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Submission Date: ________
Action-Date: ________

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** High Vacuum Tech
Suggested 20 character title

X New Course* EOPT 250 High Vacuum Technology
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] 1/12/01
College Curriculum Committee

John D. Eck 1/12/01
College Dean

____
+Director of Liberal Studies (where applicable)

[signature] 1/18/01
*Provost (where applicable)

1993

Syllabus of Record for EOPT 250

I. Catalog Description

EOPT 250 High Vacuum Technology

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

Prerequisite: PHYS 116

The student will learn how to produce and measure a vacuum. The properties of gases and the concepts of fluid flow and pumping will be presented. Many different kinds of vacuum pumps will be discussed in detail. The concept of measuring a vacuum will be introduced through the discussion of vacuum gauges and gas analyzers. The techniques of leak detection and thin film deposition will be covered. The concept of ultrahigh vacuum will be touched upon. This course includes a lab component.

II. Course Objectives

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

1. Explain the properties of gases and how those properties affect the attainment of a vacuum.
2. Discuss the different flow regimes for fluids and how they affect the pumping speed of a vacuum system.
3. Explain and apply the operation and maintenance of the different types of vacuum pumps.
4. Discuss and apply the different methods of leak detection in vacuum systems with an emphasis on helium mass spectrometer leak detectors.
5. Explain and apply some of the concepts of thin film deposition and proper protocol in a clean room.
6. Explain some of the concepts concerning ultrahigh vacuum systems.

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

A. Properties of Gases (2 hrs)
   1. Pressure and Density
   2. Basic Gas Law
   3. Velocities and Temperature of Gases
   4. Adsorption and Desorption
   5. Gas Content of Materials and Outgassing

B. Fluid Flow and Pumping Concepts (2.5 hrs)
   1. Pressure and Flow
   2. Mass Flow and Volume Flow
   3. Flow Regimes

C. Vacuum Systems (2.5 hrs)
   1. Efficacy of Various Vacuum Pumps in Different Pressure Regions
   2. Evacuation Time
   3. Conductance
   4. Outgassing Effects
   5. Pumping System Design
   6. Operation of High-Vacuum Systems

D. Coarse (Roughing) Vacuum Pumps (2 hrs)
   1. Rotary Vane Pumps
   2. Some other Coarse Pumps
   3. Oil-Free Vacuum Pumps

E. Diffusion (Vapor Jet) Pumps (2.5 hrs)
   1. Pumping Mechanism
   2. Basic Design, Performance, and Operation
   3. Pumping Fluids
   4. Performance Characterization and Design Features
   5. Maintenance

F. Turbomolecular Pumps (2 hrs)
   1. Turbomolecular Pumps
   2. Operation and Maintenance

G. Cryogenic Pumps (2.5 hrs)
   1. Basic Principles of Operation
   2. Cryosorption Pumping
   3. Gaseous Helium Cryopumps
   4. Water Vapor Pumps

H. Vacuum Gauges and Gas Analyzers (2.5 hrs)
   1. Force-Measuring Gauges
   2. Heat Transfer Gauges
   3. Ionization Gauges
   4. Mass Spectrometers or Partial Pressure Gauges

I. Leak Detection (2.5 hrs)
   1. Sizes of Leaks and Units of Measurement
   2. Leak Location and Measurement
   3. Leak Detection Methods
   4. Helium Mass Spectrometer Leak Detectors

J. Thin Film Deposition (2 hrs)

K. Clean Room Procedures (1 hr)

L. Crystal Growth (1 hr)

M. Ultrahigh Vacuum (1 hr)

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. Properties of Gases (1 lab)
1. Investigation of the basic gas law
   a. Pressure vs. temperature
   b. Pressure vs. volume
2. Investigation of vapors, vapor pressure and evaporation.

