

# Engineering Standards

**FINAL**

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## **ENGINEERING STANDARDS**

- Standard I.*** The beginning engineering teacher possesses a working knowledge of engineering fundamentals.
- Standard II.*** The beginning engineering teacher understands the design process and integrates mathematics, science, technology, engineering, and other knowledge to design solutions to engineering problems.
- Standard III.*** The beginning engineering teacher understands the legal and ethical requirements of the engineering profession.
- Standard IV.*** The beginning engineering teacher understands the concept of teaming and demonstrates knowledge of careers in engineering and technology and the role of professional and student engineering organizations in career development.
- Standard V.*** The beginning engineering teacher understands the societal contexts of engineering and technology.
- Standard VI.*** The beginning engineering teacher understands and applies knowledge of tools, equipment, technologies, and procedures used in the design and production of systems.
- Standard VII.*** The beginning engineering teacher understands the importance of professional development and knows how students learn and develop engineering skills and concepts and uses this knowledge to plan and implement effective classroom instruction and laboratory experiences to meet curricular goals.
- Standard VIII.*** The beginning engineering teacher knows how to provide a safe and productive learning environment for implementing activities in engineering education.
- Standard IX.*** The beginning engineering teacher identifies, evaluates, and utilizes new and emerging technologies.

**Standard I. The beginning engineering teacher possesses a working knowledge of engineering fundamentals.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <ul style="list-style-type: none"> <li>1.1k fundamental engineering content (e.g., statics, dynamics, electric circuits, materials science, fluid mechanics, thermodynamics, chemical systems);</li> <li>1.2k the role of economics in engineering design and decision making;</li> <li>1.3k the role of mathematics and science in solving engineering problems;</li> <li>1.4k how to integrate engineering content, mathematics, and the physical sciences to solve engineering problems;</li> <li>1.5k the theory, properties, functions, and applications of control systems (e.g., open-loop, closed-loop); and</li> <li>1.6k basic principles of information technology and computers.</li> </ul>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <ul style="list-style-type: none"> <li>1.1s apply fundamental engineering content (e.g., statics, dynamics, electric circuits, materials science, fluid mechanics, thermodynamics, chemical systems) to solve problems;</li> <li>1.2s solve problems in engineering economics (e.g., simple and compound interest, depreciation, cost estimation, budgets);</li> <li>1.3s use engineering, mathematics, physics, and chemistry concepts to design solutions to engineering problems;</li> <li>1.4s use control systems, including microcontrollers, in designing solutions to problems;</li> <li>1.5s explain the fundamental concepts associated with information technology and computers; and</li> <li>1.6s use computers, programming languages, and information technology to solve problems in engineering.</li> </ul>

**Standard II. The beginning engineering teacher understands the design process and integrates mathematics, science, technology, engineering, and other knowledge to design solutions to engineering problems.**

**Teacher Knowledge: What Teachers Know**

*Teachers of Students in Grades 8–12*

The beginning teacher knows and understands:

- 2.1k the iterative engineering design process (e.g., identification and formulation of problems, conceptualization of possible solutions, analysis of solutions to find an optimal solution based on practical and realistic constraints, implementation of the chosen solution, validation of the chosen solution, and solution redesign if necessary);
- 2.2k problem-solving procedures related to the design or redesign of devices, systems, processes, and services; and
- 2.3k oral and written communication skills necessary to communicate appropriately and effectively with professional engineers and others involved in the problem-solving process.

**Application: What Teachers Can Do**

*Teachers of Students in Grades 8–12*

The beginning teacher is able to:

- 2.1s identify an engineering problem that needs to be solved and formulate the problem in terms of engineering concepts;
- 2.2s collect, assess, test, record, organize and analyze information needed to design a product, system, or service;
- 2.3s identify realistic constraints (e.g., safety features, costs, environmental impact, societal benefits, ethical considerations) associated with an engineering problem;
- 2.4s interpret and evaluate the accuracy of information used in the design of a product, system, or service;
- 2.5s conceptualize possible solutions to an identified problem;
- 2.6s compare, evaluate, and optimize possible solutions;
- 2.7s choose an appropriate solution and formulate a detailed design;
- 2.8s use problem-solving techniques from mathematics, the physical sciences, technology, and engineering, as appropriate, throughout the design process;
- 2.9s apply principles of graphic communication to convey design specifications and characteristics;
- 2.10s utilize appropriate presentation and communication skills to market a design effectively to a customer;

**Standard II.** The beginning engineering teacher understands the design process and integrates mathematics, science, technology, engineering, and other knowledge to design solutions to engineering problems.

