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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** Wave Optics
Suggested 20 character title

X New Course* EOPT 120 Wave 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

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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	Richard D. Roberts 11/16/00
Department Curriculum Committee	Department Chair
[signature] 1/12/01	[signature] 1/12/01
College Curriculum Committee	College Dean
	[signature] 1/15/01
+ Director of Liberal Studies (where applicable)	*Provost (where applicable)

1993

Syllabus of Record for EOPT 120

I. Catalog Description

EOPT 120 Wave Optics

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

Prerequisite: EOPT 110
Corequisite or Prerequisite: MATH 110 or MATH 121

This course is designed to provide the student with the basic knowledge of the wave nature of light. Topics include spectral characteristics of light, propagation of light, interference, diffraction, polarization, windows, filters, beam splitters, and gratings. This course includes a lab component.

II. Course Objectives

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

1. Describe the basic principle of the wave theory of light as it applies to the optical phenomena of interference, diffraction, and polarization.

2. Perform in a safe manner and use correctly the basics of handling delicate optical components and test equipment.

3. Explain wave optical effects in terms of applicable mathematical expressions.

4. Build and adjust experimental setups using optical components and lasers to produce the following:
   a. Interference of light waves involving superposition of waves, interference of two beams and interference of multiple reflections.
   b. Diffraction of light waves through a single aperture, a double slit and diffraction gratings.
   c. Polarization of light by reflection, dichroism, scattering, and birefringence.

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

A. Wave Nature of Light (2.5 hrs)
   1. Difference Between "Geometric Optics" and "Wave Optics."
   2. Correspondence between Huygen's' Principle (Wave Theory) and Geometric Optics (Ray Theory).
   3. Characteristics of Light.
   4. Energy Units in Electron Volts (eV), Joules (J) and Wave Numbers (n).

B. Propagation (2.5 hrs)
   1. Laser Propagation Through the Atmosphere.

2. Beam Irradiance, Absorption, Absorption Coefficient, Transmittance, and Optical Density.
3. Rayleigh Scatter, Mie Scatter, and Large Particle (Diffraction) Scatter.

C. Interference (3.5 hrs)
  1. Constructive and Destructive Interference.
  2. The Principle of Superposition and the Importance of Coherence in the Interference Process.
  3. Young's Double-Slit Experiment.
  4. Examples of the Principle of Interference.

D. Diffraction (3.5 hrs)
  1. The Difference in Results Predicted by Geometrical Optics with those Predicted by Diffraction for Light Passing through a Small Opening.
  2. Fraunhofer (Far-Field) and Fresnel (Near-Field) Diffraction.
  3. The Determination of the Wavelength of a Monochromatic Source using a Diffraction Grating.
  4. Limit of Resolution of an Optical Instrument and Rayleigh's Criterion for Determining it.
  5. "Diffraction-Limited" Optics
  6. The Fresnel Number for a Laser.

E. Polarization (3.5 hrs)
  1. Linear, Circular, and Elliptical Polarization of Light.
  2. Production of Polarized Light by Reflection, Refraction, Scattering, Selective Absorption, and Double Refraction.
  3. Polarizers and Analyzers and the Law of Malus.
  4. Quarter-Wave (Wavelength/4) and Half-Wave (Wavelength/2) Plates.
  5. Brewster's Angle and the Brewster Window in a HeNe Laser.

F. Windows (2 hrs)
  1. Conditions for the Production of Fresnel reflection.
  2. Absorption.
  3. Transmission Curves.
  4. Brewster's Angle and the Polarization of the Reflected Ray.

G. Filters and Beam Splitters (2 hrs)
  1. Absorption Coefficient of Materials.
  2. Transmission of Filters as a Function of Wavelength.
     a. Neutral Density Filters.
     b. Cutoff Filters.
     c. Band-Pass Filters.
  3. Beam Splitters

H. Gratings (2.5 hrs)
  1. Diffraction
  2. Transmission and Reflection Gratings

3. Resolving Power of a Grating
4. Blaze Angle
5. Efficiency

I. Holography (4 hrs)
1. Transmission hologram of a three-dimensional object.
2. Light beams that lead to the real and virtual images of the original object or scene.
3. The process by which light formation (amplitude and phase) from the object is originally stored in the hologram and the process by which this information is later retrieved during the reconstruction process.

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. Wave Nature of Light (0.5 lab)
1. Using Huygen's principle, determine the reflected and refracted plane wavefronts after an incident plane wave strikes an air-glass interface.

