Fundamentals of Imaging Science

This course is designed for forty-three (43) 85-minute class sessions. Number of class sessions dedicated to each topic in the course outline is indicated in parentheses. These numbers include classroom lectures, laboratory experiences, field trips, and quizzes. Students should have a mastery of algebra, trigonometry, and matrix algebra. Assessment will be based on homework, quiz scores, lab reports, and final project.

I. Introduction/Overview (1 class/1 hr 25 min)

“History of Imaging” prepared by faculty at Center for Imaging Science at RIT

II. Observables (7 classes/9 hrs 55 min)

Topics covered in “Seeing the Light” (not in this order):

Chapter 1 – Fundamental Properties of Light

1.1 What is light?
1.2 Waves and their properties
1.3 Numbers associated with periodic waves
1.4 Electromagnetic radiation

Chapter 2 – Principles of Geometrical Optics

2.3 Reflection
2.4 Reflection at oblique incidence
2.5 Refraction
2.6 Dispersion

Chapter 12 – Wave Optics

12.2 Interference (sects A & B)
12.5 Diffraction

Chapter 13 – Scattering and Polarization

13.2 Scattering
13.3 – 13.5 Polarization

Chapter 15 – Light in Modern Physics

15.3 Atomic spectra

Appendix B – Mathematical form of Snell’s Law
Topics not covered in “Seeing the Light”:

- Aspects of interaction between light and matter not mentioned above (e.g. absorption)
- Radiometry fundamentals
- Non-electromagnetic observables

III. Visual Perception (7 classes/9 hrs 55 min)

Topics covered in “Seeing the Light” (not in this order):

Chapter 5 – The Human Eye and Vision I: Producing the Image

  5.1 Introduction
  5.2 Eye and camera
  5.3 The retina

Chapter 7 – The Human Eye and Vision II: Processing the Image

  7.1 Introduction
  7.2 Overview of the human visual system
  7.3 Elementary lightness perception
  7.4 Retinal processing I: Lateral inhibition
  7.5 Retinal processing II: Negative afterimages
  7.6 Eye movements
  7.7 Temporal response
  7.8 Channels: Spatial frequency and tilt

Chapter 8 – Binocular Vision and the Perception of Depth

  8.1 Introduction
  8.2 Accommodation
  8.3 Convergence
  8.4 Parallax
  8.5 Binocular disparity
  8.6 Three dimensions vs. two dimensions

Chapter 10 – Color Perception Mechanisms

  10.1 Introduction
  10.2 Trichromacy of color vision
  10.3 Color mixing and matching
  10.4 Opponent processing
  10.5 Color deficiency
10.6 Spatial processing of color
10.7 Temporal processing
10.8 Contingent aftereffects and memory

IV. Capturing Observables (7 classes/9 hrs 55 min)

Topics covered in “Seeing the Light” (not in this order):

Chapter 2 – Principles of Geometrical Optics

2.2 B Pinhole camera

Chapter 3 – Mirrors and Lenses

3.1 Introduction
3.2 Virtual images
3.3 Spherical mirrors
3.4 Spherical lenses
3.5 Aberrations

Chapter 4 – The Camera and Photography

4.1 Introduction
4.2 A Depth of focus, depth of field
4.3 Effect of focal length
4.4 Camera lenses
4.5 Devices to control light
4.6 Exposure
4.7 Film

Chapter 11 – Color Photography

11.1 Introduction
11.2 Principles of color photography
11.3 Additive color film
11.4 Subtractive color film

Appendix D – The mirror equation

Appendix E – The lens equation

Appendix F – Two thin lenses touching

Topics not covered in “Seeing the Light”:

- Electronic (digital) detectors
V. Digital Image Processing (7 classes/9 hrs 55 min)

Topics NOT covered in “Seeing the Light” (not in this order):

- The mathematics of imaging
- Pixelated images
- Image processing tools
- Resolution
- Compression
- Look-up tables
- Histograms
- Density plots
- Image manipulation
- Image addition and subtraction

VI. Image Display and Microstructure (7 classes/9 hrs 55 min)

Topics covered in “Seeing the Light” (not in this order):

Chapter 9 – Color

  9.1 Introduction
  9.2 Color vs. wavelength, and nonspectral colors
  9.3 Intensity-distribution curve, and classification of colors
  9.4 Color mixing by addition
  9.5 Ways of mixing colors by addition
  9.6 Color mixing by subtraction
  9.7 Dependence of subtractive color on the light source
  9.8 Water colors and printer’s ink
  9.9 Pigments, paints, and paintings

Topics not covered in “Seeing the Light”:

- Additive display systems

VII. Imaging Systems and Their Applications (7 classes/9 hrs 55 min)