**Application: What Teachers Can Do**

*Teachers of Students in Grades 8–12 (continued)*

The beginning teacher is able to:

2.11s implement and completely test a design solution using appropriate technology; and

2.12s improve a product, service, or system to meet requirements based on feedback and analysis.

**Standard III. The beginning engineering teacher understands the legal and ethical requirements of the engineering profession.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>3.1k that engineering involves ethical questions;</p> <p>3.2k that engineers must hold paramount the health, safety, and welfare of the general public;</p> <p>3.3k ethical standards (e.g., The Engineering Code of Ethics) for the engineering profession;</p> <p>3.4k requirements of regulatory agencies in the scientific, mathematics, engineering, and technology fields;</p> <p>3.5k fundamental legal and ethical issues associated with patent, trademark, copyright, and proprietary information;</p> <p>3.6k how to recognize and refute misleading information; and</p> <p>3.7k methods for protecting and conserving resources.</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>3.1s analyze ethics-related questions and scenarios that arise in engineering;</p> <p>3.2s identify ethical decisions when presented with choices and moral dilemmas;</p> <p>3.3s examine ethical issues associated with engineering and technology, including those related to the use of innovative technologies (e.g., genetic engineering, information privacy);</p> <p>3.4s apply knowledge of requirements of regulatory agencies in the fields of science, mathematics, engineering, and technology ;</p> <p>3.5s explain the fundamentals of patent, trademark, copyright, and proprietary information;</p> <p>3.6s identify and refute misleading information; and</p> <p>3.7s evaluate methods for protecting and conserving resources.</p>

**Standard IV. The beginning engineering teacher understands the concept of teaming and demonstrates knowledge of careers in engineering and technology and the role of professional and student engineering organizations in career development.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>4.1k the concept of teaming and the structure and function of technology teams;</p> <p>4.2k the traits and practices of effective leaders (e.g., ethics, honesty, decisiveness, integrity, setting an example);</p> <p>4.3k various types of skills needed for operating within an organization (e.g., interpersonal, conflict resolution);</p> <p>4.4k the knowledge and skills needed for various careers in engineering (e.g., mechanical, electrical, chemical, civil, environmental, architectural);</p> <p>4.5k the value of joining and actively participating in a professional engineering community; and</p> <p>4.6k the importance of providing students with exposure to the engineering profession through student organizations, internships, and work experience.</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>4.1s apply knowledge of challenges of working on a technology team and strategies for working effectively with multi-disciplinary teams;</p> <p>4.2s describe strategies for developing consensus to ensure the best possible outcome;</p> <p>4.3s demonstrate knowledge of management skills (e.g., collaboration, resourcefulness, flexibility, delegation, supervision) and decision-making procedures;</p> <p>4.4s apply knowledge of how to act responsibly as a team member (e.g., by completing tasks in a timely and effective manner, giving credit where appropriate, taking responsibility for decisions made);</p> <p>4.5s describe various careers in engineering and guide students in developing career skills and evaluating career options; and</p> <p>4.6s apply knowledge of strategies for providing students with opportunities to work within the engineering community.</p>

**Standard V. The beginning engineering teacher understands the societal contexts of engineering and technology.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>5.1k the cultural, social, economic, and political contexts of engineering and technology;</p> <p>5.2k the effects of engineering and technology on the economy and the environment;</p> <p>5.3k the role of society in the development and use of engineering and technology; and</p> <p>5.4k ways in which engineering and technology have influenced history.</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>5.1s synthesize data, analyze trends, and draw conclusions regarding interactions between engineering and the individual, society, and the environment;</p> <p>5.2s use various strategies to determine the risks and benefits of designed solutions to a variety of problems;</p> <p>5.3s describe and analyze the impact of engineering and technology on global society in the areas of medicine, agriculture and biotechnology, energy and power, information and communication, transportation, manufacturing, and construction;</p> <p>5.4s explain how societal needs, values, beliefs, and institutions influence the design and development of engineering products, systems, and services; and</p> <p>5.5s explore the evolution of technology and identify significant engineering achievements throughout history.</p>



