

Industrial Maintenance Program of Study and Complementary Course Standards



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Vision

All Nevada students are equipped and feel empowered to attain their vision of success

Mission

To improve student achievement and educator effectiveness by ensuring opportunities, facilitating learning, and promoting excellence



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The development of Nevada career and technical education (CTE) standards and assessments is a collaborative effort sponsored by the Nevada Department of Education (NDE) Office of Career Readiness, Adult Learning, and Education Options. The Nevada Department of Education relies on educators and industry representatives who have the technical expertise and teaching experience to develop standards and performance indicators that truly measure student skill attainment. More importantly, the NDE would like to recognize the time and commitment by the writing team members in developing the career and technical standards for Industrial Maintenance.

Standards Development Members

Name	Occupation/Title	Stakeholder Affiliation	School/Organization
Thomas Bruns	Instructor	Postsecondary Educator	Great Basin College, Elko
Anthony Chapple	Instructor	Secondary Educator	Northwest Career and Technical Academy, Clark County School District
Michael DeBlasi	Training Manager	Business and Industry Representative	Tesla, Sparks, NV
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Business and Industry Validation

All CTE standards developed through the Nevada Department of Education are validated by business and industry through one or more of the following processes: (1) the standards are developed by a team consisting of business and industry representatives, or (2) a separate review panel is coordinated with industry experts to ensure the standards include the proper content, or (3) nationally recognized standards currently endorsed by business and industry.

The Industrial Maintenance standards were validated through active participation of business and industry representatives on the development team.

Introduction

The standards in this document are designed to clearly state what the student should know and be able to do upon completion of a high school Industrial Maintenance program of study. These standards are designed for a two-credit course sequence that prepares the student for a technical assessment directly aligned to the standards.

These exit-level standards are designed for the student to complete all standards through their completion of a program of study. These standards are intended to guide curriculum objectives for a program of study.

The standards are organized as follows:

- **Content Standards** are general statements that identify major areas of knowledge, understanding, and the skills students are expected to learn in key subject and career areas by the end of the program.
- **Performance Standards** follow each content standard. Performance standards identify the more specific components of each content standard and define the expected abilities of students within each content standard.
- **Performance Indicators** are very specific criteria statements for determining whether a student meets the performance standard. Performance indicators may also be used as learning outcomes, which teachers can identify as they plan their program learning objectives. The indicators are followed by designations that reflect the course sequence (e.g., L1 for the first-year course of a two-year program and L2 for the second-year course, C is to designate the indicators to be taught in the complementary course) as referenced in the Core Course Sequence table.

The crosswalks and alignments are located in the Program Supplemental Program Resources document. These will show where the performance indicators support the Nevada Academic Content Standards. For individual course descriptions, please reference the Supplemental Program Resource or the Nevada CTE Catalog.

All students are encouraged to participate in the career and technical student organization (CTSO) that relates to the Industrial Maintenance program. CTSOs are co-curricular national organizations that directly reinforce learning in the CTE classroom through curriculum resources, competitive events, and leadership development. CTSOs provide students the ability to apply academic and technical knowledge, develop communication and teamwork skills, and cultivate leadership skills to ensure college and career readiness.

The Employability Skills for Career Readiness identify the skills needed to be successful in all careers and must be taught as an integrated component of all CTE course sequences. These standards are available in a separate document.

The **Standards Reference Code** is only used to identify or align performance indicators listed in the standards to daily lesson plans, curriculum documents, or national standards. The Standards Reference Code is an abbreviated name for the program, and the content standard, performance standard and performance indicator are referenced in the program standards. This abbreviated code for identifying standards uses each of these items. For example, INDUS is the Standards Reference Code for Industrial Maintenance. For Content Standard 2, Performance Standard 3 and Performance Indicator 4 the Standards Reference Code would be INDUS.2.3.4.

