EC400: Optics and Waves for Engineers

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Tentative Course Syllabus

28 lectures – 14 weeks course duration

0. Introduction

0.1. *Historical Perspective: Optics in Engineering*
0.2. *Rays vs Waves*
0.3. *From Waves to Fields*
0.4. *Essential vector calculus for the optical engineer*

1. Engineering ray trajectories

1.1. *Introduction to geometrical optics*
1.2. *Vision and perspective drawing*
1.3. *Fermat's principle and ray paths*
1.4. *Variational formulation and the ray equation*
1.5. *Ray tracing: matrix approach*
1.6. *The paraxial ray equation with applications to atmospheric refraction, graded-index optical components, satellite communications, submarine communications.*
1.7. *Optical components: lenses, stops, mirrors, prisms, focal imaging and pinhole cameras*
1.8. *Fundamental imaging considerations: field of view, resolution, depth of focus*

2. Optical waves

2.1. *The description of periodic wave phenomena*
2.2. *Harmonic waves and their analysis: the complex representation of waves*
2.3. *Harmonic oscillators and wave coupling*
2.4. *Spring-mass models: waves in harmonic chains*
2.5. *The wave equation and its solutions*
2.6. *Localized waves, pulses and polychromatic light*
2.7. *Speckles patterns in optical engineering*
2.8. *Engineering applications to vision, the microscope, telescopes, and cameras*

3. Optical interference and applications

3.1. *Interference in various contexts: dielectric films, Fizeau fringes, Newton's rings, double mirrors, double prisms.*
3.2. *The Huygens-Fresnel Principle and Kirchhoff's Scalar Diffraction*
3.3. *Diffraction gratings: elementary approach and applications*
3.4. *Spatial and temporal coherence: the van Cittert-Zernike theorem*
3.5. *Analysis of interferometers: Michelson, Twyman-Green, Mach-Zehnder, Fabry-Perot*
3.6. *Rotating interferometers, stellar interferometers, correlation interferometers*
3.7. *Engineering applications of modern interferometry*

4. Polarization and light scattering

4.1. *Intro to Maxwell's equations and vector waves*
4.2. *The nature of polarized waves, Stokes and Jones vectors*
4.3. *Polarizing optical components and Muller matrices*
4.4. *Birefringence and wave retarders*
4.5. *Rayleigh scattering, radiation and polarization*
4.6. *Fresnel reflection equations, stratified media*

Textbook
Optics, 4th edition Eugene Hecht, (Addison-Wesley, 2002)

Notes prepared by the instructor will also be distributed.
Programming examples and projects will be assigned

Other references
Optics. Learning by Computing, with Examples Using Mathcad, Matlab, Mathematica, and Maple, by K. D. Möller (Springer, 2nd Ed. 2007)

Prerequisites: CAS MA 123/124 (Calculus I/II), **CAS MA 225** (Multivariate Calculus), **CAS PY212** (Physics II), Linear Algebra, **ENG EK 127/128** (Engineering Computation), **ENG EK 102/CAS MA 142** (Intro linear algebra)