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)

L. Crystal Growth (1 hr)

M. Ultrahigh Vacuum (1 hr)

Testing (2 hrs)

[redacted]

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. [redacted]

[redacted]

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

[redacted]

c. An Ionization Gauge: a Cold Cathode Gauge or a Hot Cathode Gauge.

L Leak Detection (1 lab)

[redacted]

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

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

Academic Press, 1997

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

[redacted]

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

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