**Standard VI. The beginning engineering teacher understands and applies knowledge of tools, equipment, technologies, and procedures used in the design and production of systems.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>6.1k the use of computer applications in the design process;</p> <p>6.2k various types of software, design tools, and measuring devices used in engineering;</p> <p>6.3k appropriate methods of measurement and statistical analysis;</p> <p>6.4k how to use appropriate design tools to develop and explore engineering concepts and ideas;</p> <p>6.5k principles of product development (e.g., design, prototype construction, product testing);</p> <p>6.6k properties of materials (e.g., metals, polymers, ceramics, composites) used in product development; and</p> <p>6.7k the fundamentals of quality assurance and issues associated with product liability.</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>6.1s solve problems and communicate information using a variety of computer applications (e.g., spreadsheets, word processors, mathematics packages, graphics programs,);</p> <p>6.2s utilize computer-based design and simulation tools in the design process;</p> <p>6.3s apply procedures for researching, identifying, and evaluating emerging design tools (e.g., desktop manufacturing systems);</p> <p>6.4s use various measuring devices (e.g., micrometers, digital multimeters, oscilloscopes, calipers, scales, environmental sensors);</p> <p>6.5s identify and apply criteria to select an appropriate material for a given project;</p> <p>6.6s use a variety of tools, equipment, and processes to construct a prototype;</p> <p>6.7s develop and implement a variety of tests to evaluate a prototype; and</p> <p>6.8s apply statistical analysis tools to evaluate the validity and significance of test data.</p>

**Standard VII. The beginning engineering teacher understands the importance of professional development and knows how students learn and develop engineering skills and concepts and uses this knowledge to plan and implement effective classroom instruction and laboratory experiences to meet curricular goals.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>7.1k current theory, research, and practice regarding how students learn engineering design;</p> <p>7.2k how students' prior knowledge of and attitudes toward engineering may affect their learning;</p> <p>7.3k common student misconceptions and errors regarding engineering;</p> <p>7.4k how learning may be facilitated through the use of flow diagrams, mathematical analyses, and data collection and evaluation;</p> <p>7.5k the role of individual and group projects in promoting learning and creating a learning environment that actively engages students in learning and encourages self-motivation;</p> <p>7.6k the relationship between instruction and assessment;</p> <p>7.7k the importance of establishing collegial relationships with other teachers and professional staff;</p> <p>7.8k the benefits of participating in workshops, courses, conferences, and other professional activities that address topics related to the teaching of engineering design;</p> <p>7.9k the benefits of discussing current ideas, trends, and directions in engineering with colleagues and students through local organizations, professional publications, and electronic communities;</p> <p>7.10k the importance of participating in school and community efforts to effect positive change in engineering and technology; and</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>7.1s use students' prior knowledge in mathematics, science, and technology to build conceptual links to new knowledge;</p> <p>7.2s employ instructional strategies that build on the linguistic, cultural, and socioeconomic diversity of students;</p> <p>7.3s develop a variety of instructional activities to guide students in constructing engineering knowledge;</p> <p>7.4s teach students to recognize and correct common engineering misconceptions and errors;</p> <p>7.5s engage students in tasks that require them to communicate their engineering reasoning;</p> <p>7.6s motivate students and actively engage them in the learning process by using a variety of interesting, challenging, and worthwhile engineering design tasks in individual, small-group, and large-group settings;</p> <p>7.7s develop effective assessments to evaluate student learning and guide instruction;</p> <p>7.8s communicate effectively with engineering teachers at other grade levels to ensure continuity of students' education;</p> <p>7.9s develop and use professional relationships to create links between the engineering design curriculum and other disciplines;</p> <p>7.10s apply knowledge of how to use workshops and other professional development activities to keep up with current technology and enhance instructional effectiveness;</p>

**Standard VII.** The beginning engineering teacher understands the importance of professional development and knows how students learn and develop engineering skills and concepts and uses this knowledge to plan and implement effective classroom instruction and laboratory experiences to meet curricular goals.

