telescopes, laser beam optics, etc; 7) Apply nonsequential ray tracing to analyze optical systems involving multiple reflections and beam splitting.
Program Outcomes	
Topics Covered	1. Optical surface shapes and conventions; paraxial ray tracing & y-nu ray trace method. 2. System parameters from ray tracing: marginal and chief rays, stops and pupils, optical invariant. 3. Wave-front and ray aberration theory. 4. Automated optimization of optical designs (solves, merit functions, Gaussian quadrature…).

	5. Interferometric testing of optical surfaces, components, and systems. 6. Calculating aberration coefficients from ray-trace data. 7. Lens shape & aberration balancing. 8. Use of symmetry to reduce off-axis aberrations; flattening curved wave fronts. 9. Chromatic variation of aberrations (sphero-chromatism; achromats, aplanats, apochromats…). 10. Optical Transfer Function and estimation of image contrast and resolution (Strehl ratio). 11. Optical effects of windows, field lenses, mirrors, and corrector plates. 12. Telescope design using spherical & aspherical mirrors. 13. The Hubble space telescope, its famous optical problems and how it was fixed. 14. Tolerancing of optical systems (determining sensitivities of a design to parameter changes). 15. Nonsequential ray tracing. 16. Design projects of your own choice.
Prepared by	Joe Shaw (04/29/2015)