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CURRICULUM PROPOSAL COVER SHEET

University-Wide Undergraduate Curriculum Committee

I. CONTACT

Contact Person: Dennis Whitson and W. Larry Freeman Phone 7-4593/4592

Department: Physics

II. PROPOSAL TYPE (Check All Appropriate Lines)

X **COURSE** Geometric Optics
Suggested 20 character title

X New Course* EOPT 110 Geometric Optics
Course Number and Full Title

___ Course Revision ___
Course Number and Full Title

___ Liberal Studies Approval + for new or existing course ___
Course Number and Full Title

___ Course Deletion ___
Course Number and Full Title

___ Number and/or Title Change ___
Old Number and/or Full Old Title

___
New Number and/or Full New Title

___ Course or Catalog Description Change ___
Course Number and Full Title

Rev.

PROGRAM: ___ Major ___ Minor ___ Track

___ New Program* ___
Program Name

___ Program Revision* ___
Program Name

___ Program Deletion* ___
Program Name

___ Title Change ___
Old Program Name

___
New Program Name

III. Approvals (signatures and date)

Kenneth E Hershman 11/16/00
Department Curriculum Committee

Richard D. Roberts 11/16/00
Department Chair

[signature] 01/12/01
College Curriculum Committee

John D. Eck 1/12/01
College Dean

+ Director of Liberal Studies (where applicable)

[signature] 1/15/01
*Provost (where applicable)

1993

Syllabus of Record for EOPT 110

I. Catalog Description

EOPT 110 Geometric Optics

2 lecture hours
3 lab hours
3 credits
(2c-3l-3sh)

Corequisite or Prerequisite: PHYS 100

Introduces the student to the principles and theory of light as a geometric ray and gives an elementary treatment of image formation. Topics include reflection, refraction, prisms, lenses, mirrors, pupils, stops, aberrations, optical instruments, aspherical surfaces, and optical system design and evaluation. This course includes a lab component.

II. Course Objectives

Upon successful completion of this course, the student will be able to:

1. Explain and discuss with a working vocabulary of terms applicable to optics, light as a ray and related optical devices. The vocabulary is designed to enable the technician to adequately deal with the literature in the field, and to facilitate rapid progress in certain specialized branches of knowledge necessary to understand the propagation, reflection, and refraction of a ray of light.
2. State the basic concept of light as a ray and understand the reflection and refraction of a ray of light.
3. Have an elementary knowledge of graphics construction and ray-tracing techniques.
4. Operate HeNe (Helium-Neon) lasers, optical power meters, and a variety of other optical devices in a safe manner.
5. Perform accurate measurements of the optical characteristics of several electro-optic systems.

III-A. Course Outline for Lectures (28 hrs)

A. Reflection at Plane Surfaces (1 hr).
   1. Law of Reflection and Diffuse and Specular Reflection.
   2. Image of an Extended Object in a Plane Mirror.

B. Reflection at Spherical Surfaces (2.5 hrs).
   1. Ray Tracing for Concave and Convex Mirrors.
   2. Relationship of Focal Length, Object Distance, Image Distance, Image Type, and Magnification for Mirrors.

C. Refraction at Plane Surfaces (2 hrs)
   1. Law of Refraction and Snell's Law:
   2. Total Internal Reflection (TIR).
   3. Refraction in a Prism.
   4. Color Dispersion.

D. Prisms (2.5 hrs).
   1. Types of Prisms and Terms Relevant to Prisms.
   2. Ray Tracing through Prisms.

E. Refraction at Spherical Surfaces (2 hrs)
   1. Concave and Convex Surfaces.
   2. Thick Lenses vs. Thin lenses.

F. Imaging with a Single Lens (3 hrs)
   1. Definition of a Thin Lens.
   2. Converging Lenses, Diverging Lenses, and Lens Types.
   3. Thin Lens Equation.
   4. Virtual and Real Images.
   5. Lensmaker's Equation.

G. Imaging with Multiple Lenses (2.5 hrs)
   1. Graphical and Analytical Solutions for Multiple lenses.

H. Optical Systems (3 hrs)
   1. The Simple Magnifier.
   2. Compound Microscope.
   3. The Astronomical Telescope.
   4. The Reflecting Telescope.
   5. Catadioptric Systems (i.e. those with both mirrors and lenses).
   6. Binoculars.
   7. Cameras.

I. Aspherical Surfaces (1.5 hrs)

J. Lens Aberrations (1.5 hrs)
   1. Spherical Aberration, Chromatic Aberration, and other aberrations.
   2. Anti-Reflective Coatings.
   3. Effects of Aberrations in a Camera.

K. Optical Component Fabrication (cutting, grinding, and polishing) (2.5 hrs)

L. F-Stops and Apertures (2 hrs)
   1. Field Stop, Aperture Stop, and Entrance and Exit Pupils.
   2. The Chief Ray.

Testing (2 hrs)

III-B. Course Outline for Labs (14 labs, 3 hours per lab)

A. Introduction (1 lab)
  1. Lab Safety
  2. Lab Practice
  3. Technical Writing
     a. Notebooks
     b. Lab Reports
  4. Rules and Regulations

B. Reflection at Plane Surfaces (1 lab)
  1. Laser Safety
  2. Experimentally verify the law of reflection by performing experiments in which laser light is incident upon plane and spherical surfaces.
  3. Measure the image formed using a pin-hole camera.

