

Course Outline for: VACT 2290 High Vacuum Equipment**A. Course Description**

1. Number of credits: 1
2. Lecture hours per week: 1
3. Prerequisites: VACT 1295
4. Corequisites: none
5. MnTC Goals: none

This course introduces the equipment necessary to operate in the high vacuum regime (approximately 10^{-3} - 10^{-6} Torr), such as specialized pumps and vacuum hardware components. System conductance and pump-down performance are affected by the selection of the specific components and the underlying material properties.

B. Date last reviewed/updated: January 2023**C. Outline of Major Content Areas**

1. Characteristics of the molecular flow regime
2. Conductance and throughput in a high vacuum system
 - a. Calculating conductance of passive components in high vacuum
 - b. Calculating the effective pumping speed
 - c. Relating conductance to throughput
3. Outgassing sources in high vacuum
 - a. Effects of vapor pressure
 - b. Properties and selection of materials
4. High vacuum pumps
 - a. Comparison of high-vacuum pumping processes
 - b. Manufacturer's operation and maintenance data
5. Passive System Hardware Components
 - a. Flanges
 - b. Valves
 - c. Tubing choices
 - d. Feedthroughs
 - e. Chambers
6. Troubleshooting Techniques

D. Course Learning Outcomes

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

1. Explain the function of the components in a high vacuum system.
2. Calculate the conductance of a high vacuum system.

3. Identify the sources of gas load that impact high vacuum system operation.
4. Select appropriate vacuum pumps, valves, chambers, and tubing, with consideration of the materials of construction, to satisfy high vacuum system requirements.
5. Demonstrate fundamental troubleshooting skills as they apply to troubleshooting high vacuum systems.

E. Methods for Assessing Student Learning

Assessment methods may include, but are not limited to, the following:

1. Unit quizzes
2. A summative exam
3. Assessment of operation of high vacuum equipment, in person or remote.
4. Assessments may include
 - a. Homework assignments
 - b. Discussions
 - c. Collaborative projects
 - d. Other quizzes

F. Special Information

This course is the first of 3 modular 1-credit courses VACT 2290, VACT 2291 (High Vacuum Measurement), and VACT 2292 (High Vacuum Applications) that together are equivalent to VACT 2293 Vacuum Analysis and Troubleshooting.

Course instruction includes access to a high vacuum equipment trainer system to support measurement and data collection exercises.