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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** Indust App of Lasers
Suggested 20 character title

X New Course* EOPT 260 Industrial Applications of 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 1/12/01

John D. Ge 1/12/01
College Dean

_____
+Director of Liberal Studies (where applicable)

1/15/01
*Provost (where applicable)

Syllabus of Record for EOPT 260

I. Catalog Description

EOPT 260 Industrial Applications of Lasers — 2 lecture hours, 3 lab hours, 3 credits (2c-3l-3sh)

Prerequisite: EOPT 220

Laser power and energy measurements will be made. The theory and applications of industrial lasers will be covered. Material processing such as welding, cutting, and hole drilling will be discussed, implemented, and analyzed. The role of optics in laser machining will be covered. Laser safety will be emphasized throughout the course. This course includes a lab component.

II. Course Objectives

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

1. Explain and apply the principles of laser safety as embodied in the American National Standards Institute (ANSI) Standard.
2. Discuss and demonstrate how to make power and energy measurements of laser outputs.
3. Explain the parameters of materials processing and demonstrate materials processing such as welding, cutting, and hole drilling.
4. Discuss and use modulators, Q-switching, and mode-locking.
5. Explain and demonstrate harmonic generation in nonlinear materials.
6. Discuss and classify the many different types of lasers.

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

A. Power and Energy Measurements of Laser Outputs (2 hrs)
   1. Effects of spot size.
   2. Losses in transmission through optical paths.

B. CO_2 Lasers (3 hrs)
   1. Theory of the CO_2 Laser
   2. Advantages of the CO_2 Laser

C. Ultrashort Pulsed Laser (3 hrs)
   1. Production of Short Pulses
   2. Hole Drilling
   3. Electronic Material Processing

D. Materials Processing (4 hrs)
   1. Heat Treating
   2. Welding (lap and butt)
   3. Cutting and Material Removal
   4. Hole Drilling.
      a. Process parameters and their effect on:
         i Hole taper
         ii Hole diameter
         iii Hole entrance features (prevention of cratering)
   5. Electronic Material Processing
      a. Direct write of electrical connections.
      b. Drilling of via holes.
   6. Marking and Scribing Experiments
   7. Metallurgical Effects due to Laser Processing
   8. Workstations, Automated Control

E. Flashlamp Pumped Nd:YAG Laser (3 hrs)
   1. Theory of the Nd:YAG Laser
   2. Modulators
   3. Q-Switching
   4. Mode-Locking

F. Nonlinear Materials (1 hr)
   1. Harmonic Generation
   2. Theoretical Conversion Efficiency
   3. Applications

G. Other Lasers (5 hrs)
   1. Diode Lasers
   2. Solid State Lasers
   3. Visible Gas Lasers
   4. DYE Lasers
   5. EXCIMER Lasers

H. The Role of Optics in Laser Machining (5 hrs)
   1. Factors that affect Cutting Quality
   2. Materials used for CO_2 Laser Optics
      a. Transmissive
      b. Reflective
   3. Coatings for CO_2 Laser Optics
   4. Polarization
   5. Focusing Optics
   6. Factors Important to CO_2 Laser Optics

Testing (2 hrs)

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

A. Introduction (1 lab)
   1. Lab Safety
   2. Laser Safety: ANSI (American National Standards Institute) Standard
   3. Technical Writing
      a. Notebooks
      b. Lab Reports
   4. Rules and Regulations

B. CO_2 1.5kWatt CW (Continuous Wave) Laser (3 labs)
   1. Cutting Metal.
      a. Write and debug workstation operation program
      b. Develop process parameters (speed, power, spot size)
      c. Produce cut geometric shapes with laser under computer control
   2. Welding Metal.
      a. Produce lap welds.
      b. Produce butt welds.

C. Ultrashort Pulsed Laser Precision Machining. (3 labs)
   1. Hole Drilling.
      a. Process parameters and their effect on:
         i Hole taper
         ii Hole diameter
         iii Hole entrance features (prevention of cratering)
   2. Electronic Material Processing
      a. Direct write of electrical connections.
      b. Drilling of via holes.

D. Sealed CO_2 100 Watt Laser (3 labs)
   1. Emphasis on Modern Approach to Controlling Laser Processing.
   2. Marking and Scribing Experiments
   3. Light Metal Cutting.

For the above 3 lasers (sections A, B, and C above) the following will be done for each laser.
   1. The metals to be used for the following sections 2 and 3 are: Stainless Steel, Low Carbon Steel, and Aluminum Alloy.
   2. Power and Energy Measurements
      a. Effects of spot size.
      b. Losses in transmission through optical paths.
   3. Metallurgical Effects
      a. Examination of heat affected zone.
         i Cutting, polishing, and preparing cross-sections.
         ii Optical Microscopy

E. Flashlamp Pumped Nd:YAG Laser (2 labs)
   1. Modulators
   2. Q-Switching
   3. Mode-Locking

F. Nonlinear Generation of Frequencies (1 lab)
   1. Observe the second harmonic radiation coming from a nonlinear crystal that is excited by a laser, e.g. focusing the beam from a 1.06 mm Nd:YAG laser onto certain crystals will produce a second harmonic at 530 nm.

G. 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:
Ready, J., *Industrial Applications of Lasers, 2nd Edition*, Academic Press, 1997

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

Diels, J., *Ultrashort Laser Pulse Phenomena*, Academic Press, 1996

Duley, W., *Laser Welding*, John Wiley and Sons, 1998

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

Hecht, J. *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

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

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

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

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

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

Tam, A., (Editor), *Laser and Optics for Manufacturing*, Optical Society of America, 1996

Course analysis Questionnaire
EOPT 260, Industrial Applications of 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 the choices for 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. Camden County College; Blackwood, New Jersey
   LFO-212 Pulsed & CW Lasers & their Applications
2. Cincinnati Technical College; Cincinnati, Ohio
   LOT 6735 Industrial Laser Systems
   LOT 6740 Applications of Lasers
3. Indian Hills Community College; Ottumwa, Iowa
   LE 263V Laser Technology
4. Northcentral Technical College; Wausau, Wisconsin
   622-131 High Power Lasers and Accessories
5. Pueblo Community College; Pueblo, Colorado
   PHV 133 Pulsed Laser Systems
6. Springfield Technical Community College; Springfield, Massachusetts
   EL 450 Advanced Topics in Lasers
7. Texas State Technical College; Waco, Texas
   LET 202 Continuous Wave Lasers
   LET 303 Pulsed Lasers
8. Vincennes University; Vincennes, Indiana
   TLO 260 Laser Devices
   TLO 290 Laser Applications

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

Most of this course will be taught using space belonging to the Electro-Optics Center (EOC). For the part in the IUP 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 Spring of 02-03 AY there should be no problem with space.

b. Equipment

In order to implement this course, we will need approximately $25,000 in the first year for hardware.

c. Laboratory Supplies and other Consumable Goods

About $1,000 in the first year and about $1000 per year after that.

d. Library Materials

About $500 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 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.