C. Reflection at Spherical Surfaces (1 lab)
  1. Using two lasers make an approximate measurement of the focal length of the concave mirror and estimate the focal length of the convex mirror.
  2. Qualitatively verify the connection between object distance, focal length, and image size for both the concave and the convex mirrors.
  3. For the concave mirror use the change of type (real or virtual) of image to measure its focal length.

D. Refraction at Plane Surfaces (1 lab)
  1. Operate a HeNe (Helium Neon) laser and perform these tasks:
     a. Set up and illustrate the law of refraction.
     b. Measure the index of refraction of a piece of plastic.
  2. With appropriate equipment as provided and for a given light ray incident in air upon a plane surface of some optical material with refractive index, n, determine the following:
     a. Angle of refraction of the given light ray, analytically, from Snell's law.
     b. Angle of refraction of the given light ray, experimentally, using a laser and plane refracting surface to simulate the conditions identical to those in a.

E. Prisms (1 lab)
  1. Using a prism examine color dispersion.
  2. Using two prisms investigate the relationship among the index of refraction, the apex angle, and the minimum deviation angle.
  3. Using a F-source aperture determine what happens to the orientation of the image as the rays of light are passed through some prisms. Explain the results by tracing rays through each prism in appropriate sketches.

F. Refraction at Spherical Surfaces (1 lab)
  1. For a light ray incident in air upon a spherical surface of some optical material

with specified refractive index, n, and radius of curvature R, determine the following:
   a. Angle of refraction of the given light ray, analytically, from Snell's law.
   b. Angle of refraction of the given light ray, experimentally, using a laser and appropriate spherical refracting surface to simulate conditions similar to those in part a.
2. Repeat for two other surfaces.

G. Imaging with a Single Lens (1 lab)
1. Determine image location and size of an object placed before either a positive or a negative thin lens by each of the following methods:
   a. Graphical ray tracing.
   b. Mathematical.
   c. Experimental.
2. Repeat the above for additional lenses.

H. Imaging with Multiple Lenses (1.5 labs)
1. Given three lenses and the appropriate equipment, determine graphically, analytically, and experimentally the primary and secondary focal lengths of the lenses.
2. Given two converging lenses and the appropriate equipment, determine graphically, analytically, and experimentally the size and location of the image produced by the dual-lens system.
3. Given one converging lens and one diverging lens and the appropriate equipment, determine graphically, analytically, and experimentally the size and location of the image produced by the dual-lens system.
4. Compute and then measure the optical power of two lenses that are in contact with each other. Do this for two converging lenses and for converging and diverging lenses.

I. Optical Systems (2 labs)
1. Set up a simple astronomical telescope and a Galilean telescope. Observe the character of the image produced and measure the angular magnification for both telescopes.
2. Set up a terrestrial telescope and observe the character of the image produced.
3. Set up both Keplerian and Galilean laser collimators and measure the diameter of the expanded beam, comparing it to the calculated value.
4. Set up a compound microscope and determine its overall magnification.

J. Aspherical Surfaces (0.5 labs)
1. Measure the Focal length for Two Different Aspherical Surfaces

K. Lens Aberrations (1 lab)
1. Using the optical bench, the lamp, convex lens, lens stop, and ground glass screen investigate the aberration due to the spherical shape of the lens.
2. Investigate the chromatic aberration of two different lenses.

screen investigate the aberration due to the spherical shape of the lens.
2. Investigate the chromatic aberration of two different lenses.
3. Investigate astigmatism of a lens.

L. F-Stops and Apertures (1 lab)
   1. Determine graphically, analytically, and experimentally the exit pupil, entrance pupil, and aperture stop for two lenses with a stop placed between them.

M. Lab Practical: Students will be required to take and analyze some data from set-ups that are similar to those they worked with during the semester. (1 lab)

IV. Evaluation Methods

The final grade for the course will be determined as follows:

50%	Tests. Three tests (two during the semester and the final) consisting of solving word problems and writing short essays.
35%	Laboratory assignments
7.5%	Quizzes in the lecture on the textbook assignments
7.5%	Quizzes in the laboratory on the laboratory assignments

Grading Scale:
90-100% : A; 80-89% : B; 70-79%: C; 60-69% : D; below 60% F.

Attendance Policy: The attendance policy will conform to the University wide attendance criteria.

V. Required textbooks, supplemental books and readings

Textbook: *Geometric Optics (Modules 2-1 → 2-7) and Components (Module 6-7), Laser Electro-Optics Technology Series*, Center for Occupational Research and Development (CORD) Communications, 1987

Note: The publication date of the required textbook is 1987. In the area of Electro-Optics, while there are many texts written for the B.S., M.S., and Ph.D. level, there are very few textbooks that are written for Associate Degrees. The series written by CORD is one of few written at the proper level for the audience. The area of Geometric Optics has not changed very much over the last 50 years and a text written many years ago has essentially the same material as one written last week. This, of course, is not true for all areas of Electro-Optics.

