WISCONSIN STANDARDS FOR

Technology and Engineering

Wisconsin Department of Public Instruction
Jill K. Underly, PhD, State Superintendent

WISCONSIN STANDARDS FOR

Technology and Engineering Education

Wisconsin Department of Public Instruction

Jill K. Underly, PhD, State Superintendent Madison, Wisconsin

This publication is available from:

Wisconsin Department of Public Instruction
201 West Washington Avenue
Madison, WI 53703
(608) 266-3390
http://dpi.wi.gov/cte

April 2024, Wisconsin Department of Public Instruction

Table of Contents

Foreword

In Spring 2024, I formally adopted the *Wisconsin Standards for Technology and Engineering*. This revised set of academic standards provides a foundational framework that identifies what students should know and be able to do in Technology and Engineering.

The standards are a result of a concerted effort led by Wisconsin educators and partners who shared their expertise in Technology and Engineering and teaching from kindergarten through higher education. The public and the Wisconsin Legislature provided feedback for the writing committee to consider throughout Wisconsin's academic standards review and revision process.

Technology and Engineering is an essential part of a comprehensive PK-12 education for all students and gives Wisconsin students a way to understand and empower themselves and their worlds. The knowledge, skills, and habits of mind gained through Technology and Engineering education in Wisconsin schools support the Wisconsin Department of Public Instruction's vision of engaging learners and creating a better Wisconsin together. *Wisconsin's Standards for Technology and Engineering* also result in the following:

- Wisconsin students have the ability to develop deep understanding as confident and capable learners so that they may experience joy and confidence in themselves.
- Wisconsin's students develop proven practices and content.
- Wisconsin's students are flexible and use the standards to understand the world and question and critique the world productively.
- Wisconsin's students will have expanded professional opportunities in a wide variety of careers.

The Wisconsin Department of Public Instruction will continue to build on this work to support the implementation of the standards with resources for the field. I am excited to share the *Wisconsin Standards for Technology and Engineering*, which aims to build skills, knowledge, and engagement opportunities for all Wisconsin students.

Jill K. Underly, PhD
State Superintendent

Acknowledgments

The Wisconsin Department of Public Instruction (DPI) wishes to acknowledge the ongoing work, commitment, and various contributions of individuals to revise our state's academic standards for Technology and Engineering. Thank you to the State Superintendent's Standards Review Council for their work and guidance through the standards process. A special thanks to the Technology and Engineering Writing Committee for taking on this important project that will shape the classrooms of today and tomorrow. Thanks to the many staff members across the division and other teams at DPI who have contributed their time and talent to this project. Finally, a special thanks to Wisconsin educators, businesspeople, parents, and citizens who provided comments and feedback to drafts of these standards.

Wisconsin Standards for Technology and Engineering Education

Chairs: **James (Jim) Eastman,** Menasha School District
Aaron Hoffman, DC Everest School District

DPI Liaisons: **Jake Mihm,** Technology and Engineering Education Consultant, Career and Technical Education
Sharon Wendt, Director, Career and Technical Education
Sara Baird, Assistant Director, Career and Technical Education
Carol Hutchison, Communications Specialist, Career and Technical Education

Barb Bauer
University of Wisconsin-Stout

Allen Carlson
Amery School District

Duane Elfering
University of Wisconsin-Platteville

Natalie Elfering
Hamilton School District

Carl L. Hader
Wisconsin Automobile and Truck Dealers Foundation

Tony A. Ingram
Winneconne Community School District

Brent Kindred
Wisconsin Automotive and Truck Dealers Foundation

Alan Ligocki
DeForest Area School District

Chris Martin
Wisconsin Technical College System

Eric Mumm
Lancaster Community School District

Jeffrey Otto
Monona Grove School District

Ryan Stodola
Monona Grove School District

Randy Way
Madison College

Mason Pautsch
Milton School District

Tammy Szekeress
REI Engineering, Inc.

Erik Wolbach
Union Grove High School

Brian Schiltz
Tomahawk School District

Anna Vitale
Dodgeland School District

Department of Public Instruction, Academic Standards

Nicole Horsley, Director, Literacy and Mathematics, and Director for Academic Standards
Meri Annin, Visual Communications Lead Designer, Education Information Services

Department of Public Instruction Leaders

Sara Knueve, Policy Initiatives Advisor, Division for Academic Excellence
Dr. John Johnson, Deputy State Superintendent, Office of the State Superintendent
Tom McCarthy, Associate Deputy State Superintendent, Office of the State Superintendent

Section I

Wisconsin's Approach to Academic Standards

Purpose of the Document

The purpose of this document is to improve Technology and Engineering education for students and for communities. The Wisconsin Department of Public Instruction (DPI) has developed standards to assist Wisconsin educators and community members in understanding, developing, and implementing course offerings and curricula in school districts across Wisconsin.

This publication provides a vision for student success and follows *The Guiding Principles for Teaching and Learning (2011)*. In brief, the principles are:

1. Every student has the right to learn.
2. Instruction must be rigorous and relevant.
3. Purposeful assessment drives instruction and affects learning.
4. Learning is a collaborative responsibility.
5. Students bring strengths and experiences to learning.
6. Responsive environments engage learners.

Program leaders will find these standards valuable for making decisions about:

- Program structure and integration
- Curriculum redesign
- Staffing and staff development
- Scheduling and student grouping
- Facility organization
- Learning spaces and materials development
- Resource allocation and accountability
- Collaborative work with other units of the school, district, and community

What Are Academic Standards?

Wisconsin Academic Standards specify what students should know and be able to do. They serve as goals for teaching and learning. Setting high standards enables students, parents, educators, and citizens to know what students should have learned at a given point in time. In Wisconsin, all state standards serve as a model. Locally elected school boards adopt academic standards in each subject area to best serve their local communities. We must ensure that all children have equal access to high-quality educational programs. Clear statements about what students must know and be able to do are essential in making sure our schools offer opportunities to get the knowledge and skills necessary for success beyond the classroom.

Adopting these standards is voluntary. Districts may use the academic standards as guides for developing local grade-by-grade-level curricula. Implementing standards may require some school districts to upgrade school and district curricula. This may result in changes in instructional methods and materials, local assessments, and professional development opportunities for the teaching and administrative staff.

What is the Difference Between Academic Standards and Curriculum?

Standards are statements about what students should know and be able to do, what they might be asked to do to give evidence of learning, and how well they should be expected to know or do it. Curriculum is the program devised by local school districts used to prepare students to meet standards. It consists of activities and lessons at each grade level, instructional materials, and various instructional techniques. In short, standards define what is to be learned at certain points in time and, from a broad perspective, what performances will be accepted as evidence that the learning has occurred. Curricula specify the details of the day-to-day schooling at the local level.

Developing the Academic Standards

DPI has a transparent and comprehensive process for reviewing and revising academic standards. The process begins with a notice of intent to review an academic area with a public comment period. The State Superintendent's Academic Standards Review Council examines those comments and may recommend revision or development of standards in that academic area. The state superintendent authorizes whether or not to pursue a revision or development process. Following this, a state writing committee is formed to work on those standards for all grade levels. That draft is then made available for open review to get feedback from the public, key stakeholders, educators, and the legislature, with further review by the State Superintendent's Academic Standards Review Council. The state superintendent then determines the adoption of the standards.

Aligning for Student Success

To build and sustain schools that support every student in achieving success, educators must work together with caregivers, community members, and business partners to connect the most promising practices in the most meaningful contexts. The release of the *Wisconsin Standards for Technology and Engineering* provides a set of important academic standards for school districts to implement. This is connected to a larger vision of engaged learners creating a better Wisconsin together. Academic standards work together with other critical principles and efforts to educate every child to be an engaged learner capable of creating a better Wisconsin together. Here, the vision and Guiding Principles form the foundation for building a supportive process for teaching and learning rigorous and relevant content. The following sections articulate this integrated approach to increasing student success in Wisconsin schools and communities.

Relating the Academic Standards to All Students

Academic standards should allow ALL students to engage, access, and be assessed in ways that fit their strengths, needs, and interests. This applies to students with individualized education plans (IEPs), English learners, and gifted and talented pupils, consistent with all other students. Academic standards serve as a foundation for individualized programming decisions for all students.

Academic standards serve as a valuable basis for establishing concrete, meaningful goals for each student's developmental progress and demonstration of proficiency. Students with IEPs must be provided with specially designed instruction that meets their individual needs. It is expected that each individual student with an IEP will require unique services and supports matched to their strengths and needs in order to close achievement gaps in grade-level standards. Alternate standards are only available for students with the most significant cognitive disabilities.

Gifted and talented students may achieve well beyond the academic standards and move into advanced grade levels or into advanced coursework.

Our Vision: Engaged Learners Creating a Better Wisconsin Together

We are committed to ensuring every child graduates from high school academically prepared and socially and emotionally competent. A successful Wisconsin student is proficient in academic content and can apply their knowledge through skills such as critical thinking, communication, collaboration, and creativity. The successful student will also possess critical habits such as perseverance, responsibility, adaptability, and leadership. This vision for every child as an engaged learner guides our beliefs and approaches to education and to creating a better Wisconsin together.

Guided by Principles

All educational initiatives are guided and impacted by important and often unstated attitudes or principles for teaching and learning. *The Guiding Principles for Teaching and Learning (2011)* were drawn from research and provide the touchstone for practices that truly affect the vision of "Engaged learners creating a better Wisconsin together." When made transparent, these principles inform what happens in the classroom, direct the implementation and evaluation of programs, and most importantly, remind us of our own beliefs and expectations for students.

Engaging Learners Through Career Readiness

When educators connect their students' learning to future career opportunities, they begin to engage students in a very personal and powerful way. In addition to career readiness as a strategy to engage learners, it is also a conduit through which every student in Wisconsin, including students with an IEP, can graduate from high school with the knowledge, skills, and abilities needed to be successful in their chosen career pathway. Regardless of the postsecondary path that a graduate pursues immediately after their K-12 education, we believe in preparing all students to be lifelong learners and acknowledge that one's education and career path are inextricably linked.

The Wisconsin Career Readiness Standards (WCRS) provide the framework for educators to integrate career-readiness skills across all content areas and at every grade level from K-12. Because people begin to develop interests and biases at an early age, it is important to start integrating WCRS in the elementary grades. By middle school, students may have already developed beliefs about their abilities related to careers. Or they may have formed stereotypes about which careers are appropriate for a particular gender, race, or socioeconomic background. Exposing students to careers and helping them develop skills related to careers when they are young is one way to keep students' minds open to all possibilities.

Implementing the Wisconsin Career Readiness Standards may look different for every teacher, every program, every course, and potentially every unit or lesson. These standards were designed to be naturally and intentionally integrated into other content standards. The Wisconsin Career Readiness Standards can be found here.

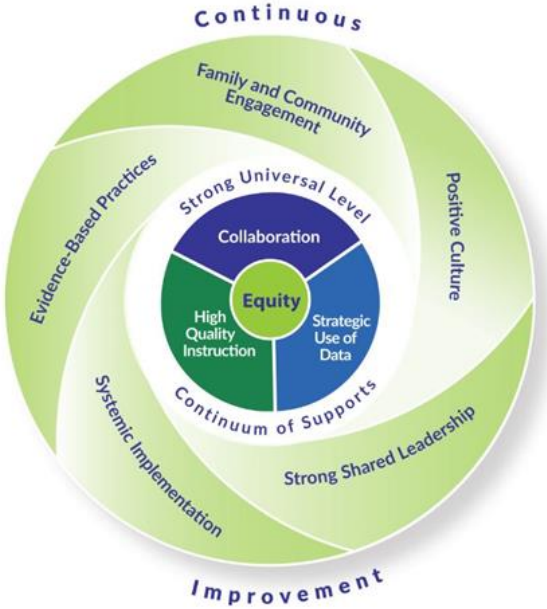
Ensuring a Process for Student Success

For Wisconsin schools and districts, implementing the *Framework for Equitable Multi-Level Systems of Supports (2017)* means providing equitable services, practices, and resources to every learner based on responsiveness to effective instruction and intervention. In this system, high-quality instruction, strategic use of data, and collaboration interact within a continuum of supports to facilitate learner success. Schools provide varying types of supports with differing levels of intensity to proactively

and responsibly adjust to the needs of the whole child. These include the knowledge, skills, and habits learners need for success beyond high school, including developmental, academic, behavioral, social, and emotional skills.

Connecting to Content: Wisconsin Academic Standards

Within this vision for increased student success, rigorous, internationally benchmarked academic standards provide the content for high-quality curriculum and instruction and for a strategic assessment system aligned to those standards. With the adoption of the standards, Wisconsin has the tools to design curriculum, instruction, and assessments to maximize student learning. The standards articulate what we teach so that educators can focus on how instruction can best meet the needs of each student. When implemented within an equitable multilevel system of supports, the standards can help to ensure that every child will graduate prepared for college and career.



