Engineering Foundations 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

Nevada Department of Education
Nevada Ready!

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Acknowledgements

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 Engineering Foundations.

Standards Development Members

Name	Occupation/Title	Stakeholder Affiliation	School/Organization
Dr. Yingtao Jiang	Mechanical Engineering Professor	Postsecondary Educator	University of Nevada, Las Vegas, NV
Bailey Keach	Professional Engineer	Business and Industry Representative	Nevada Department of Transportation, Las Vegas, 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 Engineering Foundations 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 Engineering Foundations 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., 12 for the first-year course of a two-year program and 22 for the second-year course, C is to designate the indicators to be taught in the complementary courses) 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 Engineering Foundations 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, ENG is the Standards Reference Code for Engineering Foundations. For Content Standard 2, Performance Standard 3 and Performance Indicator 4 the Standards Reference Code would be ENG.2.3.4.

Engineering Foundations

Program Information

Program of Study: **Engineering Foundations**
Standards Reference Code: **ENG**
Career Cluster: **Science, Technology, Engineering, and Mathematics**
Career Pathway(s): **Engineering and Technology, Science and Mathematics**
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 Engineering Foundations II course.

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

Required/ Complementary	Course Title	Abbreviated Name
R	Engineering Foundations I	ENG FOUND I
R	Engineering Foundations II	ENG FOUND II
C	Engineering Foundations II LAB	ENG FOUND 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 (12, 22, C)

1.1.2 Research nationally recognized CTSOs (12, 22, 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]) (12, 22, C)

Performance Standard 1.2: Develop Leadership Skills

1.2.1 Discuss the purpose of parliamentary procedure (12, 22, C)

1.2.2 Demonstrate the proper use of parliamentary procedure (12, 22, C)

1.2.3 Differentiate between an office and a committee (12, 22, C)

1.2.4 Discuss the importance of participation in local, regional, state, and national conferences, events, and competitions (12, 22, C)

1.2.5 Participate in local, regional, state, or national conferences, events, or competitions (12, 22, C)

1.2.6 Describe the importance of a constitution and bylaws to the operation of a CTSO chapter (12, 22, C)

Performance Standard 1.3: Participate in Community Service

1.3.1 Explore opportunities in community service-related work-based learning (WBL) (12, 22, C)

1.3.2 Participate in a service learning (program related) and/or community service project or activity (12, 22, C)

1.3.3 Engage with business and industry partners for community service (12, 22, 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) (12, 22, C)

1.4.2 Describe the appropriate professional/workplace attire and its importance (12, 22, C)

1.4.3 Investigate industry-standard credentials/certifications available within this Career Cluster™ (12, 22, C)

1.4.4 Participate in authentic contextualized instructional activities (12, 22, C)

1.4.5 Demonstrate technical skills in various student organization activities/events (12, 22, 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) (12, 22, C)

1.5.2 Explain the importance of participation and completion of a program of study (12, 22, C)

1.5.3 Promote community awareness of local student organizations associated with CTE programs (12, 22, 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 (12)

2.1.2 Demonstrate knowledge of the Occupational Safety and Health Administration (OSHA) and its role in workplace safety (12)

2.1.3 Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities (i.e., personal protection equipment – PPE) (12)

