Industrial Technology Standards Pilot Program

These foundational standards for Industrial Tech
are intended for a pilot for the FY20 year.

Those districts willing to utilize these
for FY20 or FY21
should contact
Pat Thieben at pat.thieben@iowa.gov
before December 31.

1.0 Industrial Technology Foundational Standards
Comprehensive Standard 1.1 Students will understand engineering and technology and the impact on the world
Content Standard 1.1.1 Students will examine how engineering and technology helps improve, manage, and control natural and engineered environments
1.1.1.1 Illustrate the purpose and impact of engineering and technology on society and the environment.
1.1.1.2 Apply the universal systems model when studying areas of engineering and technology
Analyze the interdisciplinary nature of STEM
Content Standard 1.1.2 Students will investigate the evolution of engineering, technology, and trade and industry on products, structures, and systems.
1.1.2.1 Analyze technological advancements throughout time periods in history.
1.1.2.2 Investigate inventions and innovations of products, processes, materials, and tools.
1.1.2.3 Evaluate how technology inventions and innovations have impacted (positive/negative) the society and the environment.
Comprehensive Standard 1.2 Students understand safety practices and procedures
Content Standard 1.2 Students apply safety practices in the lab and on worksites
1.2.1 Demonstrate safe practices and procedures with tools and equipment.
1.2.2 Demonstrate appropriate use of personal protective equipment
1.2.3 Document safety concerns according to local policies and procedures
1.2.4 Analyze hazardous materials procedure and OSHA.
Comprehensive Standard 1.3 Students investigate careers and skills in engineering, technology, STEM, and trade and industry fields.
Content Standard 1.3 Students apply and adapt appropriate workplace behaviors and characteristics to prepare for careers.
1.3.1 Demonstrate effective interpersonal, leadership and communication skills
1.3.2 Analyze education and skill requirements for engineering and technology and related professions.
1.3.3 Report the outlook, demand, and projected wages for engineering, technology, STEM, and trade and industry careers.
1.3.4 Research, analyze, and use data for work assignments
1.3.5 Exhibit a responsible work ethic
1.3.6 Demonstrate accepted standards for ethical behavior
1.3.7 Establish a personal career goal and develop objectives for achieving the goal
1.3.8 Create a continuing education plan that identifies further education and training options
1.3.9 Prepare for exams leading to certifications recognized by business and industry
1.3.10 Evaluate resources that keep workers current in the career field
Comprehensive Standard 1.4

1.0 Industrial Technology Foundational Standards
Students will examine the engineering design and development procedure.
Content Standard 1.4.1 Students will apply engineering principles when planning, developing, implementing and analyzing technological solutions
1.4.1.1 Apply the steps of the design process
1.4.1.2 Use the design process to create a product that addresses a real world problem.
1.4.1.3 Develop a product using the design process, while maintaining appropriate documentation.
1.4.1.4 Develop various types of models (graphical, physical, or mathematical) that help communicate solutions to peers.
Content Standard 1.4.2 Students will apply the principles of automation and robotics
1.4.2.1 Differentiate between the functions of motors, gears, sensors, wheels and control systems.
1.4.2.2 Interpret a technical document to build a working prototype of an automated system.
1.4.2.3 Design a working prototype or mechanical system to solve a pre-designated task.
1.4.2.4 Utilize the principles of computer science and information technologies by developing applications and codes applying to automation and robotics.
Comprehensive Standard 1.5 Students will apply technology concepts in various sectors.
Content Standard 1.5.1 Students will select, use, create, and evaluate transportation technologies
1.5.1.1 Compare and contrast the different types and uses of land, sea, air, space, and intermodal transportation.
1.5.1.2 Differentiate between the technical sub-systems common of all vehicles, including propulsion, structural, suspension, control, information, and support systems.
1.5.1.3 Design, develop, and evaluate transportation systems.
Content Standard 1.5.2 Students will select, use, create, and evaluate construction technologies.
1.5.2.1 Investigate various types of construction systems including residential, industrial, commercial, and civil.
1.5.2.2 Utilize appropriate designs, techniques, tools, and processes for construction systems.
1.5.2.3 Construct simulations, models, and/or structures for specific construction systems.
Content Standard 1.5.3 Students select, use, create, and evaluate manufacturing technologies
1.5.3.1 Investigate various types of manufacturing systems including continuous, batch, and custom.
1.5.3.2 Utilize appropriate designs, techniques, tools, materials, and processes for manufacturing systems.
1.5.3.3 Produce simulations, models, and/or prototypes for specific manufacturing systems.
1.5.3.4 Describe and create a logistical path a product takes from its point of origin to its destination.
Content Standards 1.5.4 Students select, use, create, and evaluate auto and diesel mechanic technologies.
1.5.4.1 Investigate various types of technologies in the auto and diesel mechanic field.
1.5.4.2 Examine appropriate designs, techniques, tools, and processes for auto and diesel mechanic systems.

2.0 Automotive
Domain 2.1 – Diagnosis
Core Standard 2.1 Students analyze vehicle components and system operations to establish accurate diagnosis and repair procedures.
2.1.1 Demonstrate knowledge of vehicle system
2.1.2 Conduct other related engine service activities
2.1.3 Examine brake systems
2.1.4 Analyze suspension and steering systems performance and determine repairs
2.1.5 Diagnose power steering systems to determine appropriate course of action
2.1.6 Diagnose steering and suspension components to determine need for replacement
2.1.7 Diagnose McPherson strut assembly according to industry standards
2.1.8 Diagnose rear suspension system and determine needed service
2.1.9 Remove, inspect and service or replace front or rear wheel bearings
2.1.10 Check and adjust all 4-wheel alignment angles and measurements
2.1.11 Inspect, rotate, mount, and balance tires
2.1.12 Perform pre-alignment checks according to industry standards
2.1.13 Diagnose ABS and traction control systems
2.1.14 Troubleshoot, clean, and replace components of transmission system.
Domain 2.2 – Repair
Core Standard 2.2 Students select appropriate industry tools and procedures to perform service and repairs on various vehicle components and systems.
2.2.1 Select and use appropriate tools and technology
2.2.2 Implement quality assurance measures and safeguards
2.2.3 Develop skills needed to enter the workforce
2.2.4 Evaluate resources that keep workers current in the career field
2.2.5 Service brake systems
2.2.6 Disable supplemental restraint systems in accordance with manufactures' procedures
2.2.7 Repair and replace steering and suspension components
2.2.8 Remove and replace McPherson struts according to industry standards
2.2.9 Remove, inspect and service or replace front or rear wheel bearings
2.2.10 Demonstrate proper shop safety practices while using brake tools and equipment
2.2.11 Repair ABS and traction control systems