Section II

Wisconsin Standards for Technology and Engineering

Technology and Engineering is a Part of Career and Technical Education

The standards outlined in this document provide an important foundation to prepare individuals for a wide range of careers in Technology and Engineering Education (TEE). TEE is part of a larger grouping referred to as career and technical education (CTE). CTE in Wisconsin is both a collection of educational programs or content areas as well as a system of preparing students for college, career, community, and life. CTE programs are delivered primarily through six specific content areas. These include:

- Agriculture, Food, and Natural Resources
- Business and Information Technology
- Family and Consumer Sciences
- Health Science
- Marketing, Management, and Entrepreneurship
- Technology and Engineering

A National Vision for CTE

The National Association of State Directors of Career and Technical Education has developed a bold vision for CTE titled *"Without Limits: A Shared Vision for the Future of Career Technical Education"* (CTE Without Limits). This vision lays out a cohesive, flexible, and responsive career preparation ecosystem designed to close equity gaps in educational outcomes and workforce readiness, and leverage CTE as a catalyst for ensuring each learner can reach success in the career of their choice. Wisconsin supports the five interconnected and equally critical principles:

- Each learner engages in a cohesive, flexible, and responsive career preparation ecosystem.
- Each learner feels welcome in, is supported by, and has the means to succeed in the career preparation ecosystem.
- Each learner skillfully navigates their own career journey.
- Each learner's skills are counted, valued, and portable.
- Each learner can access CTE without borders. In other words, as learners become increasingly mobile and not place-based, and as more learning and work happens remotely, geographic barriers that limit access and opportunities for learners, particularly those in rural communities, need to be removed.

Wisconsin's Vision for Career and Technical Education

The Wisconsin vision for career and technical education (CTE) is shaped by Wisconsin practitioners, experts, and the business community, and is informed by work at the national level and in other states. The overarching goal of Wisconsin's vision for CTE is for students to see themselves as confident doers and learners in a career pathway, supporting the department's vision to be engaged learners fully prepared to create a better Wisconsin together.

Building a Foundation of Career Readiness

As noted in Section I, the Wisconsin Career Readiness Standards (WCRS) capture the knowledge, skills, and abilities that students need to be successful in their chosen career pathway and will lead to workplace success. Because career and technical education (CTE) prepares all students for their future careers, education, and, ultimately, life success, the WCRS is a natural fit for any CTE course. Educators will find many of the WCRS embedded in the TEE standards. Here is an example of what WCRS looks like in TEE:

Wisconsin Career Readiness Standards	Wisconsin Technology and Engineering Standards
Career Ready (CAR) **WCRS.CAR.2.A:** Identify the in-demand career and entrepreneurship opportunities that align with personal interests, skills, and work values.	**Broad Based (BB)** **TE.BB.2:** Students will demonstrate an understanding of career opportunities within career and technical education, science, technology, engineering, and mathematics.
Learning Ready (LRN) **WCRS.LRN.2: Critical thinking and problem-solving** Develop the motivation and acquire the critical thinking and creative problem-solving skills needed to prepare for future education and careers.	**Engineering (ENG)** **TE.ENG.2:** Students will understand and apply the engineering design process to solve problems. **TE.ENG.2.A.i.1:** Understand that the engineering design process is an iterative multistep process that requires a failure analysis and repeat of steps until a valid solution is developed.

Life Ready (LIF)	Environmental Technology (ET)
WCRS.LIF.1: Self-awareness, management, and responsibility Gain insight into oneself to help inform and build paths to success in personal, educational, and career settings.	**TE.ET.3.A:** Develop awareness and understanding of the impact human decision-making and technological advancements have on the environment we occupy.

CTE in the Elementary Grades

Another way to build the foundation for career readiness is to expose students to career and technical education in the elementary grades. We encourage elementary educators to intentionally weave appropriate CTE standards into subject areas such as math, science, social studies, and English. Educators will be able to learn more about how to implement the Wisconsin Career Readiness Standards and other CTE standards in elementary grades in a future publication, "Wisconsin's Guide to K-5 Career Readiness."

Delivering CTE Through Career Pathways

Through CTE, learners not only gain awareness of various careers but also have opportunities to engage in deeper exploration and preparation through a career pathway. Each pathway—whether health science, agriculture, business, construction, or engineering, to name a few—includes elements of career and technical education that help students develop the knowledge and skills to be successful in the career of their choice.

Elements of CTE that create a career pathway include:

- A sequence of CTE courses that build from introductory to more advanced levels
- Work-based learning experiences
- Career and technical student organizations (CTSOs)
- Dual enrollment or college credit opportunities
- Industry-recognized credentials

Wisconsin schools use the above elements as a framework to engage with stakeholders to provide rich and authentic opportunities and experiences that help students gain knowledge and skills that go beyond the classroom experience.

While schools may independently build their own career pathways, Wisconsin's regional career pathway (RCP) approach makes the process easier for individual school districts by vetting some of the career pathway components on a regional basis and tailoring pathways to address regional employment needs. Wisconsin's regional career pathway network covers seven regions—each with its own advisory group of local employers, educational organizations, and economic and workforce development interests.

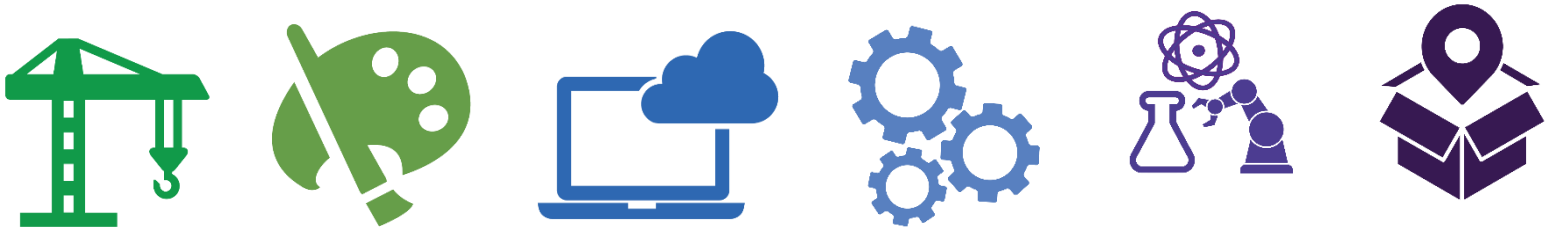
Partnerships that bring business and educational organizations together are an effective way to ensure that students are gaining practical and up-to-date knowledge and skills necessary to get a jump-start on a career in their regional industries. Leading employers share direct input on the latest tools, practices, and processes in an industry, while K-12 schools and other educational organizations offer the professional expertise to engage and teach young learners using standards within this document.

Career Pathway Elements

A sequence of CTE courses that build from introductory to more advanced levels

Academic standards define what students should know and be able to do in an area of study. In career and technical education, standards are integrated with technical skill development based on industry standards. A coordinated sequence of two or more academic courses incorporating challenging state standards builds student knowledge, technical skills, and employability skills. The TEE standards are designed to allow educators to build these courses from introductory-level content to advanced skills. The TEE standards were developed with reference to the national standards.

The sequencing of courses in TEE fits several different career clusters, most specifically related to:



Architecture and Construction | **Arts, Audio/Video Technology, and Communications** | **Information Technology** | **Manufacturing** | **Science, Technology, Engineering, and Math** | **Transportation, Distribution, and Logistics**

Work-Based Learning

Work-based learning (WBL) opportunities are employer-connected experiences that allow K-12 students to participate in career awareness, career exploration, and career development. Academic standards serve as the foundation of WBL and allow students to apply knowledge and technical skills to real-world projects and problems alongside professionals. Having students participate in work-based learning is a priority in Wisconsin and is reflected on DPI's School Report Cards and federal (Perkins V) accountability reports. Participation in work-based learning is only calculated if the program meets the following criteria:

1. Involves sustained interactions, either paid or unpaid, with industry or community professionals.
    - Sustained = minimum of 90 hours, which can be rotated among employers or positions. The employer is engaged throughout the experience. It can take place in one semester, an entire year, the summer, or even a six-week period.
    - Interactions must be more than just observing and include direct communication and involvement with industry or community professionals.
2. Takes place in real workplace settings (as practicable) or simulated environments at an educational institution.
3. Fosters in-depth, firsthand engagement with the tasks required in a given career.

4. Aligns with a course (generally speaking, should be a minimum of one semester). It is highly encouraged to provide credit for the work-based learning experience as well as credit for the school-based course.
5. Must include a training agreement between the student, employer/business, and school that defines the roles and responsibilities of the student, the employer, and the school.
6. Business and education partners work together to evaluate and supervise the experiences, which must be documented with training or learning plans and evaluation forms.

There are numerous work-based learning programs designed to support student mastery of competencies and also count towards accountability measures. These programs are all outlined in the *Wisconsin Guide to Implementing Career-Based Learning Experiences*.

In TEE, career-based learning can take many forms, including:

- School-based enterprise (SBE)
- Student entrepreneurial experience (SEE)
- Internship or local co-op
- State-certified employability skills co-op
- State-certified occupational program co-op
- Youth Apprenticeship – Apprenticeships may be in science, technology, engineering, and math (STEM)-related fields, including all skilled trades, manufacturing, transportation, and information technology, as well as apprenticeship opportunities related to arts, audio/video technology, and communications.

Career and Technical Student Organizations

Career and technical student organizations (CTSOs) develop citizenship, technical, leadership, and teamwork skills essential for students who are preparing for the workforce and further education. They enhance students' civic awareness and provide opportunities for developing social competencies and a wholesome attitude about living and working.

Wisconsin has six state and nationally recognized CTSOs that are intracurricular. In other words, they connect directly to the classroom through curriculum, activities, and community resources. All CTSOs include leadership development and competitive events where students demonstrate technical and leadership skills. CTSOs prepare young people to become productive citizens and leaders in their communities and their careers. This is done through school activities along with regional, state, and national leadership conferences and competitions. Students grow and develop through these events and receive recognition for the work they have done and the skills they have developed. CTSOs provide an exceptional extension of CTE instruction. Wisconsin's CTSOs include:

WISCONSIN DECA · Wisconsin FBLA · FCCLA WISCONSIN STATE ASSOCIATION · WISCONSIN ASSOCIATION OF FFA · hosa future health professionals WISCONSIN · SkillsUSA

SkillsUSA is a partnership of students, teachers, and industry leaders working together to ensure the country has a skilled workforce. As a nonprofit CTSO, SkillsUSA serves middle-school, high-school, and postsecondary students preparing for careers in trade, technical, and skilled service occupations. SkillsUSA is recognized by the U.S. Department of Education and the U.S. Department of Labor as a successful model of employer-driven youth development training. It was chartered in 1965 and adopted by Wisconsin in 1973 with a mission to empower students to become skilled professionals, career-ready leaders, and responsible community members. This mission is accomplished through the Framework of Personal Skills, Workplace Skills, and Technical Skills grounded in academics. The Framework is the blueprint for career readiness. Students build on these skills through SkillsUSA leadership events, competitions, community service opportunities, as well as career exploration with support from business and industry professionals. For more information, visit SkillsUSA online.

Industry-Recognized Credentials

Industry-recognized credentials (IRCs) are certifications, credentials, or licenses that are vetted by employers and recognize skill attainment needed for recruitment, screening, hiring, retention, advancement, or to mitigate workforce shortages. Earning industry credentials while in high school helps students prove their competence and improve their employment prospects, sometimes immediately after graduation. CTE courses are designed to improve career-based learning, and many IRCs fit perfectly into the curriculum and can be added to the student's resume following certification.

Dual Enrollment or College Credit Opportunities
Dual enrollment includes a variety of programs through which high school students are enrolled simultaneously in both high school and college to earn credit through each. A dual enrollment course can take place at the high school, at a college or university, or through an online or distance course. Local school districts partner with higher education partners to provide training for instructors to offer these courses or avenues for students to participate in courses on campus or online. Successful completion of the coursework by a student will not only gain them a grade toward high school graduation but also transferable credits for their postsecondary education.

