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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** Detection & Measure
Suggested 20 character title

X New Course* EOPT 210 Detection and Measurement
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

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] 1/13/01
*Provost (where applicable)

1993

Syllabus of Record for EOPT 210

I. Catalog Description

EOPT 210 Detection and Measurement

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

Prerequisites: EOPT 120, EOPT 125

This course covers electronic amplification, optical detectors, and the measurement of small distances using interference effects. Operational amplifiers are used to build circuits to measure the output of photon and thermal detectors. In order to accurately measure properties such as wavelengths, absorption of wavelengths, defects in lenses, prisms, and flat plates the following instruments are used by the students: monochromators, spectrophotometers, and interferometers. A lab is included in this course.

II. Course Objectives

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

1. Use the black-box concept of an amplifier.
2. Design voltage follower and inverting amplifier circuits with the operational amplifier.
3. Describe and apply photon and thermal detectors.
4. Use instruments such as monochromators, spectrophotometers, and interferometers (e.g. Michelson, Fabry-Perot, and Twyman-Green).
5. Describe and apply the concept of the spatial resolution of optical systems.

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

A. Amplifiers (2 hrs)
   1. Differential and Single Ended Gain
   2. Input and Output Impedance

B. Operational Amplifiers (2 hrs)
   1. Voltage Follower Circuit
   2. Inverting Amplifier Circuit

C. Photon Detectors (2 hrs)
   1. Photoconductive
   2. Photovoltaic
   3. Photoemissive

D. Thermal Detectors (3 hrs)
   1. Bolometers and Thermistors
   2. Thermocouples
   3. Calorimeters
   4. Pyroelectric

E. Monochromators (3 hrs)
   1. Basic Design
   2. Used as Wavelength Analyzer.
   3. Used as a Monochromatic Light Source
   4. Used to Measure the Transmittance of an Optical Filter

F. Spectrophotometers (3 hrs)
   1. Prism or Grating
   2. Transmittance and Absorbance vs. Wavelength

G. Michelson Interferometers (3 hrs)
   1. Production of Circular and Straight-Line Fringes of Both Monochromatic Light and White Light Due to Small Path Differences of Two Beams.
      a. Accurate Comparison of Wavelengths.
      b. Measure the Refractive Index of Gases and Transparent Solids.
      c. Determine Small Changes in Length Quite Precisely.

H. Fabry-Perot Interferometers (3 hrs)
   1. The Fabry-Perot Etalon.
      a. Optical Resonator Properties.
   2. Spherical Mirror Fabry-Perot Interferometers
      a. Used to Determine and/or reduce the Linewidth of Optical Sources such as Lasers

I. Twyman-Green Interferometers (2.5 hrs)
   1. Used for Measuring Defects in Optical Components such as Lenses, Prisms, Plane-Parallel Windows, Laser Rods, and Plane Mirrors.
   2. Beam Splitter and Mirror Arrangement Similar to Michelson Interferometer.
   3. Used with a Monochromatic Point Source which is located at the Principal Focus of a Well-Corrected Lens.

J. Spatial Resolution of Optical Systems (2.5 hrs)
   1. The Modulation Transfer Function (MTF)
      a. Measure of System's Imaging Capabilities.
      b. Largely Determines the Amount of Fine Detail that will be Observed in the Image.
      c. Measurement of MTF.

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. Operational Amplifiers (1 lab)
   1. Inverting Amplifier Circuit
      a. Measure the input and output resistance as a function of R_1 and R_f where R_1 is the external input resistor and R_f is the external feedback resistor.
      b. Measure the frequency response of the gain as a function of the ratio of R_f over R_1.
   2. Voltage Follower Circuit
      a. Measure the frequency response of the gain.

C. Photon Detectors (1 lab)
   1. Using an operational amplifier circuit, an incandescent lamp, and some filters, measure the frequency response of a Photoconductive device.
   2. Using an operational amplifier circuit, an incandescent lamp, and some filters, measure the frequency response of a Photovoltaic device.

D. Thermal Detectors (1 lab)
   1. Using an operational amplifier circuit, an incandescent lamp, and some filters, measure the frequency response of a bolometer.
   2. Using an operational amplifier circuit, an incandescent lamp, and some filters, measure the frequency response of a thermocouple.