2.1.4 Use safe procedures for handling of tools and equipment (12)

2.1.5 Operate lab equipment according to safety guidelines (12)

2.1.6 Identify and use proper lifting procedures and proper use of support equipment (12)

2.1.7 Use proper ventilation procedures for working within the lab/shop area (12)

2.1.8 Identify marked safety areas (12)

2.1.9 Identify the location and the types of fire extinguishers and other fire safety equipment (12)

2.1.10 Demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment (12)

2.1.11 Identify the location and use of eye wash stations (12)

2.1.12 Identify the location of the posted evacuation routes (12)

2.1.13 Identify and wear appropriate clothing for lab/shop activities (12)

2.1.14 Secure hair and jewelry for lab/shop activities (12)

2.1.15 Demonstrate knowledge of the safety aspects of low and high voltage circuits (12)

2.1.16 Locate and interpret safety data sheets (SDS) (12)

2.1.17 Prepare time or job cards, reports, or records (12)

2.1.18 Perform housekeeping duties (12)

2.1.19 Follow verbal instructions to complete work assignments (12)

2.1.20 Follow written instructions to complete work assignments (12)

Performance Standard 2.2: Use Tools and Equipment Safely

2.2.1 Identify hand tools and their appropriate usage (12)

2.2.2 Identify standard and metric designation (12)

2.2.3 Demonstrate the proper techniques when using hand tools, power tools, and equipment (12)

2.2.4 Demonstrate safe handling and use of appropriate tools (12)

2.2.5 Demonstrate proper cleaning, storage, and maintenance of tools and equipment (12)

CONTENT STANDARD 3.0: ASSESS THE IMPACT OF ENGINEERING ON SOCIETY

Performance Standard 3.1: Investigate Related Careers in Engineering

3.1.1 Define engineering (12)

3.1.2 Examine engineering achievements throughout history (12)

3.1.3 Investigate engineering careers, training, and associated opportunities (12)

3.1.4 Describe the difference between engineering disciplines and job functions (12)

3.1.5 Explore career opportunities and list the educational requirements for a given engineering field (12)

3.1.6 Describe the importance of engineering teams (12)

Performance Standard 3.2: Analyze Ethics in Engineering

3.2.1 Analyze current professional engineering codes of ethics (12)

3.2.2 Analyze ethical engineering issues (12)

3.2.3 Analyze and explain ethical and technical issues contributing to an engineering disaster (12)

3.2.4 Investigate the evolution of a product (e.g., telephones, cars, building materials) (12)

3.2.5 Describe how ethics influences the engineering process (12)

CONTENT STANDARD 4.0: ANALYZE THE ENGINEERING DESIGN PROCESS

Performance Standard 4.1: Interpret the Engineering Design Process

4.1.1 Identify the design process (12)

4.1.2 Identify the activities that occur during each phase of the design process (12)

4.1.3 Apply the steps of the design process to solve a variety of design problems (12)

4.1.4 Describe how social, environmental, and financial constraints influence the design process (12)

4.1.5 Diagram the lifecycle of a product as it applies to the design/development process (12)

CONTENT STANDARD 5.0: CONSTRUCT ENGINEERING DOCUMENTATION

Performance Standard 5.1: Demonstrate Freehand Technical Sketching Techniques

5.1.1 Develop design ideas using freehand sketching (12)
5.1.2 Identify the six primary orthographic views (12)
5.1.3 Create pictorial and multi-view sketches (e.g., for prototyping, clarifying) (12)
5.1.4 Use the alphabet of lines (i.e., styles and weights) (12)
5.1.5 Legibly annotate sketches (12)

Performance Standard 5.2: Demonstrate Measuring and Scaling Techniques

5.2.1 Identify industry standard units of measure (Standard American English [SAE], metric, etc.) (12)
5.2.2 Convert between industry standard units of measure (12)
5.2.3 Determine appropriate engineering and metric scales (12)
5.2.4 Measure speed, distance, object size, area, mass, volume, and temperature (12)
5.2.5 Determine and apply the equivalence between fractions and decimals (12)
5.2.6 Demonstrate proper use of precision measuring tools (12)

Performance Standard 5.3: Use Engineering Documentation Procedures

5.3.1 Demonstrate record keeping procedures and communication in engineering (12)
5.3.2 Identify the importance of proprietary documentation in engineering (12)
5.3.3 Research the copyright and patent processes (12)
5.3.4 Illustrate project management timelines (12)

Performance Standard 5.4: Produce Technical Drawings

5.4.1 Interpret basic elements of a technical drawing (i.e., title block information, dimensions, and line types) (12)
5.4.2 Produce drawings from sketches (12)
5.4.3 Identify industry standard symbols (12)
5.4.4 Describe and construct various types of drawings (i.e., part, assembly, pictorial, orthographic, isometric, and schematic) (12)
5.4.5 Construct drawings utilizing metric and customary (i.e., SAE and Imperial) measurement systems (12)
5.4.6 Create schematic diagrams using proper symbols (12)
5.4.7 Arrange dimensions and annotations using appropriate standards (i.e., ANSI and ISO) (12)
5.4.8 Use geometric dimensioning and tolerancing (GDT) annotation standards within industry practices (12)
5.4.9 Construct bill of materials or schedule (12)

Performance Standard 5.5: Demonstrate Modeling Techniques

5.5.1 Identify the areas of modeling (i.e., physical, conceptual, and mathematical) (12)
5.5.2 Create a scale model or working prototype (12)
5.5.3 Evaluate a scale model or a working prototype (12)
5.5.4 Identify methods and sources for obtaining modeling materials and supplies (12)

CONTENT STANDARD 6.0: INVESTIGATE MATERIAL PROPERTIES

Performance Standard 6.1: Identify Material Properties and Science

6.1.1 Identify the major material families used in manufacturing (e.g., polymers, ceramics, metals and alloys, composites, biomaterials, semiconductors) (22)