Discipline Standards Structure

The *Wisconsin Standards for Technology and Engineering* follow a specific structure:

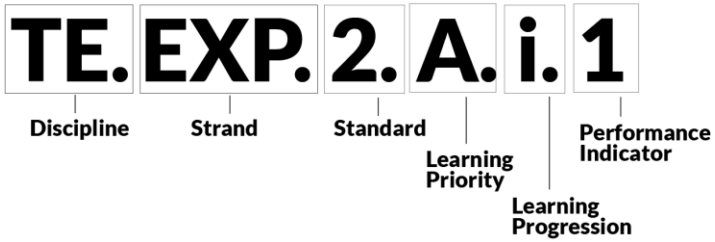
Standards Formatting

- **Discipline:** CTE program area
- **Strand:** Instructional topic within the discipline
- **Standard:** Broad statement that tells what students are expected to know or be able to do
- **Learning Priority:** Breaks down the broad statement into manageable learning pieces
- **Performance Indicator by Learning Progression:** Measurable degree to which a standard has been developed or met

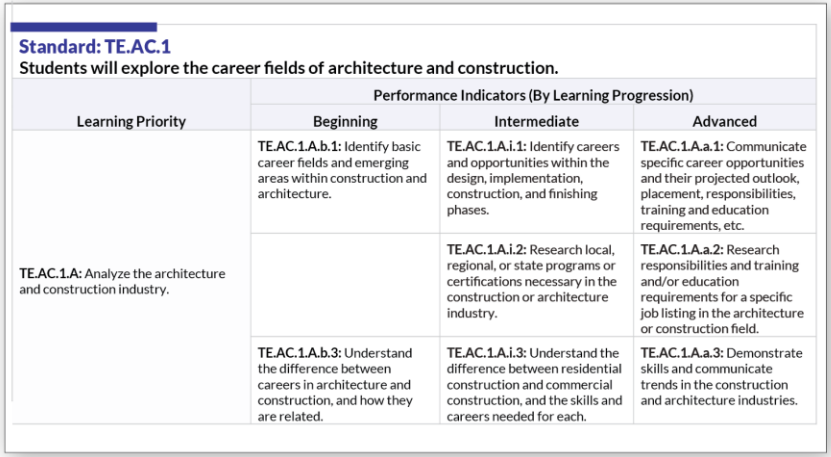
Standard Coding
Strands for Technology and Engineering in this code structure include:

- Architecture and Construction (AC)
- Electricity, Electronics, and Controls (EEC)
- Biotechnology (BT)
- Broad Based (BB)
- Engineering (ENG)
- Environmental Technology (ET)
- Information and Communication Technology (ICT)
- Manufacturing (MFG)
- Power and Energy (PE)
- Transportation, Distribution, and Logistics (TDL)

Key to Standards Coding



Sample of Standards Table



Standard: TE.AC.1

Students will explore the career fields of architecture and construction.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.AC.1.A: Analyze the architecture and construction industry.	TE.AC.1.A.b.1: Identify basic career fields and emerging areas within construction and architecture.	TE.AC.1.A.i.1: Identify careers and opportunities within the design, implementation, construction, and finishing phases.	TE.AC.1.A.a.1: Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
		TE.AC.1.A.i.2: Research local, regional, or state programs or certifications necessary in the construction or architecture industry.	TE.AC.1.A.a.2: Research responsibilities and training and/or education requirements for a specific job listing in the architecture or construction field.
	TE.AC.1.A.b.3: Understand the difference between careers in architecture and construction, and how they are related.	TE.AC.1.A.i.3: Understand the difference between residential construction and commercial construction, and the skills and careers needed for each.	TE.AC.1.A.a.3: Demonstrate skills and communicate trends in the construction and architecture industries.

Performance Indicator by Learning Progression

The 2024 Wisconsin Standards for Career and Technical Education (CTE) mark a shift in how progress is recognized in a CTE subject area. The new standards describe three levels of proficiency or mastery of industry expectations: beginning, intermediate, and advanced. This contrasts with the 2013 CTE standards, which focused on performance indicators by three grade bands: PK-5, 6-8, and 9-12.

Given the wide range of delivery models used, CTE does not lend itself to grade bands. In other words, CTE programming may be either nonexistent or robust at the elementary or middle-school levels. A beginning course, for example, may be offered in any grade. The 2024 CTE standards, more appropriately, shift from looking at knowledge and skills acquired by the end of certain grade levels to the increasing mastery a student acquires as they pursue their desired career pathway, regardless of the grade the student begins on that path. Here, then, are the three levels in more detail:

- Beginning: Developing awareness
- Intermediate: Building foundational knowledge and skills
- Advanced: Implementing specific knowledge and skills

The standards were designed to be flexible based on the unique needs of each Technology and Engineering program. Courses are meant to be aligned to the standards through the scaffolding of student learning and the level of mastery desired. Each learning priority has one or more performance indicators by learning progression, reflecting a sequential flow of learning and a continuum from beginning to advanced. Course design may consist of the full continuum or may begin and end with any learning progression level. Furthermore, the performance indicator descriptors may cross over or overlap each other from one level to the next. For example, the beginning level may include some foundational knowledge and skill-building connected to the intermediate level versus solely focusing on developing awareness.

TEE performance indicators were written to allow the educator to build content from beginning to advanced levels based on the design of the course. In several standards, there is not a set sequence of performance indicators. This allows the educator to pull a performance indicator from a different standard but lays the foundation for intermediate or advanced learning taking place. Many beginning performance indicators can be used across different standards, and the need to repeat performance indicators in all locations where they could be placed would have been overwhelming for educators. The design allows for flexibility to fit the needs of the educator, course, and district in order for students to demonstrate their knowledge of the content.

More aligned to postsecondary curriculum than past standards, the 2024 CTE standards provide programs an opportunity to help students build content knowledge, explore career pathways, and plan for postsecondary options. They also align with industry requirements, ensuring they meet current needs yet are flexible enough to absorb inevitable changes in industry processes and the economy as a whole.

In conclusion, these standards provide a foundation for a variety of applications in each of Wisconsin's districts.

Section III

Discipline: Technology and Engineering

Technology and Engineering

Strand: Architecture and Construction (AC)

Standard: TE.AC.1

Students will explore the career fields of architecture and construction.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.1.A: Analyze the architecture and construction industry.	**TE.AC.1.A.b.1:** Identify basic career fields and emerging areas within construction and architecture.	**TE.AC.1.A.i.1:** Identify careers and opportunities within the design, implementation, construction, and finishing phases.	**TE.AC.1.A.a.1:** Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
	TE.AC.1.A.b.2: Understand the levels of education required for careers in architecture and construction.	**TE.AC.1.A.i.2:** Research local, regional, or state programs or certifications necessary in the construction or architecture industry.	**TE.AC.1.A.a.2:** Research responsibilities and training and/or education requirements for a specific job listing in the architecture or construction field.
	TE.AC.1.A.b.3: Understand the difference between careers in architecture and construction, and how they are related.	**TE.AC.1.A.i.3:** Understand the difference between residential construction and commercial construction, and the skills and careers needed for each.	**TE.AC.1.A.a.3:** Demonstrate skills and communicate trends in the construction and architecture industries.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.A: Demonstrate the safe and appropriate use of all tools common to the construction industry.	**TE.AC.2.A.b.1:** Identify and explain the use of simple hand tools such as hammers, screwdrivers, handsaws, etc.	**TE.AC.2.A.i.1:** Demonstrate proficiency in the use of simple hand tools such as hammers, screwdrivers, handsaws, planes, sandpaper, nail sets, aviation snips, framing squares, utility knives, chalk lines, etc.	**TE.AC.2.A.a.1:** Properly and safely use common hand tools of the trade; demonstrate industry-standard application. For example, use a framing square to lay out stair stringers or rafter pitch.
	TE.AC.2.A.b.2: Identify, understand, and discuss the proper, safe use of machinery, stationary and hand-held power tools, and pneumatic tools.	**TE.AC.2.A.i.2:** Demonstrate the safe and proper use of all applicable power tools, such as circular saws, table saws, saber saws, drills, planers, sanders, pneumatic nail guns, and impact wrenches.	**TE.AC.2.A.a.2:** Identify and choose the correct tool or procedure for a given construction project or problem.
			TE.AC.2.A.a.3: Demonstrate proficiency in the proper care of hand and power tools common to the construction industry.
TE.AC.2.B: Analyze construction requirements, materials, structures, techniques, and maintenance.	**TE.AC.2.B.b.1:** Recognize that people live, work, and go to school in buildings that are of different types: houses, apartments, office buildings, and schools.	**TE.AC.2.B.i.1:** Select designs for structures based on factors such as building codes and requirements, style, convenience, cost, climate, culture, and function.	**TE.AC.2.B.a.1:** Analyze how structures are constructed using a variety of processes and procedures.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.B: Analyze construction requirements, materials, structures, techniques, and maintenance.	**TE.AC.2.B.b.2:** Identify types of temporary and permanent structures.	**TE.AC.2.B.i.2:** Explain the function of foundations and why structures rest on a foundation.	**TE.AC.2.B.a.2:** Recognize that the design of structures includes a number of requirements; identify and interpret local and global building codes.
	TE.AC.2.B.b.3: Describe how structures need to be maintained.	**TE.AC.2.B.i.3:** Discuss how modern communities are usually planned according to guidelines.	**TE.AC.2.B.a.3:** Analyze how structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use.
	TE.AC.2.B.b.4: Identify multiple systems that are used in buildings.	**TE.AC.2.B.i.4:** Identify a variety of materials and subsystems that buildings generally contain.	**TE.AC.2.B.a.4:** Compare building materials based on application; discuss how structures or substructures can be prefabricated or customized.
TE.AC.2.C: Apply measurement systems in the planning and layout process used in the construction industry.	**TE.AC.2.C.b.1:** Recognize and identify the rooms in a home.	**TE.AC.2.C.i.1:** Based on occupancy, calculate approximate number of rooms, room sizes, and room types required for a structure.	**TE.AC.2.C.a.1:** Identify design solutions for construction problems, such as the number of exits required based on structural materials and occupancy.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.C: Apply measurement systems in the planning and layout process used in the construction industry.	**TE.AC.2.C.b.2:** Demonstrate scale and proportion. For example, a toy car is a scale model of a full-sized car.	**TE.AC.2.C.i.2:** Identify the differences in line weights and styles. Demonstrate the convention of lines and their applications.	**TE.AC.2.C.a.2:** Calculate the required materials for simple structures. Estimate the cost for required materials.
	TE.AC.2.C.b.3: Communicate ideas and plans through sketching or drawing.	**TE.AC.2.C.i.3:** Demonstrate basic dimensioning skills, including the use of dimension, extension, center, and leader lines.	**TE.AC.2.C.a.3:** Understand the use of an architect's scale; apply the use of a scale through drawing or measuring blueprint drawings of a given construction project.
	TE.AC.2.C.b.4: Demonstrate use of the standard measuring system to the 1/4" and the metric measuring system to millimeters.	**TE.AC.2.C.i.4:** Demonstrate use of the standard measuring system to the 1/16" and be able to convert to decimal and metric equivalency.	**TE.AC.2.C.a.4:** Apply conventional construction measurement processes accurately, including geometric and trigonometric functions.
	TE.AC.2.C.b.5: Add, subtract, multiply, and divide in the standard measuring system to the 1/4" and the metric measuring system to millimeters.	**TE.AC.2.C.i.5:** Add, subtract, multiply, and divide fractions and mixed numbers.	**TE.AC.2.C.a.5:** Use conventional construction formulas to determine production requirements.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.D: Demonstrate project management procedures and processes as they occur in a construction process.	**TE.AC.2.D.b.1:** Explain and recognize the importance of communication, recordkeeping, and drawings to complete a building project.	**TE.AC.2.D.i.1:** Demonstrate proficiency in preparing an estimate from simple drawings and specifications.	**TE.AC.2.D.a.1:** Interpret and use construction blueprints and specifications to estimate materials.
	TE.AC.2.D.b.2: Recognize and explain the many events in a construction process.	**TE.AC.2.D.i.2:** Organize the sequencing of the stages of a construction process.	**TE.AC.2.D.a.2:** Solve common construction problems such as framing, plumbing, and electrical design by using official building codes adopted by the state or municipality.
	TE.AC.2.D.b.3: Examine building codes, understanding their need to ensure that structures are safe.	**TE.AC.2.D.i.3:** Demonstrate proficiency in creating a simple project log.	**TE.AC.2.D.a.3:** Model effective customer service and relations as applied to project management and meeting the needs of the client.
		TE.AC.2.D.i.4: Explain how building codes vary based on geological, environmental, and political influences.	**TE.AC.2.D.a.4:** Generate a needs assessment or a viability study for a proposed project.
		TE.AC.2.D.i.5: Demonstrate the importance of positive and constructive communication skills.	**TE.AC.2.D.a.5:** Prepare and produce applicable permits and required documentation for a proposed project.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.E: Demonstrate the value and necessity of practicing occupational safety in the construction industry facility and on the job site.	**TE.AC.2.E.b.1:** Recognize the potential accidents and injuries that may occur in a given work environment.	**TE.AC.2.E.i.1:** Explain proper material handling, including the purpose and use of Safety Data Sheets.	
	TE.AC.2.E.b.2: Understand the need and proper usage of Personal Protective Equipment (PPE).	**TE.AC.2.E.i.2:** Demonstrate the safe use of tools and equipment relevant to the construction industry.	**TE.AC.2.E.a.2:** Describe requirements related to handling and disposal of environmentally hazardous materials in accordance with the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) regulations.
	TE.AC.2.E.b.3: Understand machine and tool ergonomics and their relation to worker fatigue and injuries.	**TE.AC.2.E.i.3:** Demonstrate proper harnessing and ladder safety and other fall protection measures.	**TE.AC.2.E.a.3:** Communicate the importance of safety training, management, and reporting in the workplace or worksite.
TE.AC.2.F: Demonstrate the variety of building phases, materials, systems, and techniques used in architecture and construction.	**TE.AC.2.F.b.1:** Discuss how structures are based on drawings and completed according to schedules and timelines.	**TE.AC.2.F.i.1:** Create a completion schedule or Gantt chart for a simple project.	**TE.AC.2.F.a.1:** Develop building plans and schedules by using computer software common in the design of residential and commercial construction.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.F: Demonstrate the variety of building phases, materials, systems, and techniques used in architecture and construction.	**TE.AC.2.F.b.2:** Describe simple processes and materials that are used to construct a structure.	**TE.AC.2.F.i.2:** Identify the common processes and materials used to construct a structure.	**TE.AC.2.F.a.2:** Demonstrate proficiency in the practical application of the processes and materials—structural, electrical, mechanical, finish—appropriate to architectural design and construction.
	TE.AC.2.F.b.3: Identify the different types and grades of building materials used in the construction industry.	**TE.AC.2.F.i.3:** Describe the fasteners, anchors, and adhesives used in structures and explain their uses.	**TE.AC.2.F.a.3:** Identify the uses of and safety precautions associated with different building materials, such as pressure-treated, fire-retardant lumber.
	TE.AC.2.F.b.4: Identify that many factors can affect the location and type of structure.	**TE.AC.2.F.i.4:** Describe the importance of the orientation and placement on the site of a building and analyze how the design of the structure may be affected.	**TE.AC.2.F.a.4:** Investigate material integration and anticipate future building materials and processes.
	TE.AC.2.F.b.5: List the many different professions required to complete a construction project.	**TE.AC.2.F.i.5:** Recognize and analyze the phases of residential and commercial construction.	**TE.AC.2.F.a.5:** Prepare the site layout using common surveying equipment and create a site plan.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.G: Demonstrate the impact of financial, technical, environmental, political, societal, and labor trends of the past and the future of the construction industry.	**TE.AC.2.G.b.1:** Recognize that all structures are constructed to meet the needs and wants of society.	**TE.AC.2.G.i.1:** Identify that structures are planned and constructed based on financial constraints.	**TE.AC.2.G.a.1:** Analyze significant historical trends in the construction industry; forecast future trends or processes.
	TE.AC.2.G.b.2: Recognize that structures can only be constructed with available resources and that construction impacts the environment.	**TE.AC.2.G.i.2:** Distinguish how construction can impact the environment both positively and negatively.	**TE.AC.2.G.a.2:** Develop financial plans for construction projects.
	TE.AC.2.G.b.3: Define and discuss the importance of energy efficiency.	**TE.AC.2.G.i.3:** Identify the importance of energy-efficient structures with safe, comfortable, and healthy interiors.	**TE.AC.2.G.a.3:** Compare environmental regulations that influence residential and commercial design.
	TE.AC.2.G.b.4: Examine building codes, investigating past practices and the process to update codes.	**TE.AC.2.G.i.4:** Understand how building codes are managed at the local, state, and federal levels, analyzing how each level works together.	**TE.AC.2.G.a.4:** Develop a comprehensive plan for a proposed project, including permitting required for zoning, sanitation, and building.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.G: Demonstrate the impact of financial, technical, environmental, political, societal, and labor trends of the past and the future of the construction industry.	**TE.AC.2.G.b.5:** Identify green building systems and techniques.	**TE.AC.2.G.i.5:** Compare and contrast the advantages and disadvantages of green building systems and techniques, for example, U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), Green Globes, or National Green Building Standard.	**TE.AC.2.G.a.5:** Identify the skills and building techniques that are used to construct energy-efficient structures (see TE.AC.2.G.i.5).
TE.AC.2.H: Demonstrate architectural and design principles in the planning and ideation phase used in architecture and construction.	**TE.AC.2.H.b.1:** Describe and discuss the role, purpose, and responsibilities of an architect.	**TE.AC.2.H.i.1:** Implement flow design into a proposed design problem.	**TE.AC.2.H.a.1:** Prepare and propose a structure to meet the needs of a given design problem, focusing on the space and overall aesthetics of the structure.
	TE.AC.2.H.b.2: Recognize creativity and innovation in design and incorporate artistic principles in a design.	**TE.AC.2.H.i.2:** Compare utilitarian principles to aesthetic fundamentals.	**TE.AC.2.H.a.2:** Prepare and propose a structure to meet the needs of an occupant that complies with universal design, the Americans with Disabilities Act (ADA), or any other inclusive legislation.