C. Fluid Flow and Pumping Concepts (1 lab)
1. Measurement of pressure and flow
2. Investigation of turbulent and laminar Flow

D. Vacuum Systems (1 lab)
1. Measure evacuation time
2. Measure conductance as a function of inner radius and length of tubes.
3. Measure the effect of outgassing.
4. Investigate the switching from rough to high-vacuum pumps.

E. Coarse Vacuum Pumps (1 lab)
1. Investigate the operation and maintenance of a rotary vane pump.

F. Diffusion (Vapor Jet) Pumps (1 lab)
1. Investigate the operation and maintenance of a diffusion pump.
2. Measure the pumping speed and throughput of a diffusion pump.

G. Turbomolecular Pumps (1 lab)
1. Investigate the operation and maintenance of a turbomolecular pump.
2. Measure the pumping speed and throughput of a turbomolecular pump.

H. Cryogenic Pumps (1.5 labs)
1. Investigate the operation and maintenance of a cryogenic pump.
2. Measure the pumping speed and throughput of a cryogenic pump.

I. Vacuum Gauges (1.5 labs)
  1. Using a system that has all the gauges connected to the same volume plot the pressure readings of the following gauges as a function of time.
     a. A force-measuring gauge: a Bourdon gauge, a diaphragm gauge, or a Mcleod gauge.
     b. A heat transfer gauge: a Thermocouple Gauge or a Pirani Gauge.
     c. An Ionization Gauge: a Cold Cathode Gauge or a Hot Cathode Gauge.

J. Leak Detection (1 lab)
  1. Use bubble testing to determine a leak in an enclosure.
  2. Use a helium mass spectrometer leak detector to find leaks in a high vacuum system.

K. Clean Room Procedures and Thin Film Deposition (at main campus IUP) (2 labs)
  1. In the process of depositing a thin film on a sample use the clean room to clean the sample and to place the mask and/or the photo-resist pattern on the sample.
  2. Do this for at least two different methods of thin film deposition.

L. 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:
Hablanian, Marsbed H., *High-Vacuum Technology, A Practical Guide, 2nd Edition*, Marcel Dekker, New York, NY, 1997.

Supplemental Readings:

1. Vacuum Technology Catalogs: e.g., *Liebold Inficon*
2. Handouts

VI. Special resource requirements

None

VII. Bibliography

Berman, A., *Vacuum Engineering Calculations, Formulas and Solved Exercises*, Academic Press, 1997

Chambers, A., *Basic vacuum technology, 2nd Edition*, Institute of Physics Pub., Philadelphia, 1998.

Delchar, T. A., *Vacuum physics and techniques*, Chapman & Hall, New York, 1993.

Duval, P., *High Vacuum Production in the Microelectronics Industry*, Elsevier, New York, 1988.

Hoffman, D. (Editor), et. Al., *Handbook of Vacuum Science and Technology*, Academic Press, 1997

Lafferty, J., *Foundations of Vacuum Science and Technology*, John Wiley and Sons, 1998

O'Hanlon, J., *A User's Guide to Vacuum Technology, 2nd Ed.*, John Wiley and Sons, 1989

Rene, A., *Cryopumping: Theory and Practice*, Oxford University Press, New York, 1989.

Roth A., *Vacuum Sealing Techniques*, Springer Verlag, 1994

Roth, A., *Vacuum Technology, 3rd Edition*, Elsevier Science, New York, 1990.

Stuart, R., *Vacuum Technology, Thin Films and Sputtering: An Introduction*, Academic Press, 1983

Course analysis Questionnaire
EOPT 250, High Vacuum Technology

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. Pueblo Community College; Pueblo, Colorado
   - PHV 232 Vacuum Systems II
   - PHV 236 Vacuum Systems III
   - PHV 238 Vacuum Projects
2. Texas State Technical College; Waco, Texas
   - LET 305 Vacuum Theory and Components
   - LET 317 Vacuum Systems I
   - LET 318 Vacuum Systems II

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 $40,000 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 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.