Industrial Maintenance

Program Information

- Program of Study:** Industrial Maintenance
- Standards Reference Code:** IND MAINT
- Career Cluster:** Manufacturing
- Career Pathway(s):** Maintenance, Installation, and Repair
- Program Length:** 2-year, completed sequentially
- CTSO:** SkillsUSA

Program Structure Required Program of Study Courses

The core course sequencing is provided in the following table. Complementary Courses are available and provided later in this document. The following courses provide a completed program of study. The Lab is a complementary course available concurrently with the Industrial Maintenance II course.

Core Course Sequence (R) with Lab Course(s) (C)

Required/ Complementary	Course Title	Abbreviated Name
R	Industrial Maintenance I	IND MAINT I
R	Industrial Maintenance II	IND MAINT II
C	Industrial Maintenance II LAB	IND MAINT II L

CONTENT STANDARD 1.0: INTEGRATE CAREER AND TECHNICAL STUDENT ORGANIZATIONS (CTSOs)**Performance Standard 1.1: Explore the History and Organization of CTSOs**

- 1.1.1 Discuss the requirements of CTSO participation/involvement as described in Carl D. Perkins Law Level 1 (L1), Level 2 (L2), Complementary (C)
- 1.1.2 Research nationally recognized CTSOs (L1, L2, C)
- 1.1.3 Investigate the impact of federal and state government regarding the progression and operation of CTSOs (e.g., Federal Statutes and Regulations, Nevada Administrative Code [NAC], Nevada Revised Statutes [NRS]) (L1, L2, C)

Performance Standard 1.2: Develop Leadership Skills

- 1.2.1 Discuss the purpose of parliamentary procedure (L1, L2, C)
- 1.2.2 Demonstrate the proper use of parliamentary procedure (L1, L2, C)
- 1.2.3 Differentiate between an office and a committee (L1, L2, C)
- 1.2.4 Discuss the importance of participation in local, regional, state, and national conferences, events, and competitions (L1, L2, C)
- 1.2.5 Participate in local, regional, state, or national conferences, events, or competitions (L1, L2, C)
- 1.2.6 Describe the importance of a constitution and bylaws to the operation of a CTSO chapter (L1, L2, C)

Performance Standard 1.3: Participate in Community Service

- 1.3.1 Explore opportunities in community service-related work-based learning (WBL) (L1, L2, C)
- 1.3.2 Participate in a service learning (program related) and/or community service project or activity (L1, L2, C)
- 1.3.3 Engage with business and industry partners for community service (L1, L2, C)

Performance Standard 1.4: Develop Professional and Career Skills

- 1.4.1 Demonstrate college and career readiness (e.g., applications, resumes, interview skills, presentation skills) (L1, L2, C)
- 1.4.2 Describe the appropriate professional/workplace attire and its importance (L1, L2, C)
- 1.4.3 Investigate industry-standard credentials/certifications available within this Career Cluster™ (L1, L2, C)
- 1.4.4 Participate in authentic contextualized instructional activities (L1, L2, C)
- 1.4.5 Demonstrate technical skills in various student organization activities/events (L1, L2, C)

Performance Standard 1.5: Understand the Relevance of Career and Technical Education (CTE)

- 1.5.1 Make a connection between program standards to career pathway(s) (L1, L2, C)
- 1.5.2 Explain the importance of participation and completion of a program of study (L1, L2, C)
- 1.5.3 Promote community awareness of local student organizations associated with CTE programs (L1, L2, C)

CONTENT STANDARD 2.0: IDENTIFY LAB ORGANIZATION AND SAFETY PROCEDURES**Performance Standard 2.1: Demonstrate General Lab Safety Rules and Procedures**