Standard: TE.AC.2

Students will be able to select and use architecture and construction technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.AC.2.H: Demonstrate architectural and design principles in the planning and ideation phase used in architecture and construction.	**TE.AC.2.H.b.3:** Demonstrate the formation of ideas through sketching, bubble diagrams, perspective drawings, or other similar visual communication.	**TE.AC.2.H.i.3:** Communicate plans or designs through the use of scale models or other three-dimensional means.	**TE.AC.2.H.a.3:** Understand and identify specific parts of a construction or architectural plan, including the use of elevation views, landscaping plans, section views, detail views, schematics, schedules, etc.
		TE.AC.2.H.i.4: Recognize and discuss the tenets of universal design and the need for regulations, such as the Americans with Disabilities Act (ADA).	**TE.AC.2.H.a.4:** Describe how the field has been influenced by the contribution of different cultures.
			TE.AC.2.H.a.5: Describe the social, economic, and environmental impact of decisions made by architects at the local, national, and global levels.

Strand: Electricity, Electronics, and Controls (EEC)

Standard: TE.EEC.1

Students will explore careers in electrical, electronic, and control industries.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.1.A: Understand the evolving nature of the electrical, electronics, and controls industries.	**TE.EEC.1.A.b.1:** Calculate payback time to recapture the costs of enhanced controls. For example, a motor frequency drive will save back its cost in electricity in 5 years.	**TE.EEC.1.A.i.1:** Compare options for engineering enhancements on the basis of engineering economics. For example, what is the payback period of solar panels when tax incentives and finance costs are incorporated into the analysis?	**TE.EEC.1.A.a.1:** Observe that new technologies evolve because there is a profit opportunity, that unprofitable technologies never make it to market, and that the fundamental physical characteristics for most systems are already optimized, so further optimization will come from more refined control strategies. For example, furnaces are approaching the physical limits of efficiency. The next enhancement will come from precise control of physical functions by the electronic control module.
TE.EEC.1.B: Compare and contrast the roles of producers and consumers in the electrical, electronics, and controls industries.	**TE.EEC.1.B.b.1:** Identify that about 75 percent of the workforce is engaged in nontechnical work, about 25 percent is involved in non-engineering technical work, and about 1 percent is engaged in engineering.	**TE.EEC.1.B.i.1:** Understand that science seeks to explain what is known about nature to expand human knowledge, while engineering seeks to exploit what is known about nature to meet human needs.	**TE.EEC.1.B.a.1:** Describe the value stream created in the engineered world when engineers form design intent, technologists refine and communicate design intent, and technicians execute (in the craft disciplines) or restore (in the service disciplines) design intent in engineered objects.

Standard: TE.EEC.1

Students will explore careers in electrical, electronic, and control industries.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.1.C: Compare and contrast nondegree, degree, and licensure pathways to professional competence.	**TE.EEC.1.C.b.1:** Describe nondegree (apprenticeship, technical diploma, certificate, industry credential), degree (AAS, BS, MS, PhD), and licensure (Fundamentals of Engineering, Engineer in Training, Professional Engineer) routes to professional competence.	**TE.EEC.1.C.i.1:** Link technician roles with academic credentials two or fewer years in length, technologist credentials with non-calculus-based programs lasting two or four years, and engineering credentials with calculus-based four-year programs.	**TE.EEC.1.C.a.1:** Assess postsecondary educational options based on program accreditations, such as Registered Apprenticeship, NATEF Certification, ABET accreditation, etc.

Standard: TE.EEC.2

Students will exercise appropriate precautions to work safely with electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.2.A: Recognize and control electrical hazards to work safely.	**TE.EEC.2.A.b.1:** Describe how deenergizing circuits protects workers.	**TE.EEC.2.A.i.1:** Describe what Lock Out – Tag Out (LOTO) is and how it protects workers from accidental circuit energization.	**TE.EEC.2.A.a.1:** Describe scenarios in which lock-out and tag-out may not be effective, such as improperly connected generator back-feeding power onto the line.

Standard: TE.EEC.2

Students will exercise appropriate precautions to work safely with electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.2.A: Recognize and control electrical hazards to work safely.	**TE.EEC.2.A.b.2:** Identify electrical components that are prone to a stored energy hazard, such as capacitors, high voltage batteries, and SAE conductor color standards for high voltage conductors in hybrid and electric vehicles.	**TE.EEC.2.A.i.2:** Describe the operation of engineering strategies to mitigate stored energy hazards, such as bleed down resistors and battery contactors.	**TE.EEC.2.A.a.2:** Mitigate stored energy hazards. For example, safely discharge a capacitor, attend to the importance of the order of terminals when connecting and disconnecting batteries, etc.
	TE.EEC.2.A.b.3: Recognize circuits that meet the OSHA threshold for high voltage engineering risk controls (≥ 50 volts).	**TE.EEC.2.A.i.3:** Assess tools and equipment for compliance with OSHA requirements and referenced standards for working on system voltages >50 volts. For example, insulated hand tools must comply with the EN/IEC 60900 standards.	**TE.EEC.2.A.a.3:** Perform work on regulated energized circuits using safeguards in compliance with the OSHA standard: Personal protective equipment (PPE) and insulated tools, for example.
	TE.EEC.2.A.b.4: Recognize electrical power transmission components, including single and three-phase power wires, transformers, line fuses, automatic reconnectors, lightning arresting wires, hierarchy of conductors on a pole: least hazardous lowest, power higher, lightning arresting wire highest.	**TE.EEC.2.A.i.4:** Discern between 345 kV, 69kV, and 34.5kV electrical power infrastructure. Estimate voltage by counting insulators (approximately 10kV per insulator).	**TE.EEC.2.A.a.4:** Determine safe working distances from energized power lines, and acknowledge potential hazards in the area of fallen wires.

Standard: TE.EEC.2

Students will exercise appropriate precautions to work safely with electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.2.A: Recognize and control electrical hazards to work safely.	**TE.EEC.2.A.b.5:** Identify sources of static electric discharge. For example, plastic gas cans on a plastic bedliner can create an arc that ignites fuel vapors when filling cans.	**TE.EEC.2.A.i.5:** Describe the voltage and current characteristics of electrostatic discharges.	**TE.EEC.2.A.a.5:** Use engineering controls for static electric discharge to minimize risks, such as wrist tether, conductive floor grid, ambient relative humidity, grounding, and bonding.

Standard: TE.EEC.3

Students will observe the dual roles of electricity as a means to transmit power and to process information.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.3.A: Categorize applications of electrical and electronic technologies.	**TE.EEC.3.A.b.1:** Characterize electrical circuits as primarily for the transmission of power or data.	**TE.EEC.3.A.i.1:** Discern between analog and digital transmission of data.	**TE.EEC.3.A.a.1:** Contrast electrical circuits with other means of power and data transmission, such as hydraulic logic and hydrostatic power transmission.

Standard: TE.EEC.3

Students will observe the dual roles of electricity as a means to transmit power and to process information.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.3.A: Categorize applications of electrical and electronic technologies.	**TE.EEC.3.A.b.2:** Identify potential failure modes of mechanical control systems, such as pitting of breaker points and wear of governor components.	**TE.EEC.3.A.i.2:** Observe the evolution of control systems from mechanical to electrical to electronic to embedded programmed logic to cloud-based logic.	**TE.EEC.3.A.a.2:** Hypothesize electronic and software approaches to control strategies that historically have been executed mechanically.

Standard: TE.EEC.4

Students will fabricate and maintain electrical and electronic assemblies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.4.A: Perform electrical and electronic fabrication and maintenance tasks.	**TE.EEC.4.A.b.1:** Measure voltage or resistance of an intact circuit without causing damage by back probing connectors.	**TE.EEC.4.A.i.1:** Apply chemicals to clean (terminal cleaner), dry (water dispersant), and protect (dielectric grease) electrical connectors.	**TE.EEC.4.A.a.1:** Disconnect and connect electrical connectors. For example, weather pack connectors following manufacturers' procedures.
	TE.EEC.4.A.b.2: Inspect and repair power conductors pursuant to tightness and cleanliness.	**TE.EEC.4.A.i.2:** Terminate a wire with a solderless connector.	**TE.EEC.4.A.a.2:** Electrically bond components with solder joints.
	TE.EEC.4.A.b.3: Land conductors in screw type and clip type terminal strips.	**TE.EEC.4.A.i.3:** Route and secure conductors using loom, zip ties, and cable clips.	**TE.EEC.4.A.a.3:** Insulate electrical connections using electrical tape, liquid electrical tape, or shrink tubing.

Standard: TE.EEC.5

Students will interpret technical information sources related to electrical, electronic, and control technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.5.A: Interpret electrical diagrams.	**TE.EEC.5.A.b.1:** Identify conductors based on color and gauge using a wiring diagram.	**TE.EEC.5.A.i.1:** Locate components in a circuit by matching the item to the conductor layout and schematic symbols in a wiring diagram.	**TE.EEC.5.A.a.1:** Develop an electrical test strategy by using a pinout diagram to identify where to connect the meter.
	TE.EEC.5.A.b.2: Discern the difference between a wiring diagram and a schematic diagram.	**TE.EEC.5.A.i.2:** Translate between schematic and wiring diagrams to identify components common to both.	**TE.EEC.5.A.a.2:** Interpret a schematic diagram to predict voltages, currents, and resistances of an operating circuit.
	TE.EEC.5.A.b.3: Interpret ladder diagrams to describe how circuits will react to changes in input state.	**TE.EEC.5.A.i.3:** Configure Ladder Logic inputs in AND / OR configurations. (e.g., two switches in series form AND logic, two switches in parallel form OR logic).	**TE.EEC.5.A.a.3:** Develop Ladder Logic that results in a Latch function. (consider using a clear case relay to demonstrate this – it provides a visual indication of latched status).
TE.EEC.5.B: Interpret the National Electrical Code (NFPA 70E).	**TE.EEC.5.B.b.1:** Wire a branch circuit observing wire color protocols (black = hot, white = neutral, green = ground) and fixture screw color protocols (copper = hot, silver = neutral, green = ground, black = common).	**TE.EEC.5.B.i.1:** Choose conductor gauge based on current load according to guidance of the National Electrical Code.	**TE.EEC.5.B.a.1:** Determine the number of conductors permitted in a conduit based on conductor and conduit size.

