

# 2024 Pre-Engineering

## Program Standards

### CONTENT STANDARD 1.0: PROFESSIONAL ORGANIZATIONS AND LEADERSHIP

Performance Standard 1.1: Student Leadership in Career Technical Student Organizations (CTSO) and Professional Associations

- 1.1.1 Explore the role of professional organizations and/or associations in the engineering industry.
- 1.1.2 Define the value, role, and opportunities provided through career technical student organizations.
- 1.1.3 Engage in career exploration and leadership development.

### CONTENT STANDARD 2.0: LAB/WORKPLACE SAFETY AND TOOL USE

Performance Standard 2.1: Safety

- 2.1.1 Describe the role of the Occupational Safety and Health Administration (OSHA).
- 2.1.2 Comply with requirements for personal protection equipment (PPE).
- 2.1.3 Describe material handling, storage, use, and disposal requirements.
- 2.1.4 Interpret safety data sheets (SDS) before using materials (i.e., handling, storage use, disposal requirements).
- 2.1.5 Interpret safety signage for hazards, evacuation routes, and safety areas.
- 2.1.6 Identify the location and the types of fire extinguishers and other fire equipment.
- 2.1.7 Describe procedures for using fire extinguishers and other fire safety equipment.
- 2.1.8 Describe the requirements for using eye-wash stations.
- 2.1.9 Describe electrical hazards and the effects of electrical shock on the human body.

Performance Standard 2.2: Tool Identification and Safe Use

- 2.2.1 Identify hand tools and power tools, including precision measuring tools.
- 2.2.2 Maintain tools.
- 2.2.3 Match tools to their intended use and purpose.
- 2.2.4 Perform a safety check before using tools.

### CONTENT STANDARD 3.0: IMPACT OF ENGINEERING

Performance Standard 3.1: Engineering Careers

- 3.1.1 Define engineering.
- 3.1.2 Research career opportunities and the educational requirements for a given engineering field.
- 3.1.3 Create an education and career plan for a career in engineering.
- 3.1.4 Describe the importance of collaboration in the engineering industry.

Performance Standard 3.2: Ethics in Engineering

- 3.2.1 Identify current engineering codes of ethics and their purpose.
- 3.2.2 Describe ethical engineering issues.
- 3.2.3 Analyze the ethical issues involved in an engineering failure.

### CONTENT STANDARD 4.0: ENGINEERING DESIGN PROCESS

Performance Standard 4.1: Design Process Concepts

- 4.1.1 Apply the steps of the design process to solve a design problem (i.e., define the problem, generate concepts, develop a solution, develop a design proposal, construct and test a prototype, refine the design, evaluate a solution, and communicate the processes and results).
- 4.1.2 Describe how social, environmental, regulatory, and financial constraints influence the design process.

- 4.1.3 Describe the evolution and lifecycle of a product (i.e., introduction, growth, maturity, decline).

#### Performance Standard 4.2: Measuring and Scaling

- 4.2.1 Identify imperial/standard and metric/SI units of measure and level of accuracy requirements for an engineering problem/design.
- 4.2.2 Convert between imperial/standard and metric/SI units of measure in an engineering problem/design.
- 4.2.3 Determine scale on a blueprint.
- 4.2.4 Apply algebraic and geometric calculations to determine size, mass, volume, and surface area in an engineering problem/design.
- 4.2.5 Convert between fractions and decimals in an engineering problem/design.
- 4.2.6 Report measurements by using and reading precision measuring tools.

#### Performance Standard 4.3: Technical Sketching and Drawing

- 4.3.1 Communicate ideas, using freehand sketching (e.g., pictorial, multi-view) and annotations.
- 4.3.2 Produce drawings from sketches.
- 4.3.3 Identify the six primary orthographic views.
- 4.3.4 Identify the alphabet of lines (i.e., styles, weights) and line conventions.
- 4.3.5 Apply basic elements (e.g., title block information, dimensions, and line types) in a technical drawing.
- 4.3.6 Identify basic industry standard symbols on sketches, drawings, and blueprints.
- 4.3.7 Produce various types of drawings (e.g., part, assembly, pictorial, orthographic, isometric, and schematic), given an engineering design.
- 4.3.8 Arrange dimensions and annotations, using ANSI and ISO standards for an engineering problem/design.
- 4.3.9 Create a bill of materials or schedule from blueprints and specifications.

#### Performance Standard 4.4: Engineering Documentation

- 4.4.1 Describe documentation and communication methods used in engineering.
- 4.4.2 Maintain documentation during the engineering design process.
- 4.4.3 Describe the importance of proprietary documentation (e.g., copyright, patent) in engineering.
- 4.4.4 Create project-management timelines for an engineering design.
- 4.4.5 Write a technical report for an engineering design.

#### Performance Standard 4.5: Modeling

- 4.5.1 Identify the areas of modeling (e.g., physical, conceptual, mathematical).
- 4.5.2 Create a scale model or a working prototype.
- 4.5.3 Evaluate the accuracy of a scale model or a working prototype.

