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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** Intro to Lasers
Suggested 20 character title

X New Course* EOPT 220 Introduction to Lasers
Course Number and Full Title

_____ Course Revision _____
Course Number and Full Title

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_____ 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

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

College Curriculum Committee 12/12/00

John D. Ede 1/12/01
College Dean

_____
+Director of Liberal Studies (where applicable)

1/15/01
*Provost (where applicable)

1993

Syllabus of Record for EOPT 220

I. Catalog Description

EOPT 220 Introduction to Lasers

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

Prerequisite: EOPT 120

Different types of incoherent light sources will be discussed and investigated. The concepts of laser safety will be introduced. The elements and operation of an optical power meter will be covered. The energy-level diagrams and the energy-transfer processes in the active medium will be discussed. The spatial and temporal properties of lasers be will be investigated along with other characteristics such as modes of oscillation. Some applications of lasers will be investigated. This course includes a lab component.

II. Course Objectives

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

1. Discuss the properties of incoherent light sources.
2. Explain the properties of laser light that make it different than other light sources.
3. Explain and operate an optical power meter.
4. Follow the safety precautions for operating a low-powered helium-neon gas laser.
5. Explain the energy-level diagram of a HeNe laser and the energy-transfer processes in the active medium.
6. Explain and illustrate the emission and absorption of light by atoms and the lasing process.
7. Explain optical cavities and modes of oscillation.
8. Explain and measure some of the temporal characteristics of lasers.
9. Explain and interpret some of the spatial characteristics of lasers such as transverse electromagnetic modes in a laser, beam diameter, diffraction-limited beam divergence, and near-field and far-field of a laser.

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

A. Incoherent Light Sources and their Characteristics (2 hrs)
   1. Incandescent Sources, Light Emitting Diodes, etc.
   2. Point Sources and Extended Sources
   3. Continuous Spectrum

B. Introduction to Laser Safety (2 hrs)
   1. Physiological Effects
   2. American National Standards Institute (ANSI) Standards.

C. Optical Power Meter (2 hrs)
   1. Relationship Between the Power and the Irradiance of the Laser.
   2. Wavelength Calibration curves.

D. Emission and Absorption of Light (3 hrs)
   1. Bohr Theory of the Atom
   2. Units of Energy: Wavenumber, Erg, Joule, Electron Volt, Reciprocal Centimeter
   3. Absorption, Spontaneous Emission, and Stimulated Emission of a Photon
   4. The Emission Spectrum of an Atomic Gas and the Absorption Spectrum of a Solid.

E. Lasing Action (3.5 hrs)
   1. Normal Population Distribution and Population Inversion.
   2. Gain Coefficient of a Laser, Length of Active Medium, and Amplifier Gain.
   3. Energy Level Diagrams of Three and Four-Level Lasers.
   4. Energy-Transfer Processes
   5. Properties of Laser Light.
      a. Monochromaticity
      b. Directionality
      c. Coherence

F. Optical Cavities and Modes of Oscillation (3.5 hrs)
   1. Optical Axis.
   2. Loop, Small Signal, Amplifier, and Saturated Gain.
   3. Mode Volume.
   4. Longitudinal Mode.
   5. Mode Spacing.
   6. Fluorescent Linewidth.
   7. Cavity and Active Length of the Laser.

G. Temporal Characteristics of Lasers (3.5 hrs)
   1. Pulse Duration, Repetition Rate, and Repetition Time.
   2. Peak Pulse Power and Duty Cycle.
   3. Longitudinal Coherence Length.
   4. Normal, Q-Switched, and Mode-Locked Pulses.

H. Spatial Characteristics of Lasers (3.5 hrs)
   1. Transverse Electromagnetic Modes in a Laser.
   2. Beam Diameter at $1/e^2$ Points.
   3. Diffraction-Limited Beam Divergence.
   4. Near-Field and Far-Field of a Laser.

I. Helium-Neon Gas Laser-A case Study (3 hrs)
   1. Energy-Level Diagram of a HeNe Laser and the Energy-Transfer Processes in the Active Medium.
   2. Suppression of Unwanted Laser Lines.
   3. Gas Ratio and Pressure.
   4. Optimization of Tube Current.
   5. Electrical Characteristics of Gas Discharges.
   6. Feedback Mechanism and Output Coupler.

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. Incoherent Light Sources and their Characteristics (1.5 labs)
   1. Using a "point" source and an optical sensor map out lines of equal irradiance. Compare these lines to those expected from an ideal point source.
   2. Using an extended source and an optical sensor map out lines of equal irradiance. Determine how the shape of the source affects the shape of these lines.
   3. Using an incandescent lamp and a grating observe the continuous spectrum.
   4. Using an incandescent lamp, a set of filters, and an optical sensor measure the spectral emission of the lamp. Plot the relative power vs. the wavelength of the filters.

C. Operation of a Laser and an Optical Power Meter (1 lab)
   1. Measure the Power of the Laser and Calculate the Irradiance.
      a. For an unexpanded beam.
      b. For an expanded beam.

D. Measure the Irradiance of Laser Light Reflection. (1.5 labs)
   1. Diffuse Reflections
      a. Function of distance
      a. Function of angle
   2. Fresnel Reflections
      a. Reflection from glass slide
      b. Reflection from positive lens.

E. Emission and Absorption of Light (1.5 labs)
   1. Using a spectroscope observe and measure the wavelengths of the emission spectra of Helium, Hydrogen, Neon, and Mercury.
   2. Using Bohr's Theory of the Atom Compare the Experimental and Theoretical Results for Hydrogen and Helium.
   3. Using an incandescent light bulb and a spectroscope measure the absorption spectrum of a Nd:YAG Laser Rod and a Nd:Glass rod.