**Teacher Knowledge: What Teachers Know**

*Teachers of Students in Grades 8–12 (continued)*

7.11k the availability of resources, including state resources, to support teachers of engineering.

**Application: What Teachers Can Do**

*Teachers of Students in Grades 8–12 (continued)*

7.11s select and use materials from appropriate professional publications to develop lesson plans and instructional activities; and

7.12s apply procedures for organizing various types of activities (e.g., creating newsletters and web pages, planning fundraisers and field trips) to enhance communication and interaction involving parents/guardians, students, and the engineering community.

**Standard VIII. The beginning engineering teacher knows how to provide a safe and productive learning environment for implementing activities in engineering education.**

<b>Teacher Knowledge: What Teachers Know</b>	<b>Application: What Teachers Can Do</b>
<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher knows and understands:</p> <p>8.1k safety regulations and guidelines for engineering facilities and equipment;</p> <p>8.2k procedures for storing, securing, and maintaining scientific and engineering equipment used in instructional activities;</p> <p>8.3k procedures for the safe and effective use of design tools used in instructional activities;</p> <p>8.4k use of the laboratory for engineering design activities;</p> <p>8.5k regulations and guidelines (e.g., space requirements, environmental controls, safety equipment) for engineering education facilities;</p> <p>8.6k characteristics and layouts of effective instructional facilities used for engineering education programs;</p> <p>8.7k procedures for assessing the facilities of the engineering education program;</p> <p>8.8k how to select and acquire tools, equipment, and materials (e.g., computer hardware and software, multimedia equipment, measuring tools, power tools) used in engineering education program; and</p> <p>8.9k how to access information related to the installation, maintenance, and repair of equipment used in engineering education facilities.</p>	<p><i>Teachers of Students in Grades 8–12</i></p> <p>The beginning teacher is able to:</p> <p>8.1s identify and use appropriate safety procedures for various types of instructional activities, including laboratory projects, field activities, and classroom demonstrations;</p> <p>8.2s determine space requirements for safely carrying out engineering activities in the classroom and laboratory;</p> <p>8.3s provide students with ongoing instruction and training in safety procedures for engineering laboratory and field activities, student demonstrations, and independent projects;</p> <p>8.4s select and safely use appropriate tools, technologies, materials, and equipment for instructional activities in engineering;</p> <p>8.5s apply procedures for monitoring students' use of materials, tools, and instruments;</p> <p>8.6s evaluate the effectiveness of the space and physical arrangement of instructional facilities for instructional purposes; and</p> <p>8.7s apply procedures for making engineering resources available to all students.</p>

**Standard IX. The beginning engineering teacher identifies, evaluates, and utilizes new and emerging technologies.**

<p><b>Teacher Knowledge: What Teachers Know</b></p>	<p><b>Application: What Teachers Can Do</b></p>
<p><i>Teachers of Students in Grades 8–12</i></p>	<p><i>Teachers of Students in Grades 8–12</i></p>
<p>The beginning teacher knows and understands:</p>	<p>The beginning teacher is able to:</p>
<p>9.1k how to identify new and emerging technologies;</p>	<p>9.1s identify new and emerging technologies;</p>
<p>9.2k resources for finding out about new and emerging technologies;</p>	<p>9.2s investigate innovative and emerging applications of technology in engineering;</p>
<p>9.3k how to incorporate new and emerging technologies into the classroom; and</p>	<p>9.3s apply evolving and appropriate technologies in the classroom;</p>
<p>9.4k factors that affect the adoption or rejection of new technologies.</p>	<p>9.4s analyze how technologies change and factors that affect the adoption or rejection of new technologies; and</p>
	<p>9.5s assess potential cultural, social, economic, and political effects of new and emerging technologies.</p>