### CONTENT STANDARD 5.0: MATERIALS

#### Performance Standards 5.1: Material Properties

- 5.1.1 Identify the major categories of materials (e.g., ceramics, composites, polymers, metals) and their applications.
- 5.1.2 Describe the characteristics of materials by their applications in engineering.
- 5.1.3 Describe the cost and environmental factors that affect choosing specific materials for a design process.
- 5.1.4 Differentiate among raw material, standard stock, and finished products.

#### Performance Standards 5.2: Materials Strength

- 5.2.1 Describe the various forms of stress (e.g., compression, tension, torque, and shear) and how they affect materials selection for an engineering design.
- 5.2.2 Describe the fundamental principles of a stress-strain curve.
- 5.2.3 Create free-body diagrams of objects, identifying all forces acting on the object.
- 5.2.4 Differentiate between scalar and vector quantities.
- 5.2.5 Define magnitude, direction, and sense of a vector.

- 5.2.6 Measure the magnitude, direction, and sense of a vector.
- 5.2.7 Define moment and torque forces.
- 5.2.8 Calculate moment and torque forces in an engineering design.

## **CONTENT STANDARD 6.0: FUNDAMENTAL POWER SYSTEMS AND ENERGY PRINCIPLES**

### **Performance Standard 6.1: Basic Mechanical Systems**

- 6.1.1 Distinguish among the characteristics and components of the six simple machines.
- 6.1.2 Measure forces and distances related to mechanisms in an engineering design.
- 6.1.3 Determine efficiency in a mechanical system.
- 6.1.4 Calculate mechanical advantage and drive ratios of mechanisms.
- 6.1.5 Calculate work, power, and torque/moment.
- 6.1.6 Design a basic mechanical system.
- 6.1.7 Assemble a basic mechanical system.
- 6.1.8 Test a basic mechanical system.

### **Performance Standard 6.2: Power Systems and Energy Forms**

- 6.2.1 Identify the types of basic power systems, components, and related terminology (e.g., energy, potential energy, kinetic energy, power, work, horsepower, watts).
- 6.2.2 Describe the factors that affect the choice of power system in an engineering design.
- 6.2.3 Calculate the efficiency of power systems and conversion devices.
- 6.2.4 Categorize major forms of energy (e.g., thermal, radiant, nuclear, chemical, electrical, mechanical, fluid).
- 6.2.5 Define units used to measure energy.
- 6.2.6 Calculate conversions between common energy measurements in an engineering design.
- 6.2.7 Describe the purpose and function of an energy conversion device (e.g., solar panel, windmill, battery, turbine).

### **Performance Standard 6.3: Energy Sources and Applications**

- 6.3.1 Categorize various energy sources as nonrenewable, renewable, or inexhaustible.
- 6.3.2 Measure circuit values, using a multimeter.
- 6.3.3 Calculate power in a system that converts energy from electrical to mechanical.
- 6.3.4 Determine the efficiency of a system that converts an electrical input to a mechanical output.
- 6.3.5 Describe the relationship of voltage, current, and resistance.
- 6.3.6 Calculate values of current, resistance, and voltage in a circuit, using Ohm's law.
- 6.3.7 Create series and parallel circuits, using the basic laws of electricity and Kirchhoff's law.

### **Performance Standard 6.4: Automation Systems**

- 6.4.1 Create detailed operational flowcharts and logic in a system-control program.
- 6.4.2 Select appropriate input and output devices, based on system specifications and constraints.
- 6.4.3 Differentiate between the attributes of digital and analog devices.
- 6.4.4 Compare open and closed loop systems.
- 6.4.5 Design a control system, based on specifications and constraints.

### **Performance Standard 6.5: Basic Fluid Systems**

- 6.5.1 Define fluid systems (e.g., hydraulic, pneumatic, vacuum).
- 6.5.2 Identify the components of fluid systems and their functions.
- 6.5.3 Compare hydraulic and pneumatic systems.
- 6.5.4 Identify the advantages and disadvantages of using fluid power systems.
- 6.5.5 Describe the difference between gauge pressure and absolute pressure.
- 6.5.6 Describe the safety concerns of working with liquids and gases under pressure.
- 6.5.7 Calculate mechanical advantage, using Pascal's law.
- 6.5.8 Calculate values in a pneumatic system, using the ideal gas law (i.e., general gas equation).

## **CONTENT STANDARD 7.0: ANALYSIS OF DESIGNS AND PROTOTYPES**

### Performance Standard 7.1: Statistics

- 7.1.1 Define statistical terminology (e.g., mean, mode, median, range, standard deviation).
- 7.1.2 Illustrate frequency distribution.
- 7.1.3 Calculate the central tendency of a data array to include mean, median, and mode.
- 7.1.4 Calculate data variation to include range, standard deviation, and variance.

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