Standard: TE.EEC.5

Students will interpret technical information sources related to electrical, electronic, and control technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.5.B: Interpret the National Electrical Code (NFPA 70E).	**TE.EEC.5.B.b.2:** Cite a code requirement using the proper citation format.	**TE.EEC.5.B.i.2:** Interpret code requirements for a simple branch circuit. For example, a 15-amp circuit requires at least 14-gauge conductors, and a 20-amp circuit requires at least 12-gauge conductors.	**TE.EEC.5.B.a.2:** Given a branch circuit that does not comply with the code, identify the compliance issues and possible resolutions.
TE.EEC.5.C: Interpret service literature.	**TE.EEC.5.C.b.1:** Read service literature to identify system specifications, such as battery cold cranking amps, alternator charging amps, etc.	**TE.EEC.5.C.i.1:** Perform proprietary test procedures—for example, an alternator full field test—following instructions from a service manual.	**TE.EEC.5.C.a.1:** Use community information repositories— for example, technical service bulletins, user community forums, etc.—to gain knowledge about proprietary systems.
	TE.EEC.5.C.b.2: Document make, model, and date of manufacture of the electrical device being diagnosed.	**TE.EEC.5.C.i.2:** Document concern, cause, and correction of electrical malfunctions.	**TE.EEC.5.C.a.2:** Develop detailed case notes, including electrical values measured to inform future diagnostic efforts in similar systems.

Standard: TE.EEC.6

Students will troubleshoot and identify failure modes of electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.6.A: Describe electrical failure modes and the associated engineering safeguards.	**TE.EEC.6.A.b.1:** Describe the circuit conditions of open and overload.	**TE.EEC.6.A.i.1:** Articulate that overcurrent protection devices protect the equipment, not the person.	**TE.EEC.6.A.a.1:** Identify that electrical loads are inversely proportional to resistance, so a high electrical load has a low resistance.
	TE.EEC.6.A.b.2: Describe the operation of overcurrent protection devices such as fuses, fusible links, circuit breakers, thermal cutouts, etc.	**TE.EEC.6.A.i.2:** Describe overcurrent protection device trip management strategies such as slow blow fuses, thermal and magnetic tripping of breakers, shunt trip, etc.	**TE.EEC.6.A.a.2:** Calculate the heat released by an overcurrent during a breaker trip event.
	TE.EEC.6.A.b.3: Articulate the milliampere level of current that humans can withstand without permanent injury or death.	**TE.EEC.6.A.i.3:** Describe where circuit ground fault protection is required and why.	**TE.EEC.6.A.a.3:** Describe the operation of the comparator circuit in a ground fault circuit interrupter.
	TE.EEC.6.A.b.4: Describe the hazards of an arc fault or arc flash.	**TE.EEC.6.A.i.4:** Describe appropriate precautions for an arc flash hazard.	**TE.EEC.6.A.a.4:** Describe the operation of an arc fault breaker.
	TE.EEC.6.A.b.5: Identify circuit components used to hold potentially energized components to ground potential, such as unbroken ground path from item to ground rod.	**TE.EEC.6.A.i.5:** Observe the importance of wiring polarized plugs correctly to ensure that the cases of electrical devices remain at ground potential.	**TE.EEC.6.A.a.5:** Describe the operation of center-tapped transformers to keep the neutral leg at ground potential. Explain why ground and neutral need to be separated on runs to subpanels.

Standard: TE.EEC.6

Students will troubleshoot and identify failure modes of electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.6.A: Describe electrical failure modes and the associated engineering safeguards.	**TE.EEC.6.A.b.6:** Describe the mechanism by which lightning originates.	**TE.EEC.6.A.i.6:** Describe the operation of components of a lightning protection system.	**TE.EEC.6.A.a.6:** Explain how lightning rods leak off current by ionizing the surrounding air (e.g., Saint Elmo's Fire).
	TE.EEC.6.A.b.7: Trace the flow of current in a chassis-grounded system.	**TE.EEC.6.A.i.7:** Identify potential arc flash hazard locations in which a tool could produce an unintended current path. For example, a wrench on the positive battery terminal will produce an arc if it comes in contact with any chassis component.	**TE.EEC.6.A.a.7:** Connect and disconnect power sources, observing appropriate order based on chassis polarity. For example, in negative chassis ground systems, the negative battery is always removed first.
	TE.EEC.6.A.b.8: Describe the phenomenon of step potential observed when stray voltage is present in the ground.	**TE.EEC.6.A.i.8:** Explain why high resistance or high current in the neutral circuit of an electrical service entrance could create a step potential between the ground rod at the electric meter and the ground rod at the transformer.	**TE.EEC.6.A.a.8:** Explain why load balancing between the lines of an electrical service is important to minimize the potential of creating stray voltages.

Standard: TE.EEC.7

Students will test, troubleshoot, and diagnose faults in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.7.A: Diagnose circuit faults.	**TE.EEC.7.A.b.1:** Observe environmental clues of circuit state of operation. For example, listen for the click of a relay, palpate to feel the click of a relay, observe smells indicating overheating, etc.	**TE.EEC.7.A.i.1:** Break complex circuits into simpler subcircuits to locate faults. For example, narrow parasitic current draws to a single circuit by systematically pulling fuses.	**TE.EEC.7.A.a.1:** Identify faults in circuits through the use of substitution or bypassing. For example, jump a switch to see if eliminating it from the circuit removes the fault.
TE.EEC.7.B: Test electrical circuits using analog devices.	**TE.EEC.7.B.b.1:** Determine if it is safe to use a test lamp on a circuit. For example, are there any sensitive electronics that would be damaged by the current drawn by the test lamp?	**TE.EEC.7.B.i.1:** Use a fused jumper to bypass elements of circuits safely. For example, use jumper from battery positive directly to the starter solenoid to determine fault direction.	**TE.EEC.7.B.a.1:** Use a self-resetting circuit breaker and a compass to locate shorts in an electrical circuit.
TE.EEC.7.C: Measure voltage, current, and resistance with a multimeter.	**TE.EEC.7.C.b.1:** Describe the basic electrical quantities that can be measured by a simple multimeter: voltage, current, and resistance.	**TE.EEC.7.C.i.1:** Describe why an electrical test light is limited in its application. Note: The current drawn by the test light is many times the operating currents of digital circuits.	**TE.EEC.7.C.a.1:** Explain the reasons for ideal meter characteristics: voltmeter and ohmmeter - infinite impedance, ammeter - zero impedance.

Standard: TE.EEC.7

Students will test, troubleshoot, and diagnose faults in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.7.C: Measure voltage, current, and resistance with a multimeter.	**TE.EEC.7.C.b.2:** Select the appropriate function and range on a multimeter to measure a particular electrical quantity, such as DC voltage 0-20 V range to test the resting voltage of a 12.6 v car battery.	**TE.EEC.7.C.i.2:** "Proof" a multimeter before using by demonstrating continuity of the test leads, testing a known voltage, and constructing a circuit with a test light to flow current through the ammeter.	**TE.EEC.7.C.a.2:** Explain why the voltmeter must be connected in parallel, and the ammeter must be connected in series, and consequences of incorrect meter connections, such as blown ammeter fuse when the ammeter is connected in parallel, no operation of the circuit when the voltmeter is connected in series.
	TE.EEC.7.C.b.3: Observe meter capacity limits, such as maximum voltage, maximum current - 1A port, and 10A port.	**TE.EEC.7.C.i.3:** Identify measurements that will exceed meter capacities (for example, starter motor cranking current, ignition system secondary voltage), and identify appropriate equipment to measure these values (for example, inductive current clamp, capacitive voltage clamp, etc.).	**TE.EEC.7.C.a.3:** Describe factors affecting instrument sensitivity. For example, the sensitivity of an inductive clamp can be increased by a factor of 10 by wrapping the conductor around the clamp 10 times.

Standard: TE.EEC.7

Students will test, troubleshoot, and diagnose faults in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.7.D: Assess battery charging, state of charge, and state of health.	**TE.EEC.7.D.b.1:** Identify appropriate battery resting, cranking, and running voltages.	**TE.EEC.7.D.i.1:** Verify battery state of charge using a hydrometer or interferometer. Charge as necessary.	**TE.EEC.7.D.a.1:** Verify battery state of health with a load test.
	TE.EEC.7.D.b.2: Test for proper lead acid battery charging voltage: Bulk – 14.6v, Absorption – 14.25v, Maintenance – 13.5v for systems that are nominally 12 volts.	**TE.EEC.7.D.i.2:** Simulate an alternator load test by turning on all electrical loads and observing voltage.	**TE.EEC.7.D.a.2:** Load test an alternator.
TE.EEC.7.E: Observe waveforms using an oscilloscope.	**TE.EEC.7.E.b.1:** Identify the voltage and time scale an oscilloscope is set to by observing the graticule array.	**TE.EEC.7.E.i.1:** Calculate the voltages, period, and frequency of a waveform presented on an oscilloscope.	**TE.EEC.7.E.a.1:** Interpret oscilloscope waveforms, such as sine wave AC, ignition primary, tone ring square wave, etc.

Standard: TE.EEC.8

Students will identify components used to create information inputs in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.8.A: Identify and explain electrical sensors.	**TE.EEC.8.A.b.1:** Identify physical characteristics that can be converted into electrical signals by sensors, such as position, temperature, pressure, acceleration, opacity, etc.	**TE.EEC.8.A.i.1:** Classify sensors by their characteristic curves, such as dual state (dry contacts open or closed) or continuous (continuously varying resistance with changes in temperature).	**TE.EEC.8.A.a.1:** Describe the effects of scale saturation and hysteresis on the operation of a sensor.
	TE.EEC.8.A.b.2: Observe the signal of a dual state sensor: open or closed.	**TE.EEC.8.A.i.2:** Observe the signal of a continuously variable sensor that outputs a voltage proportional to the physical quantity being measured.	**TE.EEC.8.A.a.2:** Observe the signal of a continuously variable sensor that outputs a frequency or duty cycle modulated signal proportional to the physical quantity being measured.
	TE.EEC.8.A.b.3: Explain the operation of a wiper type potentiometer to sense position.	**TE.EEC.8.A.i.3:** Test a wiper type potentiometer for continuous output across its operating range.	**TE.EEC.8.A.a.3:** Compare and contrast wiper type variable resistors when used as potentiometers and rheostats.
	TE.EEC.8.A.b.4: Describe the advantages of inductive (magnetic reluctance) and Hall effect (magnetoresistive) position sensors over wiper type resistive sensors in sensing position.	**TE.EEC.8.A.i.4:** Explain the operation of magnetic reluctance and magnetoresistive sensors.	**TE.EEC.8.A.a.4:** Describe safeguard redundancies that must be in place when position sensors are used for critical functions like throttle control, such as an idle validation switch.

Standard: TE.EEC.8

Students will identify components used to create information inputs in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.8.A: Identify and explain electrical sensors.	**TE.EEC.8.A.b.5:** Classify materials as having a positive or negative temperature coefficient of resistance based on changes in resistance with changes in temperature.	**TE.EEC.8.A.i.5:** Explain how a thermistor exploits a linear temperature coefficient of resistance to convert sensed temperature to an electrical signal. Test a thermistor.	**TE.EEC.8.A.a.5:** Describe how sensitivity to thermistor signals can be increased by incorporating a Wheatstone Bridge circuit.
	TE.EEC.8.A.b.6: Compare and contrast the operation of thermistors and thermocouples.	**TE.EEC.8.A.i.6:** Describe how thermopiles act as voltage adders.	**TE.EEC.8.A.a.6:** Describe the Peltier effect and applications for Peltier junctions.
	TE.EEC.8.A.b.7: Identify applications for strain transducers, such as force, weight, and pressure measurement.	**TE.EEC.8.A.i.7:** Plot a graph of resistance vs. strain for a strain transducer.	**TE.EEC.8.A.a.7:** Explain how strain transducers use a Wheatstone bridge to convert changes in resistance to changes in a voltage signal.
	TE.EEC.8.A.b.8: Identify switches by means of actuation, such as momentary, detent, limit, rocker, toggle, mercury, magnetic reed, etc.	**TE.EEC.8.A.i.8:** Describe pole and throw configurations of switches, such as single pole, single throw, dual pole, dual throw, etc. Illustrate applications including three-way and four-way switching of lights.	**TE.EEC.8.A.a.8:** Construct logic circuits using switches, including AND, OR, NAND, NOR, and XOR. Use DeMorgan's Theorem to identify multiple ways to produce the same logic.