6.1.2 Differentiate between the various types of material properties and their applications (22)

6.1.3 Discuss the impact of material usage on the environment (22)

6.1.4 Explain how production is affected by the availability, quality, and quantity of resources (22)

6.1.5 Differentiate among raw material standard stock and finished products (22)

Performance Standard 6.2: Analyze the Strength of Materials

6.2.1 Describe the various forms of stress (i.e., compression, tension, torque, and shear) (22)

6.2.2 Calculate material properties relating to a stress strain curve (22)

6.2.3 Analyze the principles of statics and dynamics to calculate the strength of various engineering materials used to build a structure (22)

6.2.4 Create free body diagrams of objects, identifying all forces acting on the object (22)

6.2.5 Locate the centroid of geometric shapes using mathematics (22)

6.2.6 Calculate the moment of inertia for a rectangular shape (22)

6.2.7 Differentiate between scalar and vector quantities (22)

6.2.8 Determine magnitude, direction, and sense of a vector (22)

6.2.9 Calculate the X and Y components and determine the resultant vector (22)

6.2.10 Calculate moment forces given a specified axis (22)

6.2.11 Use equations of static equilibrium to calculate unknown forces (22)

6.2.12 Create a written report of material test evaluations (22)

CONTENT STANDARD 7.0: APPLY FUNDAMENTAL POWER SYSTEMS AND ENERGY PRINCIPLES

Performance Standard 7.1: Investigate Power Systems and Energy Forms

7.1.1 Define terms used in power systems (power, work, horsepower, watts, etc.) (22)
7.1.2 Identify the basic power systems (nuclear, solar, natural gas, electric)
7.1.3 List the basic elements of power systems (power plant, transformer, transmission line, substations, distribution line, and distribution transformer) (22)
7.1.4 Summarize the advantages and disadvantages of various forms of power (22)
7.1.5 Calculate the efficiency of power systems and conversion devices (22)
7.1.6 Define energy (22)
7.1.7 Define potential energy and kinetic energy (22)
7.1.8 Identify forms of potential energy and kinetic energy (22)
7.1.9 Categorize types of energy into major forms such as thermal, radiant, nuclear, chemical, electrical, mechanical, and fluid (22)
7.1.10 Identify units used to measure energy (22)
7.1.11 Analyze and apply data and measurements to solve problems and interpret documents (22)
7.1.12 Calculate unit conversions between common energy measurements (22)
7.1.13 Demonstrate an energy conversion device (22)

Performance Standard 7.2: Identify and Use Energy Sources and Applications

7.2.1 Distinguish between the six simple machines, their attributes and components (22)
7.2.2 Measure forces and distances related to mechanisms (22)
7.2.3 Determine efficiency in a mechanical system (22)
7.2.4 Calculate mechanical advantage and drive ratios of mechanisms (22)
7.2.5 Calculate work, power, and torque (22)
7.2.6 Design, construct, and test various basic mechanical systems (22)

Performance Standard 7.3: Identify and Use Energy Sources and Applications

7.3.1 Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible (22)
7.3.2 Define the possible types of power conversion (e.g., solar or chemical to mechanical) (22)
7.3.3 Measure circuit values using a digital multimeter (22)
7.3.4 Calculate power in a system that converts energy from electrical to mechanical (22)
7.3.5 Determine efficiency of a system that converts an electrical input to a mechanical output (22)
7.3.6 Compute values of current, resistance, and voltage using Ohm's law (22)
7.3.7 Solve series and parallel circuits using basic laws of electricity including Kirchhoff's laws (22)
7.3.8 Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell (22)
7.3.9 Experiment with a solar hydrogen system to produce mechanical power (22)
7.3.10 Design, construct, and test recyclable insulation materials (22)
7.3.11 Test and apply the relationship between R-values and recyclable insulation (22)
7.3.12 Complete calculations for conduction, R-values, and radiation (22)

Performance Standard 7.4: Identify and Use Machine Control Systems

- 7.4.1 Create detailed operational flowcharts (22)
- 7.4.2 Create system control programs (i.e., sequential, logic) (22)
- 7.4.3 Select appropriate input and output devices based on system specifications and constraints (22)
- 7.4.4 Differentiate between the characteristics of digital and analog devices (22)
- 7.4.5 Compare and contrast open and closed loop systems (22)
- 7.4.6 Design and create a control system based on specifications and constraints (22)