- 2.1.1 Describe general shop safety rules and procedures (L1)
- 2.1.2 Demonstrate knowledge of Occupational Safety and Health Administration (OSHA) and its role in workplace safety (L1)
- 2.1.3 Comply with the required use of personal protective equipment (PPE) during lab/shop activities (L1)
- 2.1.4 Utilize safe procedures for handling of tools and equipment (L1)
- 2.1.5 Operate lab equipment according to safety guidelines (L1)
- 2.1.6 Identify and use proper lifting procedures and proper use of support equipment (L1)
- 2.1.7 Utilize proper ventilation procedures for working within the lab/shop area (L1)
- 2.1.8 Identify marked safety areas (L1)
- 2.1.9 Identify the location and the types of fire extinguishers and other fire safety equipment (L1)
- 2.1.10 Demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment (L1)
- 2.1.11 Identify the location and use of eye wash stations (L1)
- 2.1.12 Identify the location of the posted evacuation routes (L1)
- 2.1.13 Identify and wear appropriate clothing for lab/shop activities (L1)
- 2.1.14 Secure hair and jewelry for lab/shop activities (L1)
- 2.1.15 Demonstrate knowledge of the safety aspects of high voltage circuits requiring lock-out/tag-out (industry standard 50 volts) (L1)
- 2.1.16 Locate and interpret safety data sheets (SDS) (L1)
- 2.1.17 Prepare time or job cards, reports, or records (L1)
- 2.1.18 Perform housekeeping duties (L1)
- 2.1.19 Follow verbal instructions to complete work assignments (L1)
- 2.1.20 Follow written instructions to complete work assignments (L1)

Performance Standard 2.2: Identify and Utilize Hand Tools

- 2.2.1 Identify hand tools and their appropriate usage (L1)
- 2.2.2 Identify standard and metric designation (L1)
- 2.2.3 Demonstrate the proper techniques when using hand tools (L1)
- 2.2.4 Demonstrate safe handling and use of appropriate tools (L1)
- 2.2.5 Demonstrate proper cleaning, storage, and maintenance of tools (L1)

Performance Standard 2.3: Identify and Utilize Power and Battery-Operated Tools and Equipment

- 2.3.1 Identify power tools and their appropriate usage (L1)
- 2.3.2 Identify data collection tools and their appropriate usage (L1)
- 2.3.3 Demonstrate the proper techniques when using power tools and equipment (L1)
- 2.3.4 Demonstrate safe handling and use of appropriate power tools and equipment (L1)
- 2.3.5 Demonstrate proper cleaning, storage, and maintenance of power tools and equipment (e.g., battery charging, interface downloading) (L1)

CONTENT STANDARD 3.0: APPLY FUNDAMENTAL PRINT READING, MEASURING, AND SKETCHING TECHNIQUES**Performance Standard 3.1: Demonstrate Print Reading Practices**

- 3.1.1 Examine the basic elements of a technical drawing (e.g., legend, title block information, dimensions, line types, versioning) (L1)
- 3.1.2 Identify American National Standards Institute (ANSI) and International Organization for Standardization (ISO) industry standard symbols (i.e., hydraulic, pneumatic, electrical, welding, mechanical) (L1)
- 3.1.3 Prepare a materials list from a technical drawing (L1)
- 3.1.4 Describe various types of drawings (e.g., part, assembly, pictorial, orthographic, isometric, schematic) (L1)
- 3.1.5 Understand dimensioning, sectional drawings, fasteners, tables, charts, and assembly drawings (L1)

Performance Standard 3.2: Demonstrate Measuring and Scaling Techniques

- 3.2.1 Identify industry standard units of measure (L1)
- 3.2.2 Convert between customary (i.e., Society of Automotive Engineers [SAE], Imperial or metric systems) (L1)
- 3.2.3 Determine appropriate engineering and metric scales (L1)
- 3.2.4 Measure and calculate speed, distance, object size, area, and volume (L2)
- 3.2.5 Demonstrate proper use of precision measuring tools (e.g., micrometer, dial-indicator, dial-caliper) (L2)

Performance Standard 3.3: Demonstrate Freehand Technical Sketching Techniques

- 3.3.1 Prepare freehand and field sketches (L1)
- 3.3.2 Identify appropriate proportions (L1)
- 3.3.3 Create schematic diagrams using proper symbols (L2)
- 3.3.4 Annotate sketches legibly(L2)

