**Course Description:**

This class focuses on the mechanical maintenance, processing, and data collection of vacuum systems typically used in semiconductor processes such as thin film deposition, ion implantation, and reactive ion etching. The lectures consist of a broad introduction to the use of vacuum pumps in semiconductor manufacturing and how to measure vacuum pressure within a multi-pump system. In Lab, students will gown up in a bunny suit and simulate working in a cleanroom environment.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome 1.1. Employability Skills:** Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and post-secondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, résumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**Outcome 1.3. Business Ethics and Law:** Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], U.S. Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.6. Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).

1.3.8. Verify compliance with computer, copyright and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational and professional ethical standards.

**Outcome 1.4. Knowledge Management and Information Technology:** Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, electronic mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to industry pathway.

1.4.4. Use system hardware to support software applications.

1.4.5. Use information technology tools to maintain, secure and monitor business records.

1.4.6. Use electronic database to access and create business and technical information.

1.4.7. Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books).

1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

**Outcome 1.5. Global Environment:** Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.

**Competencies**

1.5.1. Describe how cultural understanding, cultural intelligence skills and continual awareness are interdependent.

1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.

1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.

1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.

1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.

1.5.6. Analyze work tasks for understanding and interpretation from a different cultural perspective.

1.5.7. Use intercultural communication skills to exchange ideas and create meaning.

1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

**Strand 3 Computer Integrated Manufacturing**

Learners apply the principles of computer integrated manufacturing related to computer numerical control, robotics, programmable logic controllers and power systems.

**Outcome 3.4 Power Technologies:** Install, maintain and troubleshoot power systems.

**Competencies**

3.4.1 Calculate fluid pressure and flow and describe how it relates to the functioning of hydraulic and pneumatic actuator.

3.4.2 Describe the relationship between force, pressure and power.

3.4.6 Read and interpret hydraulic, pneumatic and vacuum schematics and model codes.

3.4.7 Select a fluid power system based on project needs (e.g., pressure, flow, temperature, dissipation, filtration, fluid, maintenance).

3.4.8 Explain the fundamental principles of pneumatics, hydraulics and vacuum technology.

3.4.9 Troubleshoot power loss within a system.

3.4.13 Perform general maintenance on pneumatic, hydraulic and vacuum systems.

3.4.14 De-energize pneumatic, hydraulic and vacuum systems.

**Outcome 3.5 Pumping Systems:** Install, maintain, and troubleshoot pumps and pumping systems.

**Competencies**

3.5.5 Disassemble and assemble pumping stations.

3.5.6 Troubleshoot pump system failure conditions (e.g., cavitation).

**Outcome 3.8 Cleanroom Vacuum System:** Understand the mechanics and operation of a vacuum system.

**Competencies**

3.8.1 Explain the operational mechanisms and process use of vacuum pumps in the semiconductor industry (i.e., wafer transport, dry clean or etching with reactive ion etch, thin film deposition, ion implantation).

3.8.2 Differentiate atmosphere, course/rough/low vacuum, high vacuum and ultra-high vacuums.

3.8.3 Explain vacuum measurement on a roughing pump and record pressures during a roughing pump-down.

3.8.4 Summarize high vacuum pumps evolution and applications.

3.8.5 Distinguish why high-volume systems may have more than one roughing pump.

3.8.6 Describe series and/or parallel vacuum pump use with qualitative and quantitative examples.

3.8.7 Use charts to compare pumping speed and ultimate pressure.

3.8.8 Differentiate crossover pressure with the use of high vac and low vac pump systems.

3.8.9 Classify types of pressure gauges, measurement ranges, plumbing connections

3.8.10 Describe roughing and high vacuum pump components (e.g. gauges, valves, fittings).

3.8.11 Explain how a high vacuum pump works with a roughing pump and measure pressure during pump-down, observing crossover pressure.

**Strand 7 Precision and Advanced Machining**

Learners apply principles of protection, prevention and mitigation to create and maintain safe working conditions at manufacturing sites. Knowledge and skills may be applied in all aspects of personal and site safety, including handling materials, using tools and equipment, working with and around electricity and using personal protective equipment.

**Outcome 7.3 Industrial Maintenance Safety:** Plan, develop and ensure industrial maintenance safety.

**Competencies**

7.3.1 Safely operate machinery and equipment.

7.3.3 Perform leak checks on equipment.

7.3.4 Report and document unsafe machinery conditions.

7.3.6 Identify tools and equipment requiring safety certification.

7.3.7 Use environmental data systems.

7.3.8 Monitor equipment for unsafe conditions.

7.3.9 Identify the benefits of cross‐training.

7.3.10 Deliver set‐up and operational procedures.

7.3.11 Demonstrate cleanroom gowning (Lab) using Standard Operating Procedures (SOP).

7.3.12 Explain the safety processes and practices of high vacuum systems.

**Outcome 7.4** **Industrial Maintenance Installation and Repair:** Inspect, maintain and repair industrial equipment.

**Competencies**

7.4.1 Identify installation techniques using manuals, checklists, and regulations.

7.4.2 Identify equipment alarms.

7.4.3 Maintain inspection processes and records.

7.4.5 Inspect and correct machine malfunctions.

7.4.6 Perform roughing pump system maintenance using a complex set of equipment specific instructions.

7.4.7 Describe costs and benefits of proactive versus reactive maintenance.

**Strand 9 Fundamentals of Physics**

**Outcome 9.1 Physics of Engineering:** Learn the fundamentals of physics as it relates to engineering.

**Competencies**

9.1.1 Display and interpret numbers in scientific notation and logarithmic scales

9.1.2 Describe and convert SI and US system units of measurement.

9.1.3 Identify and use both metric and inch rules.

9.1.4 Express physical quantities with appropriate number of significant digits, units and dimensions.

9.1.5 Perform operations on whole numbers, fractions and mixed numbers.

9.1.6 Analyze measurements and perform technical calculations.

9.1.8 Quantitatively describe the units used in pressure measurement, such as Torr, and convert between units.

9.1.9 Describe a non-quantitative 'mean free path'

9.1.10 Describe how the measure of pressure relates to mean free path.