Performance Standard 7.5: Identify and Use Basic Fluid Systems

- 7.5.1 Define fluid systems (e.g., hydraulic, pneumatic, vacuum, etc.) (22)
- 7.5.2 Identify and define the components of fluid systems (22)
- 7.5.3 Compare and contrast hydraulic and pneumatic systems (22)
- 7.5.4 Identify the advantages and disadvantages of using fluid power systems (22)
- 7.5.5 Explain the difference between gauge pressure and absolute pressure (22)
- 7.5.6 Discuss the safety concerns of working with liquids and gases under pressure (22)
- 7.5.7 Calculate mechanical advantage using Pascal's law (22)
- 7.5.8 Calculate values in a pneumatic system using the ideal gas laws (22)
- 7.5.9 Design, construct, and test various fluid systems (22)

Performance Standard 7.6: Identify Thermodynamics

- 7.6.1 Define thermodynamic terminology (22)
- 7.6.2 Distinguish thermodynamic concepts (i.e., conduction, convection, and radiation) (22)
- 7.6.3 Identify the common units of measurement (22)
- 7.6.4 Explain the laws of thermodynamics (22)
- 7.6.5 Calculate the thermal efficiency of various materials (22)

CONTENT STANDARD 8.0: APPLY STATISTICS AND KINEMATIC PRINCIPLES

Performance Standard 8.1: Use Statistics

8.1.1 Define statistical terminology (22)
8.1.2 Calculate theoretical probability (22)
8.1.3 Calculate experimental frequency distribution (22)
8.1.4 Apply the Bernoulli process to events that only have two distinct possible outcomes (22)
8.1.5 Apply AND, OR, and NOT logic to probability (22)
8.1.6 Apply Bayes' theorem to calculate the probability of multiple events occurring (22)
8.1.7 Create a histogram to illustrate frequency distribution (22)
8.1.8 Calculate the central tendency of a data array to include mean, median, and mode (22)
8.1.9 Calculate data variation to include range, standard deviation, and variance (22)

Performance Standard 8.2: Use Kinematic Principles

8.2.1 Define kinematic terminology (22)
8.2.2 Calculate distance, displacement, speed, velocity, and acceleration based on specific data (22)
8.2.3 Calculate acceleration due to gravity based on data from a free-fall device (22)
8.2.4 Calculate the X and Y components of a projectile motion (22)
8.2.5 Determine the needed launch angle of a projectile for a specific range and initial velocity (22)
8.2.6 Design a device that stores and releases potential energy for propulsion (22)

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
Engineering Foundations	Dr. Yingtao Jiang	Mechanical Engineering Professor	Postsecondary Educator	University of Nevada, Las Vegas, NV
Engineering Foundations	Bailey Keach	Professional Engineer	Business and Industry Representative	Nevada Department of Transportation, Las Vegas, NV
Engineering Foundations	Karl Kuhles	Instructor	Secondary Educator	Reno High School, Washoe County School District, NV
Engineering Foundations	Stephen Oranchek	Instructor	Secondary Educator	Northwest Career and Technical Academy, Clark County School District, NV
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The Aerospace Engineering, Architectural and Civil Engineering, Electrical Engineering, Environmental Engineering, and Mechanical Engineering complementary standards for Engineering Foundations program of study were validated through active participation of business and industry representatives on the development team.

Complementary Course Information for Engineering Foundations

Program Information

Qualifying Program of Study: **Engineering Foundations**
Career Cluster: **Science, Technology, Engineering, and Mathematics**
Career Pathway(s): **Engineering and Technology**
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	Engineering Foundations Advanced Studies	ENG FOUND AS
C	Aerospace Engineering	AEROSPACE ENG
C	Architectural and Civil Engineering	CIVIL ENG
C	Electrical Engineering	ELEC ENG
C	Environmental Engineering	ENVIRON SUS ENG
C	Mechanical Engineering	MECH ENGR
C	Industry-Recognized Credential – Engineering Foundations	IRC ENG FOUND
C	CTE Work Experience – Science, Technology, Engineering, and Mathematics	WORK EXPER STEM

Complementary Course Standards
Aerospace Engineering

CONTENT STANDARD 1.0: ANALYZE AEROSPACE ENGINEERING DESIGN PROCESSES

Performance Standard 1.1: Analyze the Physics of Flight

1.1.1 Research the history of aerospace engineering and its milestones
1.1.2 Identify the major components, the three axes, and the four major forces which act on an aircraft
1.1.3 Explain how the motions about the three axes of an aircraft are stabilized and controlled
1.1.4 Describe the four ways that lift is generated by an airfoil and the factors that impact lift and drag
1.1.5 Calculate the values of lift, drag and Reynolds Number
1.1.6 Calculate the center of gravity of an aircraft
1.1.7 Describe the relationship of altitude, temperature, and pressure within the Earth's atmosphere
1.1.8 Calculate temperature, pressure, velocity, and density