Standard: TE.EEC.8

Students will identify components used to create information inputs in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.8.A: Identify and explain electrical sensors.	**TE.EEC.8.A.b.9:** Describe applications that sense chemical concentrations directly, such as pH sensors, oxygen sensors, etc.	**TE.EEC.8.A.i.9:** Describe how chemical sensors can be destroyed by contamination, for example, an oxygen sensor fouled by engine coolant from a blown head gasket.	**TE.EEC.8.A.a.9:** Analogize between the operation of an oxygen sensor and a chemical battery.
	TE.EEC.8.A.b.10: Explain the operations of sensors that use flame ion detection.	**TE.EEC.8.A.i.10:** Describe the operating principles of an ionization smoke detector.	**TE.EEC.8.A.a.10:** Describe the control strategy in ion-sensing ignition systems.

Standard: TE.EEC.9

Students will identify components used to process and transmit information in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.9.A: Describe the conversion of analog signals to digital, digital signal processing, gate, and embedded logic.	**TE.EEC.9.A.b.1:** Describe the advantages and disadvantages of converting analog values to digital, including diminished susceptibility to interference, less bandwidth, easy computational manipulation, and data loss through sampling.	**TE.EEC.9.A.i.1:** Use the Nyquist theorem to determine a minimum sampling rate for analog to digital conversion.	**TE.EEC.9.A.a.1:** Explain what aliasing is and how it happens.

Standard: TE.EEC.9

Students will identify components used to process and transmit information in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.9.A: Describe the conversion of analog signals to digital, digital signal processing, gate, and embedded logic.	**TE.EEC.9.A.b.2:** Explain the operation of voltage comparators as used in analog to digital conversion.	**TE.EEC.9.A.i.2:** Compare and contrast signal and noise in an electronic circuit. Explain why signal to noise ratio (SNR) is important in analog to digital conversion.	**TE.EEC.9.A.a.2:** Calculate the number of increments an analog value can be resolved into based on the analog to digital converter's bit depth. For example, an 8-bit analog to digital converter can resolve signals into 2^8=256 discrete digital values.
	TE.EEC.9.A.b.3: Compare and contrast serial and parallel forms of data communication.	**TE.EEC.9.A.i.3:** Identify communication architectures as parallel or serial, such as parallel: IEEE-488, IEEE-1284; serial: controller area network (CAN), Ethernet, HDMI, Morse code telegraphy, RS232, RS485, USB.	**TE.EEC.9.A.a.3:** Describe the operation of a shift register to convert serial signals to parallel—Serial In Parallel Out (SIPO)—and parallel signals to serial—Parallel In Serial Out (PISO).
	TE.EEC.9.A.b.4: Identify the anode and cathode ends of a diode.	**TE.EEC.9.A.i.4:** Explain how a diode operates under forward- and reverse-biased conditions.	**TE.EEC.9.A.a.4:** Explain how a Zener diode can be used for precise voltage regulation when reverse biased.
	TE.EEC.9.A.b.5: Describe the advantages of light-emitting diodes (LEDs) over other light sources, such as incandescent and fluorescent light sources.	**TE.EEC.9.A.i.5:** Explain functions and applications of optoisolators.	**TE.EEC.9.A.a.5:** Compare and contrast data transmission with electricity over copper wire vs. light over fiber optic cable or through the air, such as infrared remote control.

Standard: TE.EEC.9

Students will identify components used to process and transmit information in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.9.A: Describe the conversion of analog signals to digital, digital signal processing, gate, and embedded logic.	**TE.EEC.9.A.b.6:** Explain the function of a clamping diode to suppress transient voltages.	**TE.EEC.9.A.i.6:** Compare and contrast the advantages and disadvantages of half-wave, full-wave, and bridge rectifiers.	**TE.EEC.9.A.a.6:** Contrast peak, ripple, and root-mean-square voltages of rectified alternating current. Explain how a capacitor used in conjunction with a rectifier can reduce ripple voltage.
	TE.EEC.9.A.b.7: Based on a schematic representation, identify collector, base, and emitter terminals on PNP and NPN bipolar junction transistors.	**TE.EEC.9.A.i.7:** Compare and contrast the proportional nature of transistors with the dual state nature of relays when used in switching applications.	**TE.EEC.9.A.a.7:** Construct a circuit using a potentiometer to control collector-emitter current by varying base-emitter voltage.
	TE.EEC.9.A.b.8: Identify applications of power semiconductors, such as insulated-gate bipolar transistors and power MOSFETs, used in applications, including motor drives, hybrid cars, etc.	**TE.EEC.9.A.i.8:** Compare and contrast thyristors—DIACs, TRIACs, silicon-controlled rectifiers—with transistors. Observe fundamental differences, such as self-latching, dual state vs. proportional, etc.	**TE.EEC.9.A.a.8:** Describe the advantage of turning fully on or fully off for varying periods of time (for example, duty cycle modulation) when compared to changing voltages through the use of resistance (for example, potentiometer control of motor speed).

Standard: TE.EEC.9

Students will identify components used to process and transmit information in electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.9.A: Describe the conversion of analog signals to digital, digital signal processing, gate, and embedded logic.	**TE.EEC.9.A.b.9:** Explain the operation of a latch using relays, transistors, or ladder logic.	**TE.EEC.9.A.i.9:** Describe how a bistable multivibrator can latch in two different states. Explain how a latch can be used to store memory of a binary state.	**TE.EEC.9.A.a.9:** Construct a simple oscillator using a 555 microchip, capacitors, and resistors. Explain how the time constant of the RC circuit affects the frequency of the output.
	TE.EEC.9.A.b.10: Explain the operation of AND, OR, NOT, NAND, NOR, and XOR gates.	**TE.EEC.9.A.i.10:** Create a truth table for a digital logic circuit.	**TE.EEC.9.A.a.10:** Describe how logic gates can be used to create a flip flop.
	TE.EEC.9.A.b.11: Compare and contrast mechanical (hydraulic logic), electrical (relay logic), electronic (semiconductor logic), Programmable Logic Controller (ladder logic), and microcontroller (embedded code) control strategies.	**TE.EEC.9.A.i.11:** Use an integrated development environment (IDE)—such as Raspberry Pi or Arduino—and libraries to retrieve and edit existing code.	**TE.EEC.9.A.a.11:** Use an integrated development environment (IDE)—such as Raspberry Pi or Arduino—and libraries to develop code to control outputs in response to a problem statement.

Standard: TE.EEC.10

Students will identify components used to effect outputs in electrical, electronics, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.10.A: Describe electrically powered actuators.	**TE.EEC.10.A.b.1:** Describe the operation and applications of simple electromagnetic devices, including electromagnetic oscillators like bells and horns, speakers, and solenoids.	**TE.EEC.10.A.i.1:** Observe factors that affect the amount of force an electromagnetic actuator can make, such as ampere-turns of coil, magnetic permeability of armature, and proximity.	**TE.EEC.10.A.a.1:** Explain how an electric machine can act as either a generator or a motor, depending on the direction of energy flow.
	TE.EEC.10.A.b.2: Explain the operation of a mechanically commutated DC motor.	**TE.EEC.10.A.i.2:** Explain the advantages on an electronically commutated DC motor.	**TE.EEC.10.A.a.2:** Compare and contrast parallel wound and shunt wound DC motors in terms of counter-electromotive force, speed regulation, and torque, and current characteristics.
	TE.EEC.10.A.b.3: Explain the operation of an AC induction motor.	**TE.EEC.10.A.i.3:** Compare and contrast synchronous and asynchronous AC motors.	**TE.EEC.10.A.a.3:** Analogize between AC induction motors and transformers. Explain how the stator and rotor are analogous to the primary and secondary windings of a transformer.
	TE.EEC.10.A.b.4: Compare and contrast the operation of split-phase and three-phase electric motors.	**TE.EEC.10.A.i.4:** Compare and contrast split-phase transformers found in residential electrical services with delta and wye wound transformers found in commercial electrical services.	**TE.EEC.10.A.a.4:** Explain how the two hot legs of a center-tapped transformer act as a voltage adder, and based on this, explain why an open neutral is hazardous.

Standard: TE.EEC.10

Students will identify components used to effect outputs in electrical, electronics, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.10.A: Describe electrically powered actuators.	**TE.EEC.10.A.b.5:** Describe how thermal and overcurrent protection devices enhance the safety of electric motors.	**TE.EEC.10.A.i.5:** Explain why motor control systems incorporate soft start strategies, and how inrush currents are controlled.	**TE.EEC.10.A.a.5:** Describe the advantages of using frequency drives with AC motors over other speed control strategies, such as energy efficiency, ability to program control strategy as code, etc.
	TE.EEC.10.A.b.6: Describe the role of feedback in a servo loop.	**TE.EEC.10.A.i.6:** Characterize possible outcomes of a control command, such as undershot transition to commanded value, overshot transition to commanded value, steady oscillations around commanded value, growing oscillations around a commanded value, and diminishing oscillations around a commanded value.	**TE.EEC.10.A.a.6:** Describe engineering strategies to optimize the use of feedback to control an output (e.g., proportional-integral-derivative (PID) controller, state-space controller).

Standard: TE.EEC.11

Students will explain the operation of steady state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.11.A: Describe the flow of electrons through circuits.	**TE.EEC.11.A.b.1:** Describe electricity as the flow of electrons.	**TE.EEC.11.A.i.1:** Determine whether current will flow in a circuit based on open/closed status.	**TE.EEC.11.A.a.1:** Predict the behavior of a circuit using the mechanical analogs of pressure, flow, and friction.
	TE.EEC.11.A.b.2: Describe matter as being composed of atoms.	**TE.EEC.11.A.i.2:** Identify subatomic particles in the Bohr atom and their charges.	**TE.EEC.11.A.a.2:** Describe the process of ionization.
	TE.EEC.11.A.b.3: Classify materials as electrical conductors or insulators.	**TE.EEC.11.A.i.3:** Inventory materials along the resistance continuum, including super conductors, conductors, semiconductors, and insulators.	**TE.EEC.11.A.a.3:** Predict the conductivity of materials based on the valence electron configurations of their atoms.
	TE.EEC.11.A.b.4: Explain the purpose of safety rules that ensure cooling of conductors, such as no cords under rugs, maximum number of conductors allowed in a conduit, minimum hole size in studs to pass conductors, ambient temperature ratings on motors, etc.	**TE.EEC.11.A.i.4:** Observe that all conductors produce a voltage drop and, as a result, shed some electrical energy as heat. Determine acceptable conductor size based on anticipated current and ability to shed heat.	**TE.EEC.11.A.a.4:** Calculate the rate of heating of a conductor based on current and voltage drop. Report the answer in watts and BTUs/hr.
	TE.EEC.11.A.b.5: Identify a resistor's resistance by its color code.	**TE.EEC.11.A.i.5:** Identify a resistor's error tolerance by its color code.	**TE.EEC.11.A.a.5:** Correlate resistor size with its power capacity.

Standard: TE.EEC.11

Students will explain the operation of steady state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.11.A: Describe the flow of electrons through circuits.	**TE.EEC.11.A.b.6:** Explain why elements with four valence electrons—for example, carbon and silicon—form the basis for semiconductors.	**TE.EEC.11.A.i.6:** Describe applications of elements with four valence electrons—for example, carbon and silicon—as semiconductors.	**TE.EEC.11.A.a.6:** Explain how doping of semiconductors can produce P-type and N-type semiconductors.
	TE.EEC.11.A.b.7: Describe the diminished performance of common electrical conductors—for example, carbon—as temperature increases.	**TE.EEC.11.A.i.7:** Describe the enhanced performance of common electrical conductors—for example, carbon—approaching superconductor state at cryogenic temperatures.	**TE.EEC.11.A.a.7:** Describe how some materials have negative temperature components. For example, thermistor resistance decreases as temperature increases.
	TE.EEC.11.A.b.8: Identify the ampere as the unit of measure of flow of current in circuits.	**TE.EEC.11.A.i.8:** Define the ampere as one coulomb of charges passing a point in one second.	**TE.EEC.11.A.a.8:** Contrast the speed of electrons in meters per second with the flow of electrons in amperes.
	TE.EEC.11.A.b.9: Demonstrate creating static electricity through triboelectric charging or rubbing electrons off an insulator, such as plastic gas cans on a plastic bed liner.	**TE.EEC.11.A.i.9:** Explain the development of electrical potentials in current electricity circuits through chemical reactions and magnetic induction.	**TE.EEC.11.A.a.9:** Compare and contrast electrostatic (capacitive) and electromagnetic (inductive) fields.