3.0 Automotive Collision Repair
Domain 3.1 – Safety/Shop Basics
Core Standard 3.1 Students integrate safety and basic shop procedures into activities as appropriate to comply with professional and governmental safety standards.
3.1.1 Perform personal and shop safety practices
3.1.2 Integrate concepts to both standard and metric measurements with various types of measuring devices. The students will use rulers, calipers, dial indicators, and micrometers
3.1.3 Use proper shop safety practices while in the lab(s)—this includes wearing safety glasses (goggles) at all times while in the lab(s)
3.1.4 Identify various fasteners and their uses—this includes all of the various fasteners used on the automobile to attach a variety of body panels and pieces to the body and/or frame of the vehicle
3.1.5 Identify various hand and power tools and demonstrate their safe and proper use, storage, and maintenance—this also includes proper storing and oiling of air tools
Domain 3.2 – Metal Repair/Plastic Repair/Welding
Core Standard 3.2 Students select appropriate procedures to repair damage to specific materials.
3.2.1 Perform minor damage repair and surface painting preparation procedures
3.2.2 Use welding and cutting operations as appropriate
3.2.3 Perform outer body panel repairs per industry standards
3.2.4 Define and describe different types of metals—this includes the identification of the various types of metals used on automobiles
3.2.5 Understand Gauge metals—this includes the proper use of specific measuring tools used to gauge metals
Domain 3.3 – Glass/Trim/Interior
Core Standard 3.3 Students select appropriate procedures to repair damage to glass, trim, and vehicle interior
3.3.1 Demonstrate proper procedures for removing and replacing glass
3.3.2 Demonstrate the proper removal, installation, inspection, and replacement (if necessary) procedures of moldings and ornaments
3.3.3 Identify repair processes for plastic and adhesives
Domain 3.4 – Frame/Structural/Welding
Core Standard 3.4 Students select appropriate procedures to repair vehicle frame and structural damage.
3.4.1 Identify vehicle structural damage
3.4.2 Perform welding and cutting operations as appropriate
3.4.3 Diagnose and repair vehicle damage and perform structural analysis
3.4.4 Perform unibody diagnosis, inspection, measurement, and repairs
Domain 3.5 – Refinishing
Core Standard 3.5 Student analyzes the processes involved to paint and refinish a vehicle.
3.5.1 Identify metal conditioners as they relate to the different metals
3.5.2 Use primers and sealers according to their uses (per manufacturer's specifications) as a base for final finishes—this includes the proper mixing and application of both primers and sealers
3.5.3 Distinguish between the different paint finishes including enamel, urethane, and lacquer finishes and their applications
3.5.4 Estimate the proper amount of paint, thinner or reducer needed for a specific job

3.0 Automotive Collision Repair
3.5.5 Show proper spraying techniques using production type equipment for spraying finishes (including lacquer and enamel)
3.5.6 Demonstrate proper use and application of base coat/clear coat systems
3.5.7 Clean and maintain spray equipment to remove excess materials remaining after spraying
3.5.8 Safely handle, store, and remove toxic body shop materials
3.5.9 Prepare the jam area of a body part for painting
3.5.10 Remove paint defects using proper procedures
Domain 3.6 – Estimating
Core Standard 3.6 Students analyze vehicle paint damage to estimate repair costs in terms of man hours and materials needed.
3.6.1 Calculate repair costs for various interior, exterior, mechanical, and electrical components to prepare accurate estimates to customers
3.6.2 Calculate costs and time for various refinishing projects to prepare accurate estimates to customers

4.0 Construction
Domain 4.1 – Tools
Core Standard 4.1 Students utilize the appropriate hand, power, and stationary tools to complete various components of a building project.
4.1.1 Use basic construction hand tools
4.1.2 Demonstrate the proper use of portable power tools
4.1.3 Demonstrate the proper set-up and use of stationary power tools
4.1.4 Set up and properly use levels and transits
Domain4.2 – Plans, Specifications, and Codes
Core Standard 4.2 Students interpret data from plans, specifications and codes to construct various structures.
4.2.1 Interpret plans, specifications, codes, and welfare standards as dictated by local, state, or federal agencies
4.2.2 Apply the use of construction tools in the creation of a lab project built to plans or specifications
4.2.3 Evaluate plans based on local, state, or federal codes
Domain 4.3 – Construction Blueprint Reading
Core Standard 4.3 Students interpret residential and light commercial construction blueprints to construct structures.
4.3.1 Interpret health, safety, and welfare standards as dictated by local, state, or federal agencies
4.3.2 Identify the types of architectural lines, symbols, notations, and abbreviations used in print reading
4.3.3 Identify types of drawings such as elevation views, section views, detail views, and construction materials
4.3.4 Verify the ability to understand and explain building specifications, define dimensioning standards, and the ability to read various scales used in print reading
4.3.5 Apply and adapt knowledge and skills in reading blueprints for structural information
4.3.6 Apply and adapt systems concepts and knowledge to residential and light commercial technologies
Domain 4.4 – Floor and Wall Layout Construction
Core Standard 4.4.1 Students evaluate quantities and strength of concrete and masonry materials to perform floor and wall installations.
4.4.1.1 Create openings for access and equipment to pass through in foundation walls and basement walls
4.4.1.2 Choose the proper tools for pouring and finishing concrete flatwork
4.4.1.3 Establish proper foundation corners for a structure based on blueprints and use those corners to install walls
Core Standard 4.4.2 Students construct floor framing as dictated by local, state, or federal regulation.
4.4.2.1 Select the proper tools and material for layout in construction of a floor system
4.4.2.2 Apply and adapt methods used in laying out floor framing systems
4.4.2.3 Apply and adapt knowledge of floor framing systems by listing all required components and describing their functions
4.4.2.4 Describe the sub-assemblies, which make up the floor layout
4.4.2.5 Create a floor system in accordance with proper construction procedures and practices
Core Standard 4.4.3 Students construct wall framing as dictated by local, state, or federal regulation.