Performance Standard 1.2: Apply the Principles of Flight Planning and Navigation

1.2.1 Identify components of common aviation navigation aids
1.2.2 Interpret navigation aids on a map
1.2.3 Describe the purpose and functions of the Air Traffic Control (ATC) system
1.2.4 Describe the operation of the Global Positioning System (GPS) and devices
1.2.5 Interpret an indication shown on a navigation aid
1.2.6 Develop a route using a map or GPS device

Performance Standard 1.3: Analyze Materials and Structures

1.3.1 Describe aerospace materials and their properties
1.3.2 Classify materials for aerospace applications
1.3.3 Determine moment of inertia and Young's modulus equations
1.3.4 Recognize the impact of loading conditions on a structure
1.3.5 Analyze deformation of a structure as a result of force application
1.3.6 Design, construct and model composite structures using construction and 3D modeling techniques
1.3.7 Measure mechanical properties of materials
1.3.8 Analyze measurements from a tensile tester

Performance Standard 1.4: Analyze Propulsion Systems and Flight Physiology

1.4.1 Explain how Newton's Three Laws of Motion applies to aerodynamic forces
1.4.2 Describe the characteristics of the four types of propulsion systems
1.4.3 Identify common space propulsion systems and basic criteria to use when designing a spacecraft
1.4.4 Classify rocket engine systems and identify the thrust and impulse equations
1.4.5 Design, construct, test, calculate, and interpret data for a model rocket

1.4.6 Recognize the formula for distance with respect to time and acceleration

1.4.7 Analyze how human factors affect aerospace system design

CONTENT STANDARD 2.0: ANALYZE SPACE AND REMOTE ENGINEERING SYSTEMS

Performance Standard 2.1: Identify Space and Space Issues

2.1.1 Recognize and describe the relative sizes of common celestial bodies (e.g., galaxies, stars, planets)

2.1.2 Explain how global governance applies to space issues and space law

2.1.3 Describe space achievements and commercial organizations

2.1.4 Identify the impact that space junk has on space-based activities

Performance Standard 2.2: Analyze Orbital Mechanics and Satellite Motion

2.2.1 List major contributions made by people studying orbital mechanics

2.2.2 Describe the six Keplerian elements and explain Kepler's Laws

2.2.3 Identify the most appropriate orbital pattern for an application

2.2.4 Recognize the equations for orbital period, orbital gravitational potential energy, orbital kinetic energy, and total orbital energy

2.2.5 Explain how financial factors impact a project

2.2.6 Analyze the motion of a satellite

2.2.7 Identify orbital patterns

2.2.8 Calculate an orbiting body's orbital period, orbital gravitational potential energy, orbital kinetic energy, and total orbital energy

Performance Standard 2.3: Utilize Remote Systems

2.3.1 Explain how unmanned systems can be integrated into aerospace systems

2.3.2 Recognize factors that affect communication with equipment in space

2.3.3 Analyze how aerospace unmanned systems function

2.3.4 Describe how input and output devices function

2.3.5 Explain the purpose of a flowchart or pseudocode

2.3.6 Describe how functions of a computer program can be applied to perform a task

2.3.7 Operate output devices to perform a function

2.3.8 Relate sensor input to the environment being measured

2.3.9 Construct a control program to accomplish a specified goal

2.3.10 Operate a remote system through a series of performance tasks including autonomous navigation

2.3.11 Analyze data gathered by robot control software

2.3.12 Operate a simulated spaceflight

Complementary Course Standards
Architectural and Civil Engineering

CONTENT STANDARD 1.0: EXPLORE ARCHITECTURE AND CIVIL ENGINEERING

Performance Standard 1.1: Research the History of Architecture and Civil Engineering

1.1.1 Research the different architectural styles and design used throughout history
1.1.2 Compare modern and historical structural and architectural designs
1.1.3 Explain how historical innovations have impacted today's society
1.1.4 Identify and explain the application of principles and elements of design

Performance Standard 1.2: Investigate Career Opportunities

1.2.1 Identify the primary duties and attributes of a civil engineer and an architect
1.2.2 Explain the traditional path for becoming a civil engineer or architect
1.2.3 Identify related career paths associated with civil engineering
1.2.4 Discuss various civil engineering career opportunities (e.g., bridges, highways, rail, air, pipelines)
1.2.5 Evaluate a design charrette process
1.2.6 Differentiate the relationships of all stakeholders involved in a construction project