Standard: TE.EEC.11

Students will explain the operation of steady state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.11.B: Relate electrical quantities with respect to the mechanical analogs of force, work, power, and energy.	**TE.EEC.11.B.b.1:** Describe force and identify units: newtons.	**TE.EEC.11.B.i.1:** Contrast force, motion, and work, and identify appropriate units of each: newtons, meters, and newton meters.	**TE.EEC.11.B.a.1:** Calculate power in newton meters per second and convert to other units, such as watts, horsepower, and BTUs per hour.
	TE.EEC.11.B.b.2: Describe energy as the potential to do work.	**TE.EEC.11.B.i.2:** Identify forms of energy, including potential, kinetic, chemical, and electrical.	**TE.EEC.11.B.a.2:** Calculate energy from the product of power and time. Express in units of joules (J) or kilowatt-hours (kWh).
	TE.EEC.11.B.b.3: Identify batteries, capacitors, and inductors as electrical energy storage devices.	**TE.EEC.11.B.i.3:** Describe how batteries, capacitors, and inductors store energy chemically, electrostatically, and inductively.	**TE.EEC.11.B.a.3:** Compare energy density and specific energy of electrical energy storage devices and other means of energy storage.
	TE.EEC.11.B.b.4: Characterize the rate at which batteries, capacitors, and inductors are able to release their stored energy or power.	**TE.EEC.11.B.i.4:** Discern between measures of battery power, such as cranking amps and cold cranking amps, and battery energy content, or amp hours.	**TE.EEC.11.B.a.4:** Calculate battery internal resistance and describe factors affecting it, such as temperature, surface area, and state of charge.
	TE.EEC.11.B.b.5: Identify units of power in watts.	**TE.EEC.11.B.i.5:** Use Ohm's law to explain why voltage * current = Power	**TE.EEC.11.B.a.5:** Describe mechanical analogs to electrical power. For example, Hydraulic Power = Pressure * Flow, Mechanical Power = Torque * Speed.

Standard: TE.EEC.12

Students will explain the operation of transient state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.12.A: Describe inductive and capacitive coupling phenomena.	**TE.EEC.12.A.b.1:** Observe that current can be induced in a conductor by a changing magnetic field.	**TE.EEC.12.A.i.1:** Observe that the amount of current induced depends on the rate of change of the field, the number of magnetic lines of force cut, and the magnetic permeability of the medium.	**TE.EEC.12.A.a.1:** Observe that inducing a current produces a phase shift.
	TE.EEC.12.A.b.2: Describe the magnetic lines of flux present around a current-carrying conductor.	**TE.EEC.12.A.i.2:** Use the left- and right-hand rules of current to determine the direction of magnetic lines of flux.	**TE.EEC.12.A.a.2:** Predict the direction and magnitude of magnetic forces developed in a wire based on current flow.
	TE.EEC.12.A.b.3: Observe that conductors induce their own magnetic fields.	**TE.EEC.12.A.i.3:** Observe that magnetic fields can be concentrated by coiling conductors and using a magnetically permeable core.	**TE.EEC.12.A.a.3:** Observe that electrical energy is stored in the magnetic field of an inductor. Observe that the creation of the magnetic field creates inductive reactance, limiting current.
	TE.EEC.12.A.b.4: Observe that electrical chokes and isolation transformers can resist rapid changes in current.	**TE.EEC.12.A.i.4:** Describe the pintle bump and other observable effects of changing magnetic permeability on inductive reactance.	**TE.EEC.12.A.a.4:** Explain the purpose of clamping diodes and condensers in inductive applications.
	TE.EEC.12.A.b.5: Observe that inrush current can be limited by the use of inductors.	**TE.EEC.12.A.i.5:** Describe how inductance is like its mechanical analog of mass. Compare and contrast counter-electromotive force with inertia.	**TE.EEC.12.A.a.5:** Explain the difference in inrush current with changes in speed in shunt-wound and parallel-wound DC motors.

Standard: TE.EEC.12

Students will explain the operation of transient state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.12.A: Describe inductive and capacitive coupling phenomena.	**TE.EEC.12.A.b.6:** Describe the operation of a transformer using the mechanical analogy of gear sets.	**TE.EEC.12.A.i.6:** Describe the advantages of the modern AC power grid compared to Edison's proposed DC grid. Answer: DC cannot be transformed.	**TE.EEC.12.A.a.6:** Draw analogs between AC induction motors and transformers using Lenz's law.
	TE.EEC.12.A.b.7: Contrast the use of transformers to change voltage with the use of resistance to change voltages.	**TE.EEC.12.A.i.7:** Describe how transformers reflect electrical loads from the secondary to the primary circuit.	**TE.EEC.12.A.a.7:** Explain, in terms of Faraday's law, why frequency is a factor in how much power a transformer can pass.
	TE.EEC.12.A.b.8: Describe how and why power transfer is maximized in circuits in which voltage and current are in phase.	**TE.EEC.12.A.i.8:** Contrast apparent power, reactive power, real power, and power factor. Describe strategies to maximize power factor.	**TE.EEC.12.A.a.8:** Identify power factors used in power electricity applications and standing wave ratios used in radio frequency applications as two different manifestations of the same principle of impedance matching to keep voltage and current in phase.
	TE.EEC.12.A.b.9: Observe that because current can be observed at a single point, inductively coupled probes need only access the circuit in one location.	**TE.EEC.12.A.i.9:** Explain the operation of an inductively coupled current probe.	**TE.EEC.12.A.a.9:** Describe the characteristics of an ideal inductively coupled probe.

Standard: TE.EEC.12

Students will explain the operation of transient state circuits in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.EEC.12.A: Describe inductive and capacitive coupling phenomena.	**TE.EEC.12.A.b.10:** Observe that because voltage is expressed as a potential difference between points in a circuit, capacitively coupled voltage probes must access the circuit in two locations.	**TE.EEC.12.A.i.10:** Explain the operation of a capacitively coupled voltage probe.	**TE.EEC.12.A.a.10:** Describe the characteristics of an ideal capacitively coupled probe.

Standard: TE.EEC.13

Students will explain the operation of wireless communications in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.EEC.13.A: Explain operations and applications of electromagnetic radiation devices.	**TE.EEC.13.A.b.1:** Identify applications for bands within the electromagnetic spectrum, such as radio, microwave, infrared, light, ultraviolet, x-rays, and gamma rays.	**TE.EEC.13.A.i.1:** Identify types of electromagnetic radiation as ionizing and nonionizing, and describe safety concerns.	**TE.EEC.13.A.a.1:** Explain the photoelectric and photovoltaic effects.

Standard: TE.EEC.13

Students will explain the operation of wireless communications in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.13.A: Explain operations and applications of electromagnetic radiation devices.	**TE.EEC.13.A.b.2:** Describe the operations and applications of radar, lidar, microwave, ultrasound distance, and speed sensing in, for example, adaptive cruise control.	**TE.EEC.13.A.i.2:** Explain how radar, lidar, microwave, and ultrasound systems use Doppler shift to measure speed.	**TE.EEC.13.A.a.2:** Describe limitations of radar, lidar, microwave, and ultrasound systems, such as inability to see ground level past horizon, susceptibility to chaff, etc.
	TE.EEC.13.A.b.3: Describe engineering strategies to minimize the effects of electromagnetic interference (EMI), such as twisted pair bus wires, sheathed cables, Faraday cages, resistive spark plug wires, etc.	**TE.EEC.13.A.i.3:** Contrast the susceptibility of amplitude modulation (AM), frequency modulation (FM), and digital radio signals to electromagnetic interference (EMI).	**TE.EEC.13.A.a.3:** Describe the effects of power quality issues, such as sags, swells, transients, and harmonics, on electronic circuits.
	TE.EEC.13.A.b.4: Describe applications for Institute for Electrical and Electronics Engineers (IEEE) standard radio protocols, such as Bluetooth, Wi-Fi, cellular telephony and data, Zigbee, etc.	**TE.EEC.13.A.i.4:** Describe frequency, power, and effective range for standard radio protocols, such as Bluetooth, Wi-Fi, cellular telephony and data, Zigbee, etc.	**TE.EEC.13.A.a.4:** Describe bit handling strategy for standard radio protocols, such as Bluetooth, Wi-Fi, cellular telephony and data, Zigbee, etc.
	TE.EEC.13.A.b.5: Describe the operation of carrier waves, constructive interference, destructive interference, and superposition.	**TE.EEC.13.A.i.5:** Explain the operation of a bandpass filter.	**TE.EEC.13.A.a.5:** Describe the modulation and demodulation of signals in radio applications.

Standard: TE.EEC.13

Students will explain the operation of wireless communications in electrical, electronic, and control devices.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.13.A: Explain operations and applications of electromagnetic radiation devices.	**TE.EEC.13.A.b.6:** Characterize the limits to information transmission, or bandwidth, on the electromagnetic spectrum.	**TE.EEC.13.A.i.6:** Explain the regulation of the electromagnetic spectrum per the Federal Communications Commission.	**TE.EEC.13.A.a.6:** Describe engineering strategies to conserve electromagnetic spectrum bandwidth in the transmission of data or multiplexing.

Standard: TE.EEC.14

Students will quantify electrical and electronic measurements using International System of Units (SI).

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.14.A: Explain quantities and units related to the operation of electrical circuits.	**TE.EEC.14.A.b.1:** Match the units of volts, ohms, and amps to the voltage, resistance, and current.	**TE.EEC.14.A.i.1:** Categorize the relationships between voltage and current, current and resistance, and voltage and resistance as being direct or inverse.	**TE.EEC.14.A.a.1:** Use Ohm's law to calculate current (given voltage and resistance), voltage drop (given current and resistance), and resistance (given current and voltage drop).
	TE.EEC.14.A.b.2: Contrast electrostatic and magnetic fields at macro and atomic scales.	**TE.EEC.14.A.i.2:** Characterize the operation of capacitors and inductors as electrostatic or inductive.	**TE.EEC.14.A.a.2:** Calculate inductance in henrys and capacitance in farads.

Standard: TE.EEC.14

Students will quantify electrical and electronic measurements using International System of Units (SI).

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.14.A: Explain quantities and units related to the operation of electrical circuits.	**TE.EEC.14.A.b.3:** Observe transient currents and waves.	**TE.EEC.14.A.i.3:** Describe wave amplitude, frequency, shape, peaks, troughs, wavelength, and period. Calculate period, frequency, and wavelength.	**TE.EEC.14.A.a.3:** Calculate root-mean-square voltage from peak voltage, and calculate power based on root-mean-square voltage and resistance. Explain why root-mean-square voltage predicts power.
	TE.EEC.14.A.b.4: Determine if two quantities are within one order of magnitude of each other.	**TE.EEC.14.A.i.4:** Use magnitude prefixes (micro-, milli-, kilo-, mega-, etc.) with SI units.	**TE.EEC.14.A.a.4:** Add and subtract exponents to calculate magnitude.
	TE.EEC.14.A.b.5: Describe units of measure that incorporate multiple dimensions, such as person-days, ton-miles, etc.	**TE.EEC.14.A.i.5:** Trace the origin of SI units back to fundamental units; for example, 1 watt = 1 joule per second, 1 joule = 1 newton meter of work.	**TE.EEC.14.A.a.5:** Perform dimensional analysis with SI units.
	TE.EEC.14.A.b.6: Express quantities in the base 10 number system.	**TE.EEC.14.A.i.6:** Express quantities in the base 10 number system and the binary number system, and convert values between systems.	**TE.EEC.14.A.a.6:** Express quantities in the base 10 number system, the binary number system, and the hexadecimal number system, and convert values between systems.
	TE.EEC.14.A.b.7: Convert between SI (K, ℃) and non-SI units (℉) for temperature.	**TE.EEC.14.A.i.7:** Contrast absolute (Kelvin, Rankine) temperature scales with relative (Celsius, Fahrenheit) temperature scales.	**TE.EEC.14.A.a.7:** Contrast temperature expressed in (K or ℃) with heat expressed in Joules.

Standard: TE.EEC.15

Students will perform computational analyses of electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.15.A: Calculate voltage, current, and resistance using Ohm's law.	**TE.EEC.15.A.b.1:** Analogize between electrical and hydraulic circuits, identifying voltage as electrical pressure, current as flow, and resistance as friction.	**TE.EEC.15.A.i.1:** Identify the appropriate units for voltage (volts), current (amperes), and resistance (ohms).	**TE.EEC.15.A.a.1:** Identify that given a purely resistive circuit, current is directly proportional to voltage drop and inversely proportional to resistance.
	TE.EEC.15.A.b.2: Identify that current is the same at all points of a series circuit, and voltage is the same across all branches of a parallel circuit.	**TE.EEC.15.A.i.2:** Identify that while adding resistances to a series circuit increases the resistance, adding resistances in parallel reduces the resistance of the circuit.	**TE.EEC.15.A.a.2:** Describe the relationship between resistance and electrical load as inversely proportional. For example, a short circuit has very low resistance and very high current and is a large electrical load.
	TE.EEC.15.A.b.3: Simplify series circuits by resolving series resistances into a single resistance through addition.	**TE.EEC.15.A.i.3:** Simplify parallel circuits by resolving parallel resistances into a single resistance by finding the harmonic mean.	**TE.EEC.15.A.a.3:** Simplify series-parallel circuits into a single equivalent resistance by finding sums and harmonic means appropriately.
	TE.EEC.15.A.b.4: Identify that the sum of all voltage drops equals the applied voltage (Kirchoff's Voltage Law) and that the sum of all branch currents equals the total current (Kirchoff's current law).	**TE.EEC.15.A.i.4:** Analogize Kirchoff's laws to a hydraulic circuit. For example, the sum of all pressure drops equals the applied pressure; the sum of all branch flows equals the total flow.	**TE.EEC.15.A.a.4:** Use Ohm's law and Kirchoff's Voltage and Current laws to predict voltage, current, and resistance in circuits with one unknown component.

