PHYS-1300: PHYSICS OF OPTICAL MATERIALS

Cuyahoga Community College

Viewing: PHYS-1300 : Physics of Optical Materials

Board of Trustees:
May 2021

Academic Term:
Fall 2024

Subject Code
PHYS - Physics

Course Number:
1300

Title:
Physics of Optical Materials

Catalog Description:
Study the properties of materials related to opticianry including structure, density, conductivity, and effects of mechanical forces on materials. Special emphasis given to the nature and theory of light and its application to ophthalmic optics. Demonstrations of optical bench, blackboard optics, and other instruments used to facilitate understanding of how light functions.

Credit Hour(s):
4

Lecture Hour(s):
3

Lab Hour(s):
3

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
MATH-1190 Algebraic and Quantitative Reasoning or higher.

Outcomes

Course Outcome(s):
Apply fundamental knowledge of geometric optics to didactic and clinical experiences in ophthalmic professions.

Essential Learning Outcome Mapping:
Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):
1. Describe the optics and characteristics of ophthalmic lenses.
2. Describe aberrations produced by ophthalmic lenses.
3. Explain the physics of everyday optical phenomena.
4. Describe how ophthalmic lenses are designed; include an index of refraction, nu value, lens curves, and internal reflection in the calculation.

Course Outcome(s):
Apply fundamental knowledge of optics to attain professional credentials

Objective(s):

1. Explain the theories and physics of light.
2. Describe reflection and refraction of light by lenses and mirrors.
3. Define and describe diffraction, interference, and polarization of light.

Course Outcome(s):

Discuss the optical properties of different ophthalmic lens materials and treatments.

Essential Learning Outcome Mapping:

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Determine the index of refraction and describe its importance in ophthalmic lens design.
2. Discuss the specific gravity of ophthalmic lens materials.
3. Identify the Abbe value for all ophthalmic lens materials.
4. Describe how light moves through the ophthalmic lenses.

Methods of Evaluation:

1. Quizzes
2. Homework assignments
3. Laboratory Exercises
4. Group work

Course Content Outline:

1. History of Optics
2. Basic Trigonometry
    a. Right Triangle
        i. Angles
            1. Interior angles
            2. Right angle
        ii. Sides
            1. Adjacent
            2. Opposite
            3. Hypotenuse
        iii. Pythagorean theorem
    b. Trigonometric functions
        i. Sine
        ii. Cosine
        iii. Tangent
        iv. Cosecant
        v. Secant
        vi. Cotangent
3. Light
    a. Corpuscular Theory
    b. Electromagnetic Theory
        i. Electromagnetic spectrum
            1. Ultraviolet light
            2. Visible light
            3. Infrared light
    c. ABBE number (nu value)
    d. Reflection

        i. Mirrors
            1. Plane
            2. Convex
            3. Concave
        ii. Specular reflection
        iii. Diffuse reflection
        iv. Internal reflection
    e. Refraction
        i. Snell's Law
        ii. Index of refraction
        iii. Refractive media of the human eye
    f. Dispersion
    g. Diffraction
    h. Polarization
    i. Interference
        i. Constructive interference
        ii. Destructive interference
        iii. Double-slit experiment
    j. Color
        i. Hue
        ii. Tint
        iii. Shade
        iv. Saturation
        v. Contrast
        vi. Color Models
            1. Subtractive
                a. Cyan, Magenta, Yellow and Black
                b. Red, Yellow and Blue
            2. Additive
                a. Red, Green, and Blue
                b. Hue, Saturation, and Luminescence
4. Light Sources
    a. Candle
    b. Sun
    c. Modern artificial light sources
    d. Mobile devices
5. Ophthalmic Lenses
    a. Prisms
        i. Definition
        ii. Properties
        iii. Power (diopters)
        iv. Prism alignment in ophthalmic lenses
            1. Concave lenses
            2. Convex lenses
        v. Focal length
    b. Index of refraction
        i. Determining the refractive index of ophthalmic lenses
        ii. Impact of the index of refraction on ophthalmic lens design
    c. Treatments
        i. Anti-reflective coatings
            1. Function
            2. Design
            3. Birefringence
        ii. Mirrored lenses
        iii. Polarized lenses
        iv. Tint
            1. Absorption
            2. Transmission

   v. Photochromic
   vi. Roll and polish
  d. Lensmaker's formula
  e. Ophthalmic lens aberrations
   i. Spherical aberration
   ii. Chromatic aberration
   iii. COMA
   iv. Marginal astigmatism
   v. Distortion
   vi. Curvature of field
  f. Optics of thick lenses
  g. Optics of contact lens design
  h. Optical illusions
  i. Color perception
  j. Blue light and circadian rhythm
  k. Contrast sensitivity
  l. Optical impact of acquired color vision disorders
6. Why optics matter in modern ophthalmic lens design
  a. Matching the optics of an ophthalmic lens to the visual needs of a patient
  b. Analyzing the optical properties of emerging ophthalmic technologies

Resources

Brooks, Clifford W., and Irvin M. Borish. *System for Ophthalmic Dispensing*. 3rd ed. Boston: Butterworth-Heinenmann, 2006.

Freeland, Fergus. *Elementary Ophthalmic Optics*. Reprint. Forgotten Books, 2019.

National Academy of Opticianry. *Spectacle Exam Review Book*. National Academy of Opticianry, 2020.

Stein, Harold et al. *The Ophthalmic Assistant: A Text for Allied and Associated Ophthalmic Personnel*. 10th ed. Elsevier, 2017.

Resources Other

1. http://www.ecpuniversity.com/ (Password provided by department)
2. Mattison-Shupnick, Mark. 20/20 Magazine.*Our Eyes Weren't Made for Screens*. New York, NY: Jobson , 1 26. November 2017. (moved from Resources section)
3. Santini, Barry. "2017, 11 30"*The Science Behind Color*. 11 30. 20/20 Magazine, December. 2017. (moved from Resources section)

Professional Journals:

1. ***20/20.*** https://www.2020mag.com/
2. ***Eyecare Business.*** https://www.eyecarebusiness.com/
3. ***opt Magazine.*** http://www.optmagazine.com/
4. ***Vision Care Product News.*** https://www.visioncareproducts.com/

Online Coursework:

Exploring Light: Hands-on Activities and Strategies for Teachers Exploratorium. https://www.coursera.org/learn/teach-light-color/home/welcome (https://www.coursera.org/learn/teach-light-color/home/welcome/)

Khan Academy. https://www.khanacademy.org/

Quantum Optical. http://www.quantumoptical.com/

Visual Perception and the Brain Duke University. https://www.coursera.org/learn/visual-perception (https://www.coursera.org/learn/visual-perception/)

Additional Resources

1. **Colblindor Farnsworth-Munsell 100 HueColor Vision Test.** http://www.color-blindness.com/farnsworth-munsell-100-hue-color-vision-test/
2. **eyetec.net.** https://eyetec.net/

3. **Laramy K Opticianworks.** https://opticianworks.com/
4. ***The Physics of Light and Color*** Olympus. https://www.olympus-lifescience.com/en/microscope-resource/primer/lightandcolor/
5. **TED Talks: *Can You Believe Your Eyes* playlist.** https://www.ted.com/playlists/71/can_you_believe_your_eyes (https://www.ted.com/playlists/71/can_you_believe_your_eyes/)

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