4.0 Construction
4.4.3.1 Select the proper tools and material for layout in construction of a wall system
4.4.3.2 Apply and adapt methods used in laying out wall framing systems
4.4.3.3 Apply and adapt knowledge of wall framing systems by listing all required components and describing their functions
4.4.3.4 Describe the sub-assemblies, which make up the wall layout
Create a wall system in accordance with proper construction procedures and practices
Core Standard 4.4.4 Students apply concepts and basic skills in practical residential construction projects to layout a stairway.
4.4.4.1 Design and layout a stairway using the framing square and match applicable to stair construction
4.4.4.2 Practice safety habits- as required by the trade and OSHA- at all times
4.4.4.3 Apply and adapt knowledge of building structure, materials, and methods of construction.

5.0 Construction Electrical Focus *Students should also understand the basic construction standards*
Domain 5.1 – Electrical Basics
Core Standard 5.1 Students apply concepts of circuitry to ensure proper wiring of structure.
5.1.1 Describe the differences in AC and DC current
5.1.2 Explain the operation of capacitors, inductors, and transformers
5.1.3 Identify various power sources
Core Standard 5.2 Students design electrical circuits to ensure correct wiring operations in structures.
5.2.1 Draw a simple DC circuit and explain various components
5.2.2 Describe the properties of resistance, voltage, current and power
5.2.3 Use Ohm's Law to calculate values
5.2.4 Use a multimeter to measure values in a circuit
5.2.5 Draw and explain series, parallel, series-parallel, open and short circuits
5.2.6 Explain the properties of magnetism and electro-magnetism
5.2.7 Describe the operation of capacitors, inductors, and transformers
5.2.8 Solve mathematical problems relating to electrical systems
Core Standard 5.3 Students apply appropriate procedures when working with electricity to ensure compliance with professional and governmental regulations.
5.3.1 Explain proper fusing and wire sizing
5.3.2 Explain proper safety practices when working with electricity
5.3.3 Evaluate plans based on regulations and compliance
Domain 5.4 – Residential Wiring
Core Standard 5.4 Students apply and adapt wiring concepts in residential electrical projects to ensure compliance with National Electrical Code.
5.4.1 Select wire and devices according to code
5.4.2 Design and install typical service entrance
5.4.3 Draw a wiring diagram based on a set of blueprints, specifications and code requirements
5.4.4 Apply critical thinking skills to technical problems and information
5.4.5 Identify and interpret health, safety, and welfare standards as dictated by local, state or federal agencies
Domain 5.5 – Commercial/Industrial Wiring
Core Standard 5.5 Students apply and adapt wiring processes to all commercial/industrial electrical projects to ensure compliance with the National Electrical Code.
5.5.1 Read blueprints, interpret drawings, understand specifications, and the NEC when installing an industrial wiring system
5.5.2 Install, service, and repair electrical circuits and controllers in the industrial setting
5.5.3 Size conductors for each application
5.5.4 Identify proper machine hook-up from plans
5.5.5 Install commercial light fixtures
5.5.6 Provide protection for wiring in industrial work areas
5.5.7 Identify safety problems in the industrial areas
5.5.8 Identify proper hardware and tools needed for each job
Domain 5.6 – Electrical Troubleshooting Techniques

5.0 Construction Electrical Focus *Students should also understand the basic construction standards*
Core Standard 5.6.1 Students employ wiring concepts to solve electrical problems in generators and alternators.
5.6.1.1 Explain operating principles of DC generators
5.6.1.2 Examine single phase AC generation principles
5.6.1.3 Examine physical and electrical characteristics of three phase alternators
5.6.1.4 Perform wiring procedures for alternators
Core Standard 5.6.2 Students apply wiring concepts to solve electrical problems in transformers.
5.6.2.1 Examine basic principles of transformers
5.6.2.2 Examine single phase transformers connected in Delta
5.6.2.3 Explain Wye and Delta connections of single phase transformers
5.6.2.4 Install instrument transformers
5.6.2.5 Examine the role of three phase transformers
5.6.2.6 Understand National electrical code requirements for transformers installations