CONTENT STANDARD 4.0: APPLY FUNDAMENTAL ENERGY PRINCIPLES**Performance Standard 4.1: Identify Energy Form**

- 4.1.1 Define energy and stored energy (L1)
- 4.1.2 Categorize types of energy into major forms: thermal, radiant, nuclear, chemical, electrical, mechanical, solar, wind, and fluid (L1)
- 4.1.3 Identify units used to measure energy(L1)
- 4.1.4 Apply data and measurements to solve problems and interpret documents (e.g., resistances, Ohm's Law, power) (L1)
- 4.1.5 Calculate unit conversions between common energy measurements (L1)

Performance Standard 4.2: Distinguish Potential and Kinetic Energy

- 4.2.1 Define potential and kinetic energy (L1)
- 4.2.2 Identify forms of potential and kinetic energy (L2)

Performance Standard 4.3: Identify Thermodynamics

- 4.3.1 Define thermodynamics (L1)
- 4.3.2 Utilize industry standard terminology (L1)
- 4.3.3 Demonstrate the concepts of heat transfer (i.e., conduction, convection, radiation) (L2)

CONTENT STANDARD 5.0: APPLY FUNDAMENTAL POWER SYSTEM PRINCIPLES**Performance Standard 5.1: Identify Power Systems**

- 5.1.1 Define terms used in power systems (e.g., power, work, horsepower, watts) (L1)
- 5.1.2 Identify the basic power systems (L1)
- 5.1.3 List the basic elements of power systems (L1)
- 5.1.4 Summarize the advantages and disadvantages of various forms of power (L1)

Performance Standard 5.2: Identify and Utilize Basic Mechanical System from Various Industries

- 5.2.1 Locate and explain examples of the six simple machines and their attributes and components (L1)
- 5.2.2 Measure forces and distances related to mechanisms (L1)
- 5.2.3 Determine efficiency in a mechanical system (L1)
- 5.2.4 Calculate mechanical advantage (L1)
- 5.2.5 Measure torque and use it to calculate power (L2)

Performance Standard 5.3: Identify and Utilize Basic Fluid Systems from Various Industries

- 5.3.1 Define fluid systems (i.e., hydraulic, pneumatic, vacuum) (L1)
- 5.3.2 Discuss the difference pressure and flow (resistance and movement) (L1)
- 5.3.3 Identify the components of fluid systems (L1)
- 5.3.4 Compare and contrast hydraulic and pneumatic systems (L1)
- 5.3.5 Identify the advantages and disadvantages of using fluid power systems (L1)
- 5.3.6 Explain the difference between gauge pressure and absolute pressure (L2)
- 5.3.7 Discuss the safety concerns of working with liquids and gases stored under pressure (L2)
- 5.3.8 Test various fluid systems(L2)

Performance Standard 5.4: Identify and Utilize Basic Electrical Systems from Various Industries

- 5.4.1 Define alternating current (AC) and direct current (DC) electrical systems and terminology (L1)
- 5.4.2 Discuss the safety concerns of working with electricity (L1)
- 5.4.3 Identify series, parallel and series-parallel (combination) circuits (L1)
- 5.4.4 Solve series and parallel circuits using basic laws of electricity including Kirchoff's laws (L2)
- 5.4.5 Introduce single-phase and three-phase AC power (L2)
- 5.4.6 Construct simple electrical circuits from a schematic (L2)

Performance Standard 5.5: Identify and Utilize Advanced Mechanical Systems from Various Industries