Supplemental Readings:
1. Electro-Optics Industry journals: e.g., *Photonics Spectra, Laser Focus World,* and *Lasers and Optronics*
2. Electro-Optics Catalogs: e.g., *Newport, Melles Griot*, and *Edmond*
3. Handouts

VI. Special resource requirements

None

VII. Bibliography

Booth, K. and Hill, S., *The Essence of Optoelectronics (Essence of Engineering),* Pearson Ptr., 1998

Fowler, G., *Introduction to Modern Optics*, Dover, 1989

Jenkins, Francis A. and White, Harvey E., *Fundamentals of Optics, 4th Ed.*, McGraw Hill, New York, 1976

Lipson, H.; Tannhauser, D.; Lipson, S., *Optical Physics, 3rd Ed.*, Cambridge, 1995

Meyer-Arendt, Jurgen; *Introduction to Classical and Modern Optics, 4th Ed.*, Prentice Hall, Englewood Cliffs, New Jersey, 1995

Pedrotti, Leno, *Basic Geometrical Optics (Module 3), Fundamentals of Photonics (Course 1)*, STEP Project, Funded by NSF, 2000

Pedrotti and Pedrotti, *Introduction to Optics, 4th Ed.*, Prentice Hall, 1993.

The Photonics Design & Applications Handbook 45th Edition, Photonics Spectra, 1999

Smith, W., *Modern Optical Engineering*, McGraw Hill, 2000

Smith, W., *Practical Optical System Layout: and Use of Stock Lenses*, McGraw Hill, 1997

Course analysis Questionnaire
EOPT 110, Geometric Optics

Section A: Details of the Course

A1 This course (EOPT 110) is a requirement for the proposed degrees Associate in Applied Science in Electro-Optics (A.A.S.E.O.) and Associate in Science in Electro-Optics (A.S.E.O.). This course is not intended for inclusion in the Liberal Studies program.

A2 This course does not require changes in any other courses in the department. The Applied Physics program will have an additional track associated with the A.S.E.O. degree and this course will be part of that track.

A3 This course has not been offered on a trial basis at IUP.

A4 This course is not intended to be dual level.

A5 This course is not to be taken for variable credit.

A6 Similar courses are offered at these institutions:

1. Cincinnati Technical College; Cincinnati, Ohio
   LOT 6720 Geometrical and Wave Optics
2. Indian Hills Community College; Ottumwa, Iowa
   LE 254V Geometrical and Wave Optics
3. Monroe Community College; Rochester, New York
   OPT 131 Optical Elements and Ray Optics
4. Pueblo Community College; Pueblo, Colorado
   PHV 234 Geometric Optics
5. Springfield Technical Community College; Springfield, Massachusetts
   EL 330 Geometrical Optics
6. Texas State Technical College; Waco, Texas
   LET 205 Geometrical Optics II
7. Three Rivers Community / Technical College; Norwich, Connecticut
   PHY 140 Geometric Optics

A7 As far as is known, the contents or skills of this proposed course are not recommended or required by a professional society, accrediting authority, law or other external agency. The content and/or skills of this course cannot be incorporated into an existing course. Some of this material is taught in PHYS 112 and PHYS 132, but only a small portion of the material is covered in these classes. A significant fraction of this material is taught in PHYS 242 (Optics) but at a much higher level of mathematics, which would be inappropriate for the students in the Electro-Optics program.

Section B: Interdisciplinary Implications

B1 This course will be taught by one instructor.

B2 This course does not overlap with any course offered by any other department at the University.

B3 Seats will be available in this course for students in the School of Continuing Education.

Section C: Implementation

C1 The faculty resources are not adequate. In order to teach this course we need 0.208 FTE additional faculty. (For the source of this faculty resource see pg. 23 of "SSHE Requirements for New Programs".)

C2 Other Resources

a. Space
It is anticipated that a new building will be constructed at the North Pointe (Slate Lick) site before this program starts in the Fall of 2002. This building will house the Electro-Optics program. If the building is not ready by Fall of 2002 the program will be housed in the Electro-Optics Center (EOC) located in the West Hills.

b. Equipment
In order to implement this course, we will need approximately $45,000 for hardware and software about 6 months before classes start. The lead-time is necessary because of the time it takes to order and receive equipment; also the labs have to be tried out and the bugs worked out before classes start.

c. Laboratory Supplies and other Consumable Goods
About $2,000 approximately 6 months before classes start and about $2000 per year after that.

d. Library Materials
About $500 in years 0 and 1 and about $100 in the following years.

e. Travel Funds
None anticipated.

C3 No grant funds are associated with the maintenance of this course.

C4 This course will be offered once a year, usually in the Fall semester.

C5 One section of this course will be offered at a time.

C6 Twenty-four students will be accommodated in this course. The nature of the lab activities restricts enrollment to this number.

C7 There is no professional society that recommends enrollment limits or parameters for a course of this nature.

Section D: Miscellaneous

No additional information is necessary.