6.0 Diesel
Domain 6.1 – Engines
Core Standard 6.1 Students analyze diesel engine operations to diagnose and repair malfunctions.
6.1.1 Analyze the fundamentals of a diesel engine
6.1.4 Identify tools and equipment used in engine service
6.1.5 Adjust or measure valve and engine brake clearance
6.1.6 Utilize scan tools for engine service
6.1.7 Identify new emission controls and serviceability
6.1.8 Perform injector replacement procedures
6.1.9 Diagnose drivability concerns
6.1.10 Demonstrate proper shop safety practices while servicing engines
Domain 6.2 – Systems
Core Standard 6.2.1 Students examine various systems to diagnose and repair malfunctions.
6.2.1.1 Diagnose and repair fuel systems, electrical/electronic systems, and lubrication systems
6.2.1.2 Analyze and repair heating/cooling system
6.2.1.3 Assess and repair intake and exhaust systems
6.2.1.4 Perform preventative maintenance to the fuel system and lubricating system
6.2.1.5 Service the cold starting aid system
Core Standard 6.2.2 Students analyze all components of Diesel electrical systems to determine corrective actions needed for diagnosis and repair.
6.2.2.1 Identify various types of fasteners and their grades
6.2.2.2 Take both standard and metric measurements with various types of measuring devices
6.2.2.3 Explain how a modern Diesel battery works
6.2.2.4 Explain how a modern starting motor works
6.2.2.5 Demonstrate an understanding of how a modern charging system works
6.2.2.6 Demonstrate an understanding of how a modern lighting system works
6.2.2.7 Utilize modern automotive testing equipment
6.2.2.8 Diagnose common electrical problems in a modern vehicle
6.2.2.9 Interpret a modern wiring diagram
6.2.2.10 Diagnose and repair electrical and electronic fuel systems
6.2.2.11 Diagnose and repair electrical and electronic components of the lubrication systems
6.2.2.12 Analyze and repair electrical and electronic components of the heating/cooling system
6.2.2.13 Assess and repair electrical and electronic components of the intake and exhaust systems
6.2.2.14 Diagnose electrical and electronic components that effect engine performance
6.2.2.16 Inspect and repair electrical and electronic components of the pneumatic/hydraulic braking systems
6.2.2.16 Organize, research, and implement a complete preventive maintenance and inspection (P.M.I.)
Domain 6.3 – Fluids
Core Standard 6.3 Students evaluate fuel and other fluids used in diesel engines to perform appropriate maintenance and optimization procedures.
6.3.1 Identify the type of fuel and lubricating oil required for a diesel engine

7.0 Drafting and Design
Domain 7.1 – Utilizing the Design Process in Architectural Drafting
Core Standard 7.1 Students apply and adapt the design process to challenges found in architectural drafting scenarios.
7.1.1 Identify and utilize the design process
7.1.2 Recognize that budget constraints and customer needs are part of the design process
7.1.3 Interpret demographics in a given area and relate it to the design process
Domain 7.2 – Drawing Concepts in Architectural Drafting
Core Standard 7.2 Students integrate architectural concepts to produce industry standard drawings. Standards
7.2.1 Use various architectural and construction terminology correctly
7.2.2 Show familiarity with conventional drafting standards
7.2.3 Demonstrate proper use of drafting equipment and drafting symbols
7.2.4 Identify pictorial, isometric, and orthographic drawing types
7.2.5 Demonstrate advanced design sketching
7.2.6 Demonstrate architectural lettering to quality standards for
7.2.7 Interpret scaled detailed drawings
7.2.8 Demonstrate acceptable line work and construction techniques
7.2.9 Use and interpret sectioning techniques involving numerous line types
7.2.10 Interpret residential planning and bubble diagrams
7.2.11 Read an architectural scale and create a drawing to scale
Domain 7.3 – Utilization of CAD Software in Architecture
Core Standard 7.3 Students select specific commands to develop drawings to meet industry standards.
7.3.1 Demonstrate competence in the use of CAD software through assignments
7.3.2 Identify and use multiple input methods to select commands on the CAD system
7.3.3 Retrieve and use help commands
7.3.4 Navigate through and identify various parts of the CAD environment
7.3.5 Modify drawing elements using editing commands
7.3.6 Complete assignments using specific software commands and processes
7.3.7 Explain coordinate systems
7.3.8 Utilize the following features xref, design center, advanced plotting techniques, advance dimensioning, viewports, and materials library to meet industry standards
7.3.9 Troubleshoot and problem solve mathematical concepts by utilizing CAD tools
Domain 7.4 – Solving Design Challenges in Architectural Drafting
Core Standard 7.4 Students synthesize architectural knowledge to design and create solutions.
7.4.1 Develop and draw a floor plan, site plan, and foundation plan
7.4.2 Interpret roof framing and calculations
7.4.3 Draw wall sections
7.4.4 Design elevations
7.4.5 Interpret schedules
7.4.6 Manage 3D space
7.4.7 Create, modify, and use 3D wire frame, surface, and solid models
7.4.8 Construct a surface or a solid model

7.0 Drafting and Design
7.4.9 Create production drawings of the 3D models
7.4.10 Create 2D drawings from 3D Architectural objects
7.4.11 Design a commercial floor plan and commercial roof plans
7.4.12 Create floor systems and reflected ceiling plans
7.4.13 Produce production schedules
7.4.14 Create photo-realistic renderings
7.4.15 Analyze and create construction documents
7.4.16 Implement dimensioning in drawings
7.4.17 Introduce lighting to a scene
Domain 7.5 Interpret and apply required codes, standards, specifications, and cross-referencing
Core Standard 7.5 Students evaluate historical architecture to understand the styles and trends.
7.5.1 Identify the distinguishable design characteristics of the significant architectural styles in the history of civilizations
7.5.2 Integrate history, theory, technology and structures to influence formal and conceptual design manifested in materials, details, language and imagery
Domain 7.6 – Using the Design Process and Tools in Architectural Planning
Core Standard 7.6 Students establish design concepts to meet the project requirements.
7.6.1 Comprehend and discuss the purpose and need for “facilities programming”
7.6.2 Conceptualization of sketches and diagrams that demonstrate problem solving of programmatic issues
7.6.3 Utilize fundamentals of formal conceptual relationships, design methodology, and design process
7.6.4 Develop basic spatial and compositional ideas introduced through the study of typology, diagrams, and process of conceptualization
7.6.5 Demonstrate an ability to represent ideas in form and space, as a conceptual and cultural response to program, type, basic building construction, architectural language and design methods
7.6.6 Apply basic building codes in the context of social, political, civic and environmental responsibilities relative to our society
7.6.7 Analyze forces and loads on a structure
7.6.8 Identify line weights and how they relate to specific line types
7.6.9 Create standard drawings for commercial building structures