CONTENT STANDARD 2.0: APPLY RESIDENTIAL DESIGN CONCEPTS

Performance Standard 2.1: Analyze Building Design and Construction Systems

2.1.1 Outline typical components of a residential framing system
2.1.2 Identify conventional residential roof designs
2.1.3 Research building materials that address aesthetics, design loads, and environmental challenges
2.1.4 Model a small residential building utilizing architectural design software

Performance Standard 2.2: Conduct Cost and Efficiency Analysis

2.2.1 Calculate the quantity and cost of concrete
2.2.2 Estimate cost for a construction project
2.2.3 Calculate the heat loss for a building

Performance Standard 2.3: Utilize Residential Design Concepts

2.3.1 Utilize client requirements and specifications to create a plan set
2.3.2 Identify and apply principles of sustainable design
2.3.3 Sketch a plan set
2.3.4 Investigate residential site analysis
2.3.5 Determine the appropriate foundation type for a residential structure
2.3.6 Create a complete set of residential construction drawings

CONTENT STANDARD 3.0: ANALYZE COMMERCIAL APPLICATIONS

Performance Standard 3.1: Analyze Commercial Building Systems

- 3.1.1 Explain the purpose of building codes and regulations (e.g., IBC, ICC, NEC, ADA)
- 3.1.2 Identify land use and development regulations
- 3.1.3 Research the use and application of different commercial floor systems, wall systems, and roofing systems
- 3.1.4 Calculate structural efficiency
- 3.1.5 Model a small commercial building utilizing architectural design software

Performance Standard 3.2: Investigate Structural Systems

- 3.2.1 Research the different foundation types and uses for a commercial application
- 3.2.2 Describe the different types of loads and how they affect a building design
- 3.2.3 Determine live, dead, and snow loads
- 3.2.4 Calculate beam design
- 3.2.5 Utilize building codes to determine structural systems for a given building occupancy

Performance Standard 3.3: Configure Utilities and Services

- 3.3.1 Identify and explain code requirements that relate to utilities and services
- 3.3.2 Interpret HVAC, electrical, plumbing, and mechanical systems construction documents
- 3.3.3 Create HVAC, electrical, plumbing, and mechanical systems construction documents
- 3.3.4 Research energy conservation techniques

Performance Standard 3.4: Explore Site Considerations

- 3.4.1 Utilize surveying equipment to create a site plan
- 3.4.2 Identify land use and development regulations for a commercial parking lot design
- 3.4.3 Discuss soil testing
- 3.4.4 Explore management of storm water

Performance Standard 3.5: Utilize Commercial Design Concepts

- 3.5.1 Utilize a legal property description to identify the property lines
- 3.5.2 Research codes, zoning ordinances and regulations for a commercial design
- 3.5.3 Utilize project management techniques (i.e., organization charts, Gantt charts, team meetings)
- 3.5.4 Create a complete set of commercial construction drawings
- 3.5.5 Develop a commercial building design presentation using visual aids (e.g., models, renderings, PowerPoint)

Complementary Course Standards
Electrical Engineering

CONTENT STANDARD 1.0: APPLY FUNDAMENTAL DIGITAL ELECTRONIC TECHNIQUES AND PROCESSES

Performance Standard 1.1: Apply Fundamental Electronic Principles

1.1.1 Describe safety precautions and procedures pertaining to and working with electricity
1.1.2 Utilize all safety procedures when working with electronics
1.1.3 Identify and utilize the basic units of electronic measurements
1.1.4 Express numbers in scientific engineering notation (i.e., prefixes and symbols)
1.1.5 Convert from scientific notation to engineering notation
1.1.6 Identify and explain the main purposes of electronic components
1.1.7 Classify designation letters used to represent electronic components
1.1.8 Illustrate schematic symbols for various types of electrical and electronic components
1.1.9 Explain solder safety (i.e., burns, fires, lead poisoning, fumes, damages)
1.1.10 Identify types of solder and soldering equipment
1.1.11 Demonstrate the proper and safe method for soldering, de-soldering, and cleaning
1.1.12 Demonstrate the ability to solder components to a printed circuit board
1.1.13 Demonstrate the ability to de-solder components from a printed circuit board

Performance Standard 1.2: Identify Fundamental Analog Principles

1.2.1 Compare and contrast analog and digital signals
1.2.2 Identify wave form characteristics: negative alternation, positive alternation, wavelength, amplitude, and period
1.2.3 Classify various materials as conductors, insulators, or semiconductors
1.2.4 Describe the fundamental concepts of voltage, current, and resistance
1.2.5 Utilize Ohm's law to determine current, voltage, resistance, and power
1.2.6 Define key terms associated with analog electronics