E. Monochromators (2 labs)
   1. Draw the Layout of the Components of the Monochromator
   2. Calibrate the Monochromator Using a Mercury Lamp.
   3. Measure the Visible Line Spectra of a Hydrogen Source.
   4. Using the Monochromator, a Tungsten Lamp, and a Detector Measure the Wavelength Dependent Output of the Tungsten Lamp.
   5. Measure the Transmittance of Three Optical Filters (Cutoff, Broadband Pass, and Narrow Band Pass).

F. Spectrophotometers (1 lab)
   1. Determine the % Transmission and Absorbance of a dye (such as rhodamine 6G) as a function of wavelength.

G. Michelson Interferometer (2 labs)
   1. Align the Interferometer

2. Measure the Wavelength of the Sodium D-Lines.
3. Measure the Wavelength Separation of the Sodium D-Lines.
4. Using a Mercury Light Source Measure the Coherence Length of the Interferometer.

H. Fabry-Perot Interferometer (1.5 labs)
1. View the Frequencies of the Helium-Neon Laser.
2. Adjust the Aperture so that the Helium-Neon Laser is Operating in a Single Transverse Mode.
3. Determine the Longitudinal Mode Spacing of the Helium-Neon Laser and the Number of Longitudinal Modes that are lasing.

I. Twyman-Green Interferometers (1.5 labs)
1. Test an Optical Flat for Polishing Errors.
2. Observe Index of Refraction Inhomogeneities in a Plane Parallel Glass Plate
3. Test a Prism for Surface and Transmission Errors.
4. Test a Lens for Aberrations.

J. Spatial Resolution of Optical Systems (1 lab)
1. Measure the Square-Wave Modulation Transfer Function (MTF) of a Poor-Quality Lens.
2. Measure the Square-Wave MTF of the Poor-Quality Lenses when the Diameter of the lens is half that Used in the above Task.
3. Measure the Square-Wave MTF of a High-Quality Lens.

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

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

Laser/Electro-Optic Measurements (Modules 10-1 → 10-8), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Note: The publication date of one of the required textbooks is 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. The other text by Ready will be used to supplement the CORD material that is dated.

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

Derickson, D. (Editor), *Fiber Optic Test and Measurement*, Prentice Hall, 1998

Fagan, W. (Editor), *Optics in Engineering Measurement*, SPIE, 1986

Granger, E., *Metrology of Optoelectronic Systems (SPIE Proceedings Vol. 776)*, SPIE, 1987

Laser and Electro-Optic Components (Modules 6-5, 6-7, 6-8, and 6-9), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Laser/Electro-Optic Devices (Modules 7-1, 7-2, 7-3, and 7-4), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Light Sources and Wave Optics (Modules 5-6 and 5-7), Laser Electro-Optics Technology Series, Center for Occupational Research and Development (CORD) Communications, 1988

Luxmoore, A. (Editor), *Optical Transducers and Techniques in Engineering Measurement*, Chapman and Hall, 1983

McDonough, R., *Detection of Signals in Noise*, Academic Press, 1995

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

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

Poor J., *An Introduction to Signal Detection and Estimation*, Springer Verlag, 1994

Rakels, J., *Optical Surface Finish Measurement Techniques*, Chapman and Hall, 1996

Rastogi, P., *Optical Measurement Techniques and Applications*, Artech House, 1997

Ready J., *Optical Detectors and Human Vision (Module 6), Fundamentals of Photonics (Course 1),* STEP Project funded by NSF, 2000

Wickens, T., *Elementary Signal Detection Theory*, Oxford Univ., 2001

Course analysis Questionnaire
EOPT 210, Detection and Measurement

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-231 Photonics Measurements
   LFO-221 Photonics Devices
2. Cincinnati Technical College; Cincinnati, Ohio
   LOT 6750 Laser Electro-Optic Measurements
3. Indian Hills Community College; Ottumwa, Iowa
   LE 266V Photonics Applications
4. Monroe Community College; Rochester, New York
   OPT 135 Measurement and Analysis
5. Texas State Technical College; Waco, Texas
   LET 3404 Electro-Optics Measurements
6. Vincennes University; Vincennes, Indiana
   TLO 230 Optical Metrology and Holography

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 Spring of 2003-2004 AY there should be no problem with space.

b. Equipment
In order to implement this course, we will need approximately $50,000 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 $1,000 will be needed in the first year of the program and about $100 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.

<u>Section D: Miscellaneous</u>

No additional information is necessary.