8.0 Engineering and Design
Domain 8.1 – Design Process
Core Standard 8.1 Students perform the steps of the design process to develop and analyze products and systems.
8.1.1 Describe the steps in the design process.
8.1.2 Generate a valid and justifiable problem.
8.1.3 Create a design brief by constructing a problem and design statement and identifying problem constraints.
8.1.4 Apply the steps of the design process as they are used to solve the problem.
8.1.5 Describe the iterative nature of the design loop.
8.1.6 Discuss how the design process impacts the outcome when designing solutions to problems.
Assess and refine original design solutions based upon reflection, critique, practice, and research.
Domain 8.2 – Technical Drawing Standards
Core Standard 8.2 Students will produce industry standard sketches and drawings to allow for universal communication.
8.2.1 Distinguish between line types utilized on a technical drawing per industry standard (ANSI Line Conventions and Lettering Y14.2M2008).
8.2.2 Interpret and develop appropriate annotations for technical drawings.
8.2.3 Differentiate between the various types of tolerances.
8.2.4 Analyze types of fits in relation to mating parts.
8.2.5 Collect and display data related to the sizes and shapes of objects utilizing various measuring tools.
8.2.6 Determine the appropriate number of views, including alternate views (auxiliary, section, detail), to fully document the details of a design.
8.2.7 Identify and produce various pictorial drawings including isometric, oblique, and perspective drawings for technical drawing representations.
8.2.8 Differentiate when the physical properties of geometric shapes can be utilized in order to optimize design solutions.
8.2.9 Apply industry accepted dimensioning practices to technical drawings in order to annotate design features.
Identify and produce multi-view drawings in proper orientation, scale, and proportion through methods of orthographic projection.
Illustrate and calculate mathematical problems related to real world situations involving characteristics of geometric shapes and solids.
Domain 8.3 – Reverse Engineering
Core Standard 8.3 Students will perform various analyses of systems or products with the purpose of developing appropriate improvements.
Identify visual, functional and structural properties of a product.
Differentiate between invention and innovation.
Describe the relationship between reverse engineering and product/system improvement.
Create an innovation to a system or product using information obtained from a product analysis.
Evaluate the effectiveness of elements and principles in other design solutions and use analysis to revise original design.
Perform mathematical calculations to identify structural properties of a product.

8.0 Engineering and Design
Domain 8.4 – Project Documentation
Core Standard 8.4 Explain the role of intellectual property in design and the necessity of producing and keeping an engineering notebook.
Maintain a working engineering notebook for the duration of the course.
Implement design briefs in the problem solving process.
Collaborate on engineering projects by working in design teams to solve valid problems.
Manage time and the progress of a project through effective use of a Gantt chart.
Engineering and Technology Education – Introduction to Engineering Design
Domain 8.5 – Engineering Design
Core Standard 8.5 Students assess the components and ethics of engineering design to understand their role in the design process.
Discuss historical and current events related to engineering and technology and analyze the impact on society.
Discuss the importance of ethics in engineering design.
Apply the design principles and elements.
Use engineering design equipment (3D modeling software, 3D printer, etc.) to create 3D and 2D models to document engineering design.
Identify the qualities of engineering design and their relationship to a design matrix.
Examine a design (product) with respect to its quality and usability.
Use the design principles and elements to meet the design criteria and constraints to solve a valid problem.
Domain 8.6 – Modeling
Core Standard 8.6 Students create designs using a variety of modeling techniques to communicate information.
Formulate methods of communicating designs using various forms of modeling such as conceptual, graphical, mathematical, physical or computer modeling.
Utilize appropriate modeling materials to construct a physical model such as a prototype or mockup.
Interpret the details of a sketch and generate physical or computer models using appropriate modeling materials and techniques.
Recognize and utilize constraints such as dimensional, geometric, assembly and parametric constraints in regard to modeling.
Identify the six degrees of freedom of a component floating in space in the context of an assembly.
Differentiate between assemblies and subassemblies and their appropriate use.
Analyze the remaining degrees of freedom of mating components after systematically applying assembly constraints until only desired components are allowed to move.
Domain 8.8 – Aesthetics
Core Standard 8.8 Students demonstrate artistic fundamentals which are utilized throughout the engineering design process to solve visual problems and communicate ideas for a product or system.
Apply visual design principles to enhance the aesthetic appeal of a design solution.
Analyze products or systems by identifying problematic features to generate potential solution(s).
Choose appropriate symbols and metaphors from art and design and describe their origin, function, and value in the solutions.

8.0 Engineering and Design
Create multiple solutions that demonstrate and distinguish mastery in producing effective relationships between elements, media, and function.
Create design solutions that use specific elements, principles, and functions that demonstrate skill and understanding of different communication processes to solve problems.