Performance Standard 1.3: Identify Fundamental Digital Principles

1.3.1 Interpret manufacturer’s data sheet information (e.g., description, connections, functions, etc.)
1.3.2 Categorize integrated circuits
1.3.3 Evaluate logic circuit truth tables
1.3.4 Identify and describe basic logic operations (i.e., AND, OR, buffer, inverter, NAND)
1.3.5 Define key terms associated with digital electronics

CONTENT STANDARD 2.0: APPLY ADVANCED DIGITAL ELECTRONIC TECHNIQUES AND PROCESSES

Performance Standard 2.1: Analyze Combinational Logic Circuits

- 2.1.1 Identify and convert numbers between numbering systems (i.e., decimal, binary, hexadecimal, BCD)
- 2.1.2 Perform numerical calculations in numbering systems
- 2.1.3 Explain Boolean algebra and its use in digital circuitry
- 2.1.4 Explain the characteristics and usages of a truth table
- 2.1.5 Analyze combinational logic circuits and write the Boolean equation and truth table for each circuit
- 2.1.6 Utilize Karnaugh maps to simplify combinational logic circuits
- 2.1.7 Utilize logic operations (i.e., AND, OR, NOR, buffer, inverter, NAND)
- 2.1.8 Construct circuits/projects in the proper sequence
- 2.1.9 Describe the procedures for testing and troubleshooting combinational logic circuits

Performance Standard 2.2: Analyze Sequential Logic Circuits

- 2.2.1 Identify the properties of flip-flops and transparent latches
- 2.2.2 Describe the operation and application of flip-flops (i.e., single event detection circuits, data synchronizers, shift registers, frequency dividers)
- 2.2.3 Describe the operation and application of asynchronous counters (i.e., SSI, MSI, D flip-flops, J/K flip-flops, up/down and modulus counters)
- 2.2.4 Describe the operation and application of synchronous counters (i.e., SSI, MSI, D flip-flops, J/K flip-flops, up/down and modulus counters)
- 2.2.5 Discuss how state machines affect everyday life
- 2.2.6 Describe how state machines can be implemented (i.e., Mealy and Moore)
- 2.2.7 Describe the procedures for testing and troubleshooting sequential logic circuits

Performance Standard 2.3: Apply Microcontroller Principles

- 2.3.1 Describe basic principles of microcontrollers
- 2.3.2 Describe the process of executing instructions in microcontrollers
- 2.3.3 Draw a flowchart for a typical program or process
- 2.3.4 Describe the procedure for instruction coding and program debugging
- 2.3.5 Describe the fundamental principles for microcontroller interfacing
- 2.3.6 Demonstrate basic wiring procedures for a microcontroller
- 2.3.7 Write, deploy and test an original microcontroller program
- 2.3.8 Research current industry standards for application of programming
- 2.3.9 Define key terms associated with microcontrollers

Complementary Course Standards
Environmental Engineering

CONTENT STANDARD 1.0: INVESTIGATE ENVIRONMENTAL SUSTAINABILITY

Performance Standard 1.1: Analyze Water Management Concepts

1.1.1 Recognize that hundreds of millions of people suffer from a lack of access to clean, safe water
1.1.2 Discuss the characteristics of clean water and why it is necessary for survival
1.1.3 Investigate the most common sources of drinking water
1.1.4 Research common sources of drinking water contamination
1.1.5 Describe how human health is affected by the quality of drinking water sources
1.1.6 Analyze the environmental and physical factors that affect local to regional accessibility to clean, safe drinking water
1.1.7 Analyze the relationship between population growth and water resources
1.1.8 Explain how water quality is quantitatively measured using chemical and biologically based testing processes
1.1.9 Select and properly use the appropriate tool for accurately measuring specific volumes
1.1.10 Perform and analyze water samples to detect contaminants
1.1.11 Model a water purification process that includes filtration and treatment
1.1.12 Describe the interacting roles of microorganisms in a wastewater treatment ecosystem
1.1.13 Utilize the engineering design process to design, build, and test a water treatment system

Performance Standard 1.2: Investigate Biofuel Energy Sources

1.2.1 Describe the differences between renewable and non-renewable sources of energy
1.2.2 Explain the similarities and the differences between biofuels and fossil fuels
1.2.3 Describe the past, present, and future of biofuels and fossil fuels
1.2.4 Compare and contrast environmental effects from burning of fossil fuels verses biofuels
1.2.5 Discuss biofuel energy production
1.2.6 Illustrate the process of photosynthesis and how energy is stored in algae and plants
1.2.7 Describe the two main phases of the bio-manufacturing process
1.2.8 Describe how complex lipids can produce biodiesel
1.2.9 Summarize the bio-manufacturing processes for producing cellulosic ethanol
1.2.10 Utilize the engineering design process to solve an open-ended design problem
1.2.11 Analyze the performance and design requirements of a solution to determine its effectiveness