F. Measurement of Output Parameters of Pulsed Lasers (1 lab).
   1. Using a HeNe laser, a light chopper, a light detector, a power meter, and an oscilloscope make the following measurements:
      a. The time between pulses.
      b. The full width of the pulse at half maximum height.
      c. The average power.
      d. Change the pulse repetition rate and repeat the above measurements.

G. Spatial Characteristics of Lasers (1.5 labs).
   1. Beam Diameter by Transmission Through an Aperture.
   2. Beam Diameter by Scanning Beam Profile
      a. Scan the beam with a small-aperture, fiber-optic probe and plot the beam profile.
      b. Find the beam diameter by measuring the distance between $1/e^2$ points on the graph.

H. Laser Applications (3 labs)
   1. Reflective laser audio design maker
   2. Laser pulse viewer.
   3. Reflective-light wheel-alignment device.
   4. Reflective-light electroscope.
   5. Reflective-light galvanometer.
   6. Pulse width modulation
   7. Distance measurements.

I. Take a field trip to an industrial site at which lasers are used. (1 lab).
   Take notes on the types of lasers operated, on their output parameters, on intended applications, and on laboratory safety procedures in use.

J. 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:
Introduction to Lasers (Modules 1-1 → 1-11), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1987

Laser Technology (Module 3-14), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Light Sources and Wave Optics (Module 5-1), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Note (1): The modules can be purchased separately, so that having all these different titles is not a financial burden for the student.

Note (2): The publication dates of the required textbooks are1987 and 1988. 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. These modules give a good introduction to the theory and applications of lasers. In this course only the HeNe (Helium-Neon) laser will be used to illustrate the concept of a laser and these modules use the HeNe laser as the example.

Supplemental Readings:
1. *The Photonics Design & Applications Handbook 45th Edition*, Photonics Spectra, 1999
2. Electro-Optics Industry Journals: e.g., *Photonics Spectra, Laser Focus World,* and *Lasers and Optronics*

3. Electro-Optics Catalogs: e.g., *Newport, Melles Griot, and Edmond*
4. Handouts

VI. Special resource requirements

None

VII. Bibliography

Agranal, G. and Sutta, N., *Semiconductor Lasers*, Kluwer Academic, 1993

Davis, C., *Lasers and Electro Optics: Fundamentals and Engineering*, Cambridge Univ. Pr., 1996

Hecht, Jeff, *The Laser Guidebook, 2nd Ed.*, McGraw Hill, 1992

Hecht, Jeff, *Understanding Lasers, an Entry-Level Guide, 2nd Ed.*, IEEE Press, 1992

Iga, K.; Miles, R., *Fundamentals of Laser Optics (Lasers, Photonics, and Electro-Optics),* Plenum, 1994

Kapon, E., *Semiconductor Lasers I*, Academic Press, 1998

Petruzzellis, T., *Optoelectronics, Fiber Optics, and Laser Cookbook,* McGraw Hill, 1997.

Seeber, F., *Light Sources and Laser Safety (Module 2), Fundamentals of Photonics (Course 1),* STEP Project, Funded by NSF, 2000

Siegman, A., *Lasers*, Univl Science Books, 1986

Silfvast, W., *Laser Fundamentals*, Cambridge Univ. Pr., 1996

Silfvast, W., *Lasers (Module 5), Fundamentals of Photonics (Course 1),* STEP Project, Funded by NSF, 2000

Svelto, O. (Editor), Hanna, D. (Translator), *Principals of Lasers*, Plenum, 1998

Verdeyen, J., *Laser Electronics*, Prentice Hall, 1994

Course analysis Questionnaire
EOPT 220, Introduction to Lasers

Section A: Details of the Course

A1 This course is a requirement for the proposed degree Associate in Applied Science in Electro-Optics (A.A.S.E.O.) and as a choice of 2 out of 3 courses for the proposed degree 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 as a choice of 2 out of 3 courses

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. Central Carolina Community College; Lillington, North Carolina
   LEO 111 Lasers and Applications
2. Cincinnati Technical College; Cincinnati, Ohio
   LOT 6710 Introduction to Lasers
3. Indian Hills Community College; Ottumwa, Iowa
   LE 257V Laser Components
4. Monroe Community College; Rochester, New York
   OPT 231 Lasers: Technology and Applications
5. Northcentral Technical College; Wausau, Wisconsin
   622-105 Introduction to Lasers & Optics
6. Pueblo Community College; Pueblo, Colorado
   PHV 132 C-W Laser Systems
7. Springfield Technical Community College; Springfield, Massachusetts
   EL 320 Introduction to Lasers
8. Texas State Technical College; Waco, Texas
   LET 102 Fundamentals of Lasers & Laser Safety
   LET 188 Laser Electro-Optics Components
9. Three Rivers Community / Technical College; Norwich, Connecticut
   PHO 140 Introduction to Lasers
   PHO 105 Laser Safety

10. Vincennes University; Vincennes, Indiana
TLO 240 Introduction to Lasers

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. The material is not covered by any of the existing courses.

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. Since this course won't be taught until the Fall of 2003 there should be no problem with space.

b. Equipment
In order to implement this course, we will need approximately $30,000 in the first year for hardware and software.

c. Laboratory Supplies and other Consumable Goods
About $2,000 in the first year and about $2000 per year after that.

d. Library Materials
About $750 will be needed in the first year of the program and about $100 for each year thereafter.

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.