9.0 Manufacturing
Domain 9.1 – Manufacturing Impact
Core Standard 9.1 Students will analyze how advanced manufacturing impacts local, national, and global economies.
Analyze how advanced manufacturing impacts individuals, society, and the environment
Examine the role of advanced manufacturing in global economies
Report new and emerging technologies related to advanced manufacturing
Differentiate between internal and external customers
Domain 9.2 – Electricity
Core Standard 9.2 Students analyze the laws, principles, and types of electricity needed to utilize, repair, and maintain equipment used in an industrial environment.
Apply principles of electrical wiring safety in commercial settings
Apply Ohm's Law and the Power Law
Differentiate between series and parallel circuits
Solve series and parallel circuit using basic laws of electricity
Discuss power supply and voltage regulation as applied to basic electricity
Examine relay operation and applications
Demonstrate the understanding of the theory and function of switches, loads, resistors, capacitors, coils, and other basic electronic components
Troubleshoot solid state switching devices using basic circuits
Domain 9.3 – Programmable Logic Circuits
Core Standard 9.3 Students analyze the fundamentals of Programmable Logic Circuits (PLC's) to assess their role in manufacturing processes.
Distinguish between PLC components and their function
Select the most appropriate type of circuit logic for each application
Understand varying types of hardware used throughout industry
Apply suitable commands for PLC circuits
Domain 9.4 – Manufacturing Essentials
Core Standard 9.4 Students analyze essential aspects of manufacturing processes.
Describe the functional layout of a manufacturing plant based upon process flow
Report the history of and contemporary use computer numerical control (CNC) in machining
Apply basic CNC theory and process to manufacturing operations
Apply the Cartesian coordinate system in defining points, shape, form, and function in a machining environment
Domain 9.5 – Fluid Power Principles
Core Standard 9.5 Students analyze fluid power fundamentals to explore its role in equipment operation and performance.

9.0 Manufacturing
Compare and contrast hydraulic and pneumatic systems
Explain flow rate and correctly utilize industry abbreviations
Construct a simple fluid power system
Domain9.6 – Mechanical Principles
Core Standard 9.6 Students evaluate principles of mechanical advantage in equipment operations.
Describe the importance of machine specifications and how they are used
Examine the role of heat and friction in machine operations
Generate appropriate provisions for chips
Explain the relationships between rpm, horsepower, and torque
Apply simple machines to achieve mechanical advantage
Distinguish between a variety of industrial motors and motor controls
Perform mechanical power transmission safety procedures
Examine the relationship between bearings, couplings, gear drives, belt drive and chain drive operations
Demonstrate chain tensioning and tension measurement procedures
Perform fixed center chain installation procedures
Domain 9.7 – Fundamentals of Lean Manufacturing
Core Standard 9.7 Students analyze the impact of Lean principles and concepts on manufacturing to improve processes.
9.7.1 Investigate principles of Lean Manufacturing
9.7.2 Differentiate advantages of Lean over conventional operating methods
9.7.3 Identify the sources and types of waste streams in manufacturing
9.7.4 Examine methods manufacturers use to keep production costs low
9.7.5 Interpret a production schedule and manufacturing work order
9.7.6 Assess benefits of just-in-time (JIT) inventory control
9.7.7 Assess Manufacturing Resource Planning (MRP & MRP II) and Enterprise Resource Planning (ERP)
9.7.8 Implement the concepts of lean manufacturing to enhance operations
9.7.9 Examine methodologies required to achieve continuous improvement
9.7.10 Differentiate between value-added and non-value activities
Domain 9.8 – Impact and Trends
Core Standard 9.8 Students will analyze how advance manufacturing impacts national and global economies.
9.8.1 Investigate how advanced manufacturing impacts individuals, society, and the environment
9.8.2 Discuss new and emerging technologies related to advanced manufacturing
9.8.3 Apply current and emerging computer technologies utilized in industry
Domain 9.9 – CNC Programming
Core Standard 9.9 Students evaluate the fundamentals of CNC programming to perform processes and procedures.
9.9.1 Relate design information to manufacturing processes
9.9.2 Compare and contrast incremental coordinates vs. absolute coordinates
9.9.3 Determine positive and negative directions along axes
9.9.4 Identify G codes used to determine the mode of tool movement

9.0 Manufacturing
9.9.5 Examine the function of four types of mill toolpaths: contour 2D, pocket, letters, drill
9.9.6 Describe the function of six types of chaining methods
9.9.7 Explain the importance of a program's cycle time
9.9.8 Describe the function of roughing cuts and finish passes
9.9.9 Locate the edge of a part
9.9.10 Calculate spindle speeds for machine tools
9.9.11 Apply proper speed and feed rates for machine tools
Domain 9.10 – CAD/CAM & CNC Technologies
Core Standard Students create a part using CAD, CAM, & CNC programming.
9.10.1 Select appropriate annotation to document features within drawings using a scale
9.10.2 Produce a CAD Drawing using computer software
9.10.3 Interpret existing CAD files
9.10.4 Investigate the difference between machine zero and program zero on a CNC machine tool
9.10.5 Determine the work offsets and tool geometry offsets for a CNC program
9.10.6 Create programs using absolute and incremental coordinate positions
9.10.7 Compare and contrast Computer-Integrated Manufacturing and Flexible Manufacturing
9.10.8 Demonstrate how part shapes are created using CAM software
9.10.9 Develop two types of CNC programming languages: G&M codes, conversational
9.10.10 Demonstrate program verification techniques
Domain 9.11 – Programmable Logic Controllers
Core Standard 9.11 Students examine the role of programmable logic controllers in manufacturing processes.
9.11.1 Describe the common parts of programmable controllers
9.11.2 Program a start/stop circuit using a PLC
9.11.3 Interpret programming diagrams
9.11.4 Create programming diagrams for real-world applications
9.11.5 Apply timer and counter principles to industry-related problems
9.11.6 Setup and test PLC's
9.11.7 Perform basic maintenance and troubleshooting with PLC's
9.11.8 Differentiate between different types of path control systems
9.11.9 Describe the safety precautions associated with teach pendant operation
9.11.10 Design programs with a minimum of 4 axis manipulators
9.11.11 Explain the basic work cell with I/0
9.11.12 Identify the basics of the I/0 electrical control
9.11.13 Demonstrate I/0 testing procedures from the Editor Software
9.11.14 Categorize the types of sensors and explain their significance
9.11.15 Recognize requirements for an industrial controller
9.11.16 Differentiate microcontrollers from PC processors
Domain 9.12 – Automation Theory
Core Standard 9.12 Students evaluate theories and principles utilized within the automation and robotics industry to assess modern trends in advanced manufacturing.
9.12.1 Develop machine order of operations
9.12.2 Examine computer logic and scanning sequence in automated controls