Complementary Course Standards
Mechanical Engineering

CONTENT STANDARD 1.0: ANALYZE MANUFACTURING SYSTEMS AND PROCESSES

Performance Standard 1.1: Analyze Manufacturing Systems

1.1.1 Research the history of manufacturing and its milestones

1.1.2 Describe the three components of the manufacturing system (i.e., inputs, processes, and outputs)

1.1.3 Identify and explain basic flowcharting

1.1.4 Create and apply a flowchart that portrays the manufacturing system

1.1.5 Identify a control system and explain its application to manufacturing

1.1.6 Model and create a program to control an automated system

Performance Standard 1.2: Identify Manufacturing Processes

1.2.1 Identify and describe the major manufacturing processes (e.g., forming, separating, fabricating, conditioning, and finishing)

1.2.2 Categorize additive and subtractive fabricating processes

1.2.3 Discuss the impact of manufacturing processes on the environment

1.2.4 Describe lean manufacturing and explain its importance

1.2.5 Investigate manufacturing management principles (e.g., just-in-time, kaizen, etc.)

1.2.6 Discuss quality control standards (e.g., six sigma, TQM, ISO, ANSI, etc.)

Performance Standard 1.3: Utilize Design for Manufacturing Techniques

1.3.1 Outline the product design process

1.3.2 Analyze a product for design flaws

1.3.3 Identify the steps of production for a manufactured product

1.3.4 List tools needed for a manufactured product

1.3.5 Apply manufacturing systems to develop and produce a prototype for a product

1.3.6 Evaluate a product prototype and the processes used in its manufacture

Performance Standard 1.4: Utilize Product Development Processes

1.4.1 Categorize machines with their production processes
1.4.2 Calculate cutter speed and feed rate for specific tools and materials
1.4.3 Read and interpret numeric codes (i.e., G & M code)
1.4.4 Create numeric codes manually from a sketch
1.4.5 Transfer a computer aided design (CAD) drawing to a computer aided manufacturing (CAM) program
1.4.6 Create numerical code using a CAM program
1.4.7 Verify the creation of a part using a simulation software
1.4.8 Create parts using the verified numeric code
1.4.9 Create a product using manufacturing processes

CONTENT STANDARD 2.0: APPLY FUNDAMENTAL AUTOMATING MANUFACTURING SYSTEMS

Performance Standard 2.1: Identify Automating Manufacturing Systems

2.1.1 Define industry standard vocabulary (i.e., CAD, CAM, CIM, and CNC)
2.1.2 Explain the historical development and impacts of automating manufacturing systems
2.1.3 Investigate the reasons for employing automation
2.1.4 Define the types and components of computer integrated manufacturing (CIM) systems
2.1.5 Explore manufacturing or automation careers

Performance Standard 2.2: Utilize Automation Techniques

2.2.1 Choose appropriate machine control inputs and outputs, based on the need of a technological system
2.2.2 Design and create a control system, based on given needs and constraints
2.2.3 Differentiate between the characteristics of digital and analog devices
2.2.4 Select between open and closed loop systems to solve a technological problem
2.2.5 Create system control programs that utilize flowchart logic
2.2.6 Define and discuss open and closed loop systems
2.2.7 Create and use flowcharts
2.2.8 Identify components needed to integrate computer controls for an automated system
2.2.9 Plan, design, and construct an automated system
2.2.10 Program an automated system using computer hardware and software
2.2.11 Interface system output to another automated system
2.2.12 Create and program a simulated work cell with simulation software
2.2.13 Demonstrate ability to program using timers, counters, and loops
2.2.14 Identify and explain various types of electrical motors
2.2.15 Interface output devices to a computer, microcontroller, or programmable logic controller

Performance Standard 2.3: Apply Manufacturing Elements and Applications

2.3.1 Compare and contrast the major categories of CIM systems

2.3.2 Identify the components of a flexible manufacturing system (FMS)

2.3.3 Create a process design chart for a manufacturing process

2.3.4 Utilize safety procedures when working with a CIM system

2.3.5 Design and construct a manufacturing system that utilizes multiple automated components

2.3.6 Analyze each component to improve the total process flow and cycle time