- 5.5.1 Explain the differences between gasoline engines and diesel engines (e.g., torque ratios, fuel economy, compression ratios, fuel types) (L2)
- 5.5.2 Identify electrical motor systems and motor controls by application (e.g., stepper, DC drive, AC drive) (L2)
- 5.5.3 Use safety procedures for advanced mechanical systems (L2)
- 5.5.4 Examine the relationship between bearings, couplings, and gear drives (L2)
- 5.5.5 Identify the components of the engine assembly (L2)
- 5.5.6 Inspect engine assembly components for fuel, oil, coolant, and other leaks to establish a repair plan (L2)
- 5.5.7 Repair, according to repair plan, various leaks in advanced mechanical systems (e.g., engine assembly fuel, oil, coolant) (L2)
- 5.5.8 Identify the components of drivetrain assemblies (L2)
- 5.5.9 Inspect drivetrain assemblies for leakage at external seals, gaskets, and bushings and establish a repair plan (L2)
- 5.5.10 Repair, according to repair plan, drivetrain assemblies for leakage at external seals, gaskets, and bushings in advanced mechanical systems (L2)
- 5.5.11 Explain belt drive concepts, v-belt operation, belt tensioning, and belt tension measurement (L2)
- 5.5.12 Demonstrate belt tensioning procedures and pulley/sheave alignment (L2)

CONTENT STANDARD 6.0: IDENTIFY AND APPLY FASTENING AND JOINING PROCESSES

Performance Standard 6.1: Identify Fasteners

- 6.1.1 Identify various fastening methods (e.g., rivets, welds, adhesive, screws, nuts and bolts, seams) (L1)
- 6.1.2 Categorize fastening methods by appropriate applications (L1)
- 6.1.3 Interpret information on size, grade, and design of fasteners (e.g., threading, metal type, head style) (L1)
- 6.1.4 Explore the requirements of torque specifications in various applications (e.g., engines, piping systems, power plants) (L1)
- 6.1.5 Demonstrate fastening methods on various materials (L1)

Performance Standard 6.2: Demonstrate Safe and Proper Techniques in Oxy-Fuel Gas Cutting (OFC)

- 6.2.1 Perform safety inspections of OFC equipment and accessories (L2)
- 6.2.2 Make minor external repairs to OFC equipment and accessories (L2)
- 6.2.3 Sets up for OFC operations on carbon steel (L2)
- 6.2.4 Operate OFC equipment on carbon steel (L2)
- 6.2.5 Perform straight, square edge cutting operations in the flat position on carbon steel (L2)

CONTENT STANDARD 7.0: APPLY FUNDAMENTAL ELECTRONIC AND INSTRUMENTATION PRINCIPLES**Performance Standard 7.1: Demonstrate Control Technology and Automation Principles**

- 7.1.1 Research the history and fundamentals of automation and control systems (L1)
- 7.1.2 Identify applications of control logic (L1)

Performance Standard 7.2: Demonstrate Diagnostic and Troubleshooting Practices

- 7.2.1 Explain a diagnostic procedure (L1)
- 7.2.2 Identify the components of a safety procedure checklist (L2)
- 7.2.3 Utilize all safety procedures necessary before performing a repair (e.g., lock-out/tag-out, etc.) (L2)
- 7.2.4 Navigate through user software (L2)
- 7.2.5 Understand and use software instructions offered in user software (L2)
- 7.2.6 Develop a routine maintenance plan (L2)
- 7.2.7 Utilize various sources of repair, maintenance, and troubleshooting documentation (e.g., print media, electronic, tech support, local expert) (L2)
- 7.2.8 Use manufacturer's documentation for troubleshooting (L2)
- 7.2.9 Utilize diagnostic tools appropriately (L2)
- 7.2.10 Troubleshoot and repair common problems (L2)

Performance Standard 7.3: Demonstrate Analog and Digital Electronic Principles

- 7.3.1 Demonstrate safe use of electricity and lab equipment (L2)
- 7.3.2 Understand and demonstrate basic electronic theory (L2)
- 7.3.3 Identify electronic components and their applications (e.g., resistors, capacitors, inductors, transformers, etc.) (L2)
- 7.3.4 Utilize tools and test equipment appropriately (L2)
- 7.3.5 Measure electrical characteristics of voltage, current, and resistance in basic electronic circuits using multi-meters and oscilloscopes (L2)
- 7.3.6 Demonstrate appropriate solder and de-solder techniques for electronics and electrical circuits (L2)
- 7.3.7 Demonstrate appropriate use of various connectors (e.g., crimp connectors, wire nuts, RJ45, CAT5e) (L2)
- 7.3.8 Construct a simple AC circuit using passive components (i.e., resistors, inductors, capacitors) (L2)
- 7.3.9 Construct a simple AC circuit using active components (i.e., diodes, transistors, linear devices) (L2)
- 7.3.10 Demonstrate the appropriate use of relays and switches (L2)