9.0 Manufacturing
9.12.3 Convert relay logic into ladder logic diagrams
9.12.4 Explore the impact of cycle time and timing diagrams on manufacturing processes
Domain 9.13 – Robotics
Core Standard 9.13 Students develop a working knowledge of robotics and robotic parts to classify their roles in the manufacturing processes.
9.13.1 Define robot coordinate systems
9.13.2 Identify the various types of robots
9.13.3 Classify robots by their power systems, coordinate systems, and path systems
9.13.4 Compare and contrast the advantages and disadvantages of various robot types
9.13.5 Identify a robot's axes of motion and determine the importance of each articulation
9.13.6 Determine the total number of degrees of freedom needed for a robot to perform a specific job task
9.13.7 Apply basic knowledge of robot physics in manufacturing environments
9.13.8 Identify the various coordinate types of industrial robots, list the advantages and disadvantages of each, and recognize the work envelope of each
9.13.9 Select appropriate end effectors (end of arm tooling) for a given job task
9.13.11 Develop criteria to determine where, how, and with what force an end effector should grasp a part
9.13.12 Describe specific hazards associated with robots and determine appropriate safety methods for working around robots
9.13.13 Measure a robot's performance, such as speed, positioning accuracy, and repeatability, to determine if a robot meets the manufacturer's specifications
9.13.14 Program a robot using a teach pendant
Domain 9.14 – Automation
Core Standard 9.14 Students will explore the role of automation in industry.
9.14.1 Describe the hazards associated with automated machines
9.14.2 Determine appropriate safety methods for working around automated machinery
9.14.3 Critique the common types of factory automation
9.14.4 Examine the role of software controls in manufacturing
9.14.5 Design software utilizing programing software
9.14.6 Define the roles of input and output devices within automation

10.0 Precision Metalworking
Domain 10.1 – Tools and Processes
Core Standard Students apply and adapt basic hand and machine tool processes to create machined parts per industry specifications.
Perform basic benchwork
Demonstrate basic layout procedures
Perform turning operations
Perform basic milling operations
Demonstrate proper grinding wheel safety
Perform surface grinding operations
Perform basic drill press operations
Develop basic CNC programming/operations
Domain 10.2 – Quality Process Control and Inspection
Core Standard Students analyze processes and finished products to ensure compliance with job specifications.
Evaluate proper piece part inspection procedures
Recognize and explain control and improvement processes
Domain 10.3 – General Maintenance
Core Standard Students Integrate preventive maintenance schedules and tasks to ensure safe and accurate equipment upkeep.
Demonstrate general housekeeping and maintenance tasks
Identify routine preventive maintenance tasks
Recognize tooling maintenance procedures
Domain 10.4 – Engineering Drawings and Sketches
Core Standard Students draw sketches and interpret engineering drawings to determine product dimensions and specifications.
Interpret standard orthographic prints
Analyze and utilize standard GD&T orthographic prints
Identify and utilize GD&T datum, symbology and tolerances
Domain 10.5 – Measurement
Core Standard Students validate the proper use of precision measuring and layout instruments and inspection processes to ensure the quality of the finished product.
Differentiate between basic measuring instruments
Compare various precision measuring instruments
Recognize basic surface plate instruments
Domain 10.6 – Metalworking Theory
Core Standard 10.6 Students examine material properties and tooling processes to create finished products.
Explain cutting theory concepts
Identify appropriate tooling processes per product specifications
Evaluate the properties of various metals
Select appropriate machine tools for job completion
Examine the role of cutting fluids and coolants in the machining process
Domain 10.7 – Metalworking Theory

10.0 Precision Metalworking
Core Standard 10.7 Students examine material properties and tooling processes to create finished products.
Utilize cutting theory
Select and implement proper tooling processes
Evaluate and select proper materials based on properties
Examine the capabilities of machine tools
Select proper cutting fluids and coolants for product creation

11.0 Welding
Domain 11.1 – Safety and Health in Welding
Core Standard Students integrate proper safety procedures in class activities and projects to meet professional and governmental standards.
Apply safe practices according to American National Standards Institute safety standards
Utilize proper safe operation practices in work area
Demonstrates proper use and inspection of ventilation equipment
Demonstrates proper Hot Zone operation
Select proper procedures actions for working in confined spaces
Demonstrates proper use of precautionary labeling and MSDS information
Demonstrates proper inspection and operation of equipment used for each welding and thermal cutting process used
Domain 11.2 – Drawing and Welding Symbol Interpretation
Core Standard Students interpret technical drawings and documents to perform welding processes to specifications.
Analyze and interpret blueprints
Interprets basic elements of a drawing or sketch
Interprets welding symbol information
Fabricates parts from a drawing or sketch
Domain 11.3 – Manual and Mechanized Oxyfuel Cutting
Core Standard Students create sound manual and automatic oxyfuel cuts on materials to meet industry standards.
Perform manual and automatic oxyfuel gas cutting
Performs safety inspections of manual oxy fuel gas cutting (OFC) equipment and accessories
Makes minor external repairs to manual OFC equipment and accessories
Sets up for manual OFC operations on carbon steel
Operates manual OFC equipment on carbon steel
Performs straight, square edge cutting operations in the flat position on carbon steel
Performs shape, square edge cutting operations in the flat position on carbon steel
Performs straight, bevel edge cutting operations in the flat and position on carbon steel
Performs scarfing and gouging operations to remove base and weld metal, in flat and horizontal positions on carbon steel
Performs safety inspections of mechanized OFC equipment and accessories
Makes minor external repairs to mechanized OFC equipment and accessories
Sets up for mechanized OFC operations on carbon steel
Operates mechanized OFC equipment on carbon steel
Performs straight, square edge cutting operations in the flat position on carbon steel using mechanized OFC
Performs straight, bevel edge cutting operations in the flat position on of carbon steel using mechanized OFC
Examines tacks, root passes, intermediate layers, and completed welds
Domain 11.4 – Shielded Metal Arc Welding