Standard: TE.EEC.15

Students will perform computational analyses of electrical, electronic, and control systems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.EEC.15.B: Calculate circuit power.	**TE.EEC.15.B.b.1:** Calculate electrical power as the product of voltage and current.	**TE.EEC.15.B.i.1:** Derive the I^2R formula from Ohm's law and Watt's law.	**TE.EEC.15.B.a.1:** Explain why root-mean-square voltage is used in AC power calculations rather than peak to peak voltage.
	TE.EEC.15.B.b.2: Calculate apparent power.	**TE.EEC.15.B.i.2:** Calculate real power.	**TE.EEC.15.B.a.2:** Calculate reactive power and power factor.
	TE.EEC.15.B.b.3: Convert between units of power, including watts (W), joules (J/s), BTUs / hr., and horsepower (hp).	**TE.EEC.15.B.i.3:** Convert between units of energy, such as kWh, kJ, and BTUs.	**TE.EEC.15.B.a.3:** Calculate energy efficiency.
TE.EEC.15.C: Solve problems using Boolean algebra.	**TE.EEC.15.C.b.1:** Evaluate a truth table using Boolean algebra.	**TE.EEC.15.C.i.1:** Identify circuit configurations that are logically equivalent.	**TE.EEC.15.C.a.1:** Translate logic as shown in a schematic gate diagram into a Boolean expression.

Strand: Biotechnology (BT)

Standard: TE.BT.1

Students will be able to identify career paths in biotechnologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.1.A: Identify careers in biotechnologies.	**TE.BT.1.A.b.1:** Identify transferable skills between biotechnology and other career fields.	**TE.BT.1.A.i.1:** Recognize biotechnology is a complex field and requires intelligence, creativity, patience, and perseverance.	**TE.BT.1.A.a.1:** Research the employment outlook for well-qualified job-seekers in biotechnology.
	TE.BT.1.A.b.2: Define the future of biotechnology.	**TE.BT.1.A.i.2:** Discuss the thought-provoking problems biotechnology careers face.	**TE.BT.1.A.a.2:** Identify the large variety of occupations a biotechnology career contains.
	TE.BT.1.A.b.3: Discuss the endless possibilities for biotechnology jobs.	**TE.BT.1.A.i.3:** Recognize biotech jobs heavily rely on technology, which is always expanding.	**TE.BT.1.A.a.3:** Research the most suitable area of interest and skill set to enhance your future career aspects in biotech.
		TE.BT.1.A.i.4: Discuss the skills necessary to be a good employee.	**TE.BT.1.A.a.4:** Research competitive salaries of biotechnology careers.

Standard: TE.BT.2

Students will examine the foundations (advancements and historical applications) of biotechnology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.2.A: Explore, connect, and engage the ways in which biotechnology plays a part in our world.	**TE.BT.2.A.b.1:** Distinguish major innovators, historical developments, and potential applications of biotechnology.	**TE.BT.2.A.i.1:** Examine current applications of biotechnology.	**TE.BT.2.A.a.1:** Create a timeline and use it to explain the developmental progression of biotechnology.
	TE.BT.2.A.b.2: Define biotechnology; identify examples of agricultural products created through biotechnology.	**TE.BT.2.A.i.2:** Explore the historical impact biotechnology has had on society and the environment.	**TE.BT.2.A.a.2:** Examine potential future applications of biotechnology, and compare them with alternative approaches to improving products.
	TE.BT.2.A.b.3: Explore the structure and function of DNA.	**TE.BT.2.A.i.3:** Gain understanding of what DNA is and its role in the human body.	**TE.BT.2.A.a.3:** Understand structure and function of DNA.

Standard: TE.BT.3

Students will be able to understand the uses of biotechnology in healthcare.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.3.A: Analyze the role of biotechnology in healthcare.	**TE.BT.3.A.b.1:** Discuss that vaccinations protect people from getting certain diseases.	**TE.BT.3.A.i.1:** Discuss that vaccines are designed to prevent diseases from developing and spreading; medicines are designed to relieve symptoms and stop diseases from developing.	**TE.BT.3.A.a.1:** Discuss medical technologies, including prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, genetic engineering, and the systems within which health is protected and maintained.
	TE.BT.3.A.b.2: Recognize technological advances have made it possible to create new devices, repair or replace certain parts of the body, and provide a means for mobility.	**TE.BT.3.A.i.2:** Explain vaccines developed for use in immunization require specialized technologies to support environments in which sufficient amounts of vaccines are produced.	**TE.BT.3.A.a.2:** Recognize telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.
	TE.BT.3.A.b.3: Know the basic structures and functions of cells and how this is used in biotechnology advancements.	**TE.BT.3.A.i.3:** Understand DNA/RNA replication.	**TE.BT.3.A.a.3:** Recognize the science of biochemistry and molecular biology has made it possible to manipulate the genetic information found in living creatures.
	TE.BT.3.A.b.4: Recognize that advances and innovations in medical technologies are used to improve healthcare.	**TE.BT.3.A.i.4:** Understand the role of biotechnology product development in curing genetic, environmental, and behavioral diseases.	**TE.BT.3.A.a.4:** Recognize genetic engineering involves modifying the structure of DNA to produce novel genetic makeups or codes.

Standard: TE.BT.4

Students will be able to select and use biotechnologies related to life's nutritional needs.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.4.A: Identify the importance of biotechnology in food and animal science.	**TE.BT.4.A.b.1:** Discuss that the use of technologies in agriculture makes it possible for food to be available year-round and to conserve resources.	**TE.BT.4.A.i.1:** Recognize that technological advances in life science directly affect the time and number of people required to produce food for a large population.	**TE.BT.4.A.a.1:** Recognize that biotechnology applies the principles of biology to innovative agriculture techniques, such as hydroponics.
	TE.BT.4.A.b.2: Recognize the many different tools necessary to control an agricultural system.	**TE.BT.4.A.i.2:** Discuss the wide range of specialized equipment and practices used to improve the production of food, fiber, fuel, and other useful products.	**TE.BT.4.A.a.2:** Discuss how biotechnology has kept up with changing consumer habits with ingredients that can improve taste, nutrition, and shelf life.
	TE.BT.4.A.b.3: Discuss how biotechnology crops have been improved in terms of their nutritional quantity and quality.	**TE.BT.4.A.i.3:** Discuss the development of refrigeration, freezing, dehydration, preservation, and irradiation, which provide long-term storage of food and reduce the health risks caused by tainted food.	**TE.BT.4.A.a.3:** Recognize agriculture includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemicals, and other useful products.
	TE.BT.4.A.b.4: Explain the importance of proper nutrition.	**TE.BT.4.A.i.4:** Practice why and how various methods of food preservation work.	**TE.BT.4.A.a.4:** Demonstrate how enzymes are used in the food processing industry.

Standard: TE.BT.4

Students will be able to select and use biotechnologies related to life's nutritional needs.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.4.B: Identify the importance of biotechnology in food and plant science.	**TE.BT.4.B.b.1:** Explain why insect control is important to plant production.	**TE.BT.4.B.i.1:** Define the advantages and disadvantages of genetically modified plants.	**TE.BT.4.B.a.1:** Debate on genetically modified organism (GMO) vs. organic food.
	TE.BT.4.B.b.2: Explore processes used in large scale agriculture requiring different procedures, products, or systems.	**TE.BT.4.B.i.2:** Explain artificial ecosystems are human-made complexes that replicate some aspects of the natural environment.	**TE.BT.4.B.a.2:** Design, engineer, and manage artificial ecosystems.
	TE.BT.4.B.b.3: Discuss the health effects of modified foods, such as seed oils, corn starch, etc.	**TE.BT.4.B.i.3:** Explain that artificial ecosystems are human-made environments that are designed to function as a unit and are composed of humans, plants, and animals.	**TE.BT.4.B.a.3:** Define that conservation is the process of controlling soil erosion, reducing sediment in waterways, conserving water, and improving water quality.

Standard: TE.BT.5

Students will discuss and demonstrate how biotechnology is used in controlling biohazardous waste.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.5.A: Select, use, and demonstrate how biotechnology affects waste.	**TE.BT.5.A.b.1:** Explain that most agricultural waste can be recycled.	**TE.BT.5.A.i.1:** Recognize fertilizers that benefit growth come from various forms.	**TE.BT.5.A.a.1:** Research packaging products made from crops to enhance biodegradability.

Standard: TE.BT.5

Students will discuss and demonstrate how biotechnology is used in controlling biohazardous waste.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.5.A: Select, use, and demonstrate how biotechnology affects waste.	**TE.BT.5.A.b.2:** Define the concept of ecology.	**TE.BT.5.A.i.2:** Discuss how biotechnology plays a role in benefiting our environment.	**TE.BT.5.A.a.2:** Explain how oil spills can be combated with biotechnology.
	TE.BT.5.A.b.3: Practice ethical standards of integrity, honesty, and fairness in scientific practices and professional conduct.	**TE.BT.5.A.i.3:** Research current biotechnology practices and trends in dealing with waste. Discuss how to continue improving these practices.	**TE.BT.5.A.a.3:** Research and discuss the national, state, and local standards, policies, protocols, and regulations for disposing of waste in laboratory and manufacturing activities.
	TE.BT.5.A.b.4: Recognize that one of the most promising uses of biotechnology is decomposition of organic matter.	**TE.BT.5.A.i.4:** Explain how biotechnology relates to scientific principles and lab techniques to staff and stakeholders in creating packaging.	**TE.BT.5.A.a.4:** Research technical support, customer assistance, and cost-benefit analyses in the application of biotechnical approaches to the development of products and services.
		TE.BT.5.A.i.5: Research and experiment how the use of a living organism can help to remove toxins from the environment, for example, oil-eating bugs, cellulose-eating bacteria for waterways, etc.	**TE.BT.5.A.a.5:** Explore and debate uses of biological warfare.

Standard: TE.BT.6

Students will be able to select and use bioenergy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.6.A: Select, use, and identify bioenergy technologies.	**TE.BT.6.A.b.1:** Discuss plant growth, cell structure and functions, and seed formation and germination.	**TE.BT.6.A.i.1:** Examine plant modifications to increase production of starch.	**TE.BT.6.A.a.1:** Evaluate the economic impact of bioenergy fuel vs. food production.
	TE.BT.6.A.b.2: Evaluate the impact of plant biotechnology on bioenergy.	**TE.BT.6.A.i.2:** Assess the importance of ethical issues related to plant biotechnology.	**TE.BT.6.A.a.2:** Evaluate plant genetics and heritability in relation to plant science and biotechnology for fuels.
	TE.BT.6.A.b.3: Discuss the importance of plant biotechnology in life science and how our society uses them for biofuels.	**TE.BT.6.A.i.3:** Define plant reproduction as it pertains to plant biotechnology.	**TE.BT.6.A.a.3:** Identify the available technology used in a biorefinery and the scientific and regulatory advantages and disadvantages of bioenergy.
	TE.BT.6.A.b.4: Explore different types of biofuels.	**TE.BT.6.A.i.4:** Discuss the scientific importance of bioenergy in the creation of alternative fuel sources.	**TE.BT.6.A.a.4:** Evaluate the science of refining feedstock to biofuels.
			TE.BT.6.A.a.5: Research decay of natural materials to produce biofuels.

Standard: TE.BT.7

Students will be able to make ethical decisions on health and safety of biotechnologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BT.7.A: Understand ethics relating to health and safety in biotechnologies.	**TE.BT.7.A.b.1:** Identify the ethical rights and wrongs of specific technology.	**TE.BT.7.A.i.1:** Identify social consequences of new technologies.	**TE.BT.7.A.a.1:** Recognize biotechnology can help further propagate biowarfare.
	TE.BT.7.A.b.2: Recognize biotechnology has helped reduce global famine by increasing the availability of food.	**TE.BT.7.A.i.2:** Examine proper research, manufacture, regulation, and supply of biotech-generated products.	**TE.BT.7.A.a.2:** Discuss the safety, environmental nature, human nature, and religious belief controversies and applications in biotechnology.
	TE.BT.7.A.b.3: Discuss how biotechnology interferes with the social aspect of the human person.	**TE.BT.7.A.i.3:** Identify ethical, safety, bioterrorism, and environmental issues.	**TE.BT.7.A.a.3:** Assess safety, bioterrorism, and environmental issues, as well as potential solutions to these concerns.
	TE.BT.7.A.b.4: Describe the role government agencies have in regulating biotechnology.	**TE.BT.7.A.i.4:** Evaluate the availability and use of privileged information, potential for ecological harm, access to new drugs and treatments, and the idea of interfering with nature.	**TE.BT.7.A.a.4:** Discuss how to isolate and move specific genes from one plant or animal to another for human benefit.
	TE.BT.7.A.b.5: Explain the meaning of intellectual property as it relates to biotechnology, such as Roundup®.	**TE.BT.7.A.i.5:** Gain an understanding of why people either support or challenge breakthroughs in biotechnology.	**TE.BT.7.A.a.5:** Recognize that genes can be manipulated to enhance