Complementary Courses

State Complementary Skill Standards

State complementary skill standards are designed to clearly state what the student should know and be able to do upon completion of a **one-year** complementary course related to their career and technical education (CTE) program of study. **Completion of the qualifying Program of Study is required prior to enrollment in a complementary course.**

Employability Skills for Career Readiness Standards

Students have completed all program content standards and will pursue advanced study through investigation and in-depth research.

Complementary Course Standards Contributing Members

Course Contribution(s)	Name	Occupation/Title	Stakeholder Affiliation	School/Organization
Millwright Processes	Thomas Bruns	Instructor	Postsecondary Educator	Great Basin College, Elko
Millwright Processes	Anthony Chapple	Instructor	Secondary Educator	Northwest Career and Technical Academy, Clark County School District
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The Millwright Processes complementary standards for Industrial Maintenance program of study were validated through active participation of business and industry representatives on the development team.

Complementary Course Information for Industrial Maintenance

Program Information

Qualifying Program of Study: Industrial Maintenance

Career Cluster: Manufacturing

Career Pathway(s): Maintenance, Installation, and Repair

CTSO: SkillsUSA

Grade Level: 11-12

Program Structure for Complementary Courses

The complementary courses are provided in the following table. **The qualifying program of study must be completed prior to enrolling in the complementary courses** (except labs that are done concurrently with the second-year course). A program does not have to utilize the complementary courses for students to complete their program of study.

Complementary Courses

Required/ Complementary	Course Title	Abbreviated Name
C	Millwright Processes	MILL PROC
C	Industrial Maintenance Advanced Studies	IND MAINT AS
C	Industry-Recognized Credential – Industrial Maintenance	IRC IND MAINT
C	CTE Work Experience – Manufacturing	WORK EXPER MANUF

Complementary Course Standards

Millwright Processes

CONTENT STANDARD 1.0: APPLY FUNDAMENTAL ENERGY PRINCIPLES

Performance Standard 1.1: Identify Energy Forms

- 1.1.1 Classify energy resources as non-renewable or renewable energy
- 1.1.2 Classify energy resources as potential or kinetic energy

Performance Standard 1.2 Distinguish Potential and Kinetic Energy

- 1.2.1 Research energy conversions
- 1.2.2 Demonstrate proper cleaning, storage, and maintenance of power tools and equipment (e.g., battery charging, interface downloading)

Performance Standard 1.3 Identify Thermodynamics

- 1.3.1 Identify the common units of measurement
- 1.3.2 Apply the Laws of Thermodynamics

Performance Standard 1.4 compare Non-renewable and Renewable Energy Sources

- 1.4.1 Calculate the efficiency of power systems and conversion devices
- 1.4.2 Identify forms of non-renewable and renewable energy
- 1.4.3 Research non-renewable and renewable energy sources
- 1.4.4 Calculate non-renewable and renewable energy including unit conversions
- 1.4.5 Analyze the environmental impact of non-renewable and renewable energy
- 1.4.6 Assess energy efficiency and conservation

CONTENT STANDARD 2.0: APPLY FUNDAMENTAL POWER SYSTEM PRINCIPLES

Performance Standard 2.1: Identify Power Systems

- 2.1.1 Calculate the efficiency of power systems and conversion devices
- 2.1.2 Demonstrate the use of an energy conversion device