11.0 Welding
Core Standard 11.4 Students execute appropriate Shielded Metal Arc welds on a variety of industrial metal to meet industry standards.
11.4.1 Apply Shielded Metal Arc Welding (SMAW) welding process fundamentals to actual lab experiences
11.4.2 Set up for SMAW operations on carbon steel
11.4.3 Operate SMAW equipment on carbon steel
11.4.4 Make fillet welds in all positions on carbon steel
11.4.5 Make groove welds in all positions on carbon steel
11.4.6 Pass SMAW welder performance qualification test (2G and 3G, uphill, limited thickness test plates) on carbon steel
Domain 11.5 – Welding Inspection and Testing
Core Standard 11.5 Students evaluate various weld stages to meet inspection criteria.
11.5.1 Examine cut surfaces and edges of prepared base metal parts
11.5.2 Examine tacks, intermediate layers, and completed welds
Domain 11.6 – Gas Metal Arc Welding
Core Standard 11.6 Student creates appropriate welds on a variety of industrial metals using Gas Metal Arc Welding and cutting processes to meet industry standards.
11.6.1 Demonstrate and practice ALL SAFETY RULES that apply to welding
11.6.2 Communicate all common welding terms
11.6.3 Apply metallurgy fundamentals to welding processes
11.6.4 Performs safety inspections of GMAW equipment and accessories
11.6.5 Makes minor external repairs to GMAW equipment and accessories
11.6.6 Sets up for GMAW-S operations on carbon steel
11.6.7 Operates GMAW-S equipment on carbon steel
11.6.8 Makes fillet welds in all positions on carbon steel
11.6.9 Makes groove welds in all positions on carbon steel
11.6.10 Passes GMAW-S welder performance qualification test on carbon steel
11.6.11 Sets up for GMAW (spray) operations on carbon steel
11.6.12 Operates GMAW (spray) equipment on carbon steel
11.6.13 Makes fillet welds in the 1F and 2F positions on carbon steel
11.6.14 Makes groove welds in the 1G position on carbon steel
11.6.15 Passes GMAW (spray) welder performance qualification test on carbon steel
11.6.16 Apply Flux Cored Arc Welding (FCAW / Gas Shielded and Self Shielded) process fundamentals
11.6.17 Performs safety inspections of FCAW equipment and accessories
11.6.18 Makes minor external repairs to FCAW equipment and accessories
11.6.19 Sets up for FCAW- G/GM operations on carbon steel (Gas Shielded)
11.6.20 Operates FCAW- G/GM equipment on carbon (Gas Shielded)
11.6.21 Makes fillet welds in all positions on carbon steel (Gas Shielded)
11.6.22 Makes groove welds in all positions on carbon steel (Gas Shielded)
11.6.23 Passes FCAW-G/GM welder performance qualification test on carbon steel (Gas Shielded)
11.6.24 Sets up for FCAW- S operations on carbon steel (Self Shielded)
11.6.25 Operates FCAW- S equipment on carbon (Self Shielded)
11.6.26 Makes fillet welds in all positions on carbon steel (Self Shielded)

11.0 Welding
11.6.27 Makes groove welds in all positions on carbon steel (Self Shielded)
11.6.28 Passes FCAW- S welder performance qualification test on carbon steel (Self Shielded)
Domain 11.7 – Gas Tungsten Arc Welding
Core Standard 11.7 Students create appropriate Gas Tungsten Arc Welds on a variety of industrial metals to meet industry standards.
11.7.1 Apply Gas Tungsten Arc Welding (GTAW) process fundamentals
11.7.2 Performs safety inspections of GTAW equipment and accessories
11.7.3 Makes minor external repairs to GTAW equipment and accessories
11.7.4 Sets up for GTAW operations on carbon steel, austenitic steel, and aluminum
11.7.5 Operates GTAW equipment on carbon steel, austenitic steel, and aluminum
11.7.6 Create fillet welds in all positions on carbon steel
11.7.7 Makes groove welds in all positions on carbon steel
11.7.8 Makes fillet welds in the 1F, 2F and 3F positions on austenitic stainless steel
11.7.9 Makes groove welds, in the 1G and 2G positions on austenitic stainless steel
11.7.10 Makes fillet welds in the 1F and 2F positions on aluminum
11.7.11 Makes groove welds in the 1G position on aluminum
11.7.12 Passes GTAW welder performance qualifications test on carbon steel, austenitic stainless steel, and aluminum
Domain 11.8 – Manual Plasma Arc Cutting and Air Carbon Arc Cutting
Core Standard 11.8 Students create appropriate Manual Plasma Arc Cutting and Air Carbon Arc Cutting cutting processes on a variety of industrial metal to meet industry standards.
11.8.1 Performs safety inspections of manual PAC equipment and accessories
11.8.2 Makes minor external repairs to manual PAC equipment and accessories
11.8.3 Sets up for manual Pac operations on carbon Steel, austenitic stainless steel, and aluminum
11.8.4 Operates manual Pac equipment on carbon steel, stainless steel, and aluminum
11.8.5 Performs straight, square cutting operations, in the flat position on carbon steel, stainless steel, and aluminum
11.8.6 Performs shape, edge cutting operations in the flat position on carbon steel, stainless steel, and aluminum
11.8.7 Performs safety inspections and minor external repairs of manual CAC-A equipment and accessories
11.8.8 Sets up manual CAC-A scarfing and gouging operations on carbon steel
11.8.9 Operates manual CAC-A equipment on carbon steel
11.8.10 Performs scarfing and gouging operations to remove base and weld metal, in the flat and horizontal positions on carbon steel