C. Propagation (1 lab)
1. Measure the transmittance of a laser beam through a given thickness of absorbing material and determine the absorption coefficient.
2. Observe and record scattering of well-defined laser beams in media containing both airborne and liquid-suspended particles.

D. Interference (2 labs)
1. Produce Interference Patterns using a Laser, a Converging Lens, and a Microscope Slide
2. Produce circular fringes on the wall using a mica sheet and a laser.
3. Produce thin film interference fringes with oil on water.
4. Set up and observe air wedge interference fringes.
5. Set up and observe Young's double-slit interference experiment.
6. Determine the surface flatness of a surface using interference patterns.

E. Diffraction (1.5 labs)
1. Experimentally produce the far-field diffraction pattern of a laser beam due to a single slit, double slit, grating, and pinhole. Measure the intensity distribution and compare with theory.

2. Measure the beam divergence and beam spot size for Fraunhofer diffraction through a circular pinhole.
3. Determine the wavelength of red light using a diffraction grating.

F. Polarization (1.5 labs)

1. Measure the Brewster's Angle of a Microscope Slide
2. Develop a method, using a plane glass surface and Brewster's law, for easy determination of the following:
    a. Direction of polarization of a linearly polarized laser beam.
    b. Plane of transmission of a specimen of H-type Polaroid.
3. Show the effect of double refraction on a beam of polarized light.
4. Make a simple quarter-wave plate out of household plastic and roughly "tune" the quarter-wave plate for HeNe laser light (633 nm).
5. Investigate the polarizing effects of the Polaroid sheets.
6. Investigate polarization by reflection.

G. Windows (1 lab)

1. Visually examine the optical surfaces of several different materials and evaluate their finish by observing the scattered light.
2. Use a microscope and grazing incidence illumination to examine two surfaces to determine the nature and severity of surface defects.
3. Use an expanding beam of coherent light to test some windows for their effect on the intensity pattern of that beam.
4. Evaluate the surface flatness of five windows, using interference fringes produced between them and a master flat.
5. Given two lenses determine which of the two has an antireflective coating.

H. Filters and Beam Splitters (1.5 labs)

1. Determine the transmittances of three combinations of neutral-density filters, and compare the experimental and calculated values of each.
2. Determine the transmittance of the spike filter at normal incidence.
3. Determine the effect of the angle of incidence on the transmittance of a spike filter.
4. Exponential Law of Absorption.
    a. Using a laser, a beam expander, a filter holder, some filters, and a power meter measure the power transmitted through different numbers (e.g. 1 → 6) of blue filters and repeat for red and green filters.
        i. From the plots of transmitted power vs. thickness calculate the absorption coefficient k for each of the color filters.
5. Set up and investigate a beam splitter.

I. Gratings (1 lab)

1. Using a HeNe laser, a transmission grating, and a screen measure the grating spacing and resolving power.
2. Using light sources other than the HeNe laser (e.g. mercury arc, sodium arc) measure the wavelengths given of by these sources.

J. Holography (2 labs)
   1. Make a hologram of a suitable three-dimensional object, develop the film, and reconstruct the virtual image.
   2. Study the properties of a hologram (either the one made above or one available) by examining the hologram (virtual image) under the following conditions:
      a. Illumination of the entire hologram with laser light of the same wavelength used in making the hologram.
      b. Illumination of the entire hologram with monochromatic light of some other wavelength (sodium light, for example) after passing the monochromatic light through pinholes of different sizes.
      c. Illumination of the hologram, as in a or b above after the hologram has been turned "front-for-back."
      d. Moving a mask with a small hole over viewing side of a fully illuminated hologram and examining the virtual image.

K. 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: *Light Sources and Wave Optics (Modules 5-3, 5-5 → 5-9)* and *Components (Modules 6-4, 6-6, 6-9), 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 Wave 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

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

Johnson, C., *Laser Light Scattering*, Dover, 1995

Kliger, D., *Polarized Light in Optics and Spectroscopy*, Academic Press, 1997

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 Physical Optics (Module 4), 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 120, Wave Optics

Section A: Details of the Course

A1 This course 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 211 Wave Optics and Applications
4. Pueblo Community College; Pueblo, Colorado
   PHV 235 Wave Optics
5. Springfield Technical Community College; Springfield, Massachusetts
   EL 420 Wave Optics
6. Texas State Technical College; Waco, Texas
   LET 2514 Wave Optics
7. Three Rivers Community / Technical College; Norwich, Connecticut
   PHY 141 Wave Optics

A7 As far as I know, 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 that 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 Spring of 02-03 AY 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 $30,000 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 Spring 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.