Performance Standard 2.2: Identify and Utilize Basic Mechanical Systems

- 2.2.1 Design, construct, and test various basic mechanical systems

Performance Standard 2.3: Identify and Utilize Basic Fluid Systems

- 2.3.1 Calculate mechanical advantage using Pascal's Law
- 2.3.2 Calculate values in a pneumatic system, using the ideal gas laws
- 2.3.3 Design various fluid systems
- 2.3.4 Construct various fluid systems

Performance Standard 2.4: Identify and Utilize Basic Electrical Systems

- 2.4.1 Identify the advantages and disadvantages of using electrical systems
- 2.4.2 Analyze the laws, principles, and types of electricity to utilize, repair, and maintain equipment used in an industrial environment
- 2.4.3 Describe the principles of generation, transmission, distribution, and storage of electricity
- 2.4.4 Compute values of current, resistance, and voltage using Ohm's Law

**CONTENT STANDARD 3.0: IDENTIFY AND APPLY FASTENING AND JOINING PROCESSES
MANUFACTURING PROCESSES****Performance Standard 3.1: Identify Material Properties and Science**

- 3.1.1 Identify the major material families used in manufacturing
- 3.1.2 Differentiate between the various types of material properties and their applications
- 3.1.3 Discuss the impact of material usage on the environment
- 3.1.4 Explain how production is affected by the availability, quality, and quantity of resources
- 3.1.5 Differentiate among a raw material standard stock and finished products

Performance Standard 3.2: Identify Manufacturing Processes

- 3.2.1 Identify and describe the five major manufacturing processes (i.e., forming, separating, fabricating, conditioning, and finishing)
- 3.2.2 Discuss the impact of manufacturing processes on the environment
- 3.2.3 Describe Lean manufacturing and explain its importance

Performance Standard 3.3: Apply Manufacturing Processes

- 3.3.1 Demonstrate cutting methods of metal and plastics
- 3.3.2 Demonstrate drilling methods of metals and plastics
- 3.3.3 Demonstrate grinding methods of metals
- 3.3.4 Demonstrate finishing methods of metals and plastics
- 3.3.5 Demonstrate additive manufacturing processes through 3D printing

**Performance Standard 3.4: Demonstrate Safe and Proper Techniques in Shielded Metal Arch
Welding (SMAW)**

- 3.4.1 Perform safety inspections of SMAW equipment and accessories
- 3.4.2 Make minor external repairs to SMAW equipment and accessories
- 3.4.3 Set up and operate SMAW equipment on carbon steel
- 3.4.4 Produce fillet and groove welds on carbon steel
- 3.4.5 Produce three AWS standard welds in the flat and horizontal position

**Performance Standard 3.5: Demonstrate Safe and Proper Techniques in Oxy-fuel Gas Cutting
(OFC)**

- 3.5.1 Perform shape, square edge cutting operations in the flat position on carbon steel

CONTENT STANDARD 4.0: APPLY FUNDAMENTAL ELECTRONIC AND INSTRUMENTATION PRINCIPLES**Performance Standard 4.1: Demonstrate Analog and Digital Electronic Principles**

- 4.1.1 Verify Ohm's Law and power equations
- 4.1.2 Construct, measure, and analyze simple series, parallel, and series-parallel (combination) circuits
- 4.1.3 Build a circuit based on a provided schematic drawing

Performance Standard 4.2: Demonstrate Control Technology and Automation Principles

- 4.2.1 Distinguish programmable controllers (PLC) and PLC components and their functions
- 4.2.2 Interpret programming diagrams
- 4.2.3 Sketch programming diagrams for real world applications
- 4.2.4 Program ladder logic statements to perform a specific task
- 4.2.5 Develop ladder/relay logic application use for a PLC to control industry specific processes
- 4.2.6 Select most appropriate type of circuit logic for each application
- 4.2.7 Understand varying types of hardware used throughout the industry
- 4.2.8 Apply suitable commands to PLC circuits
- 4.2.9 Setup and test PLCs
- 4.2.10 Understand and select proper communication drivers to interface with a PLC system
- 4.2.11 Troubleshoot issues with PLCs
- 4.2.12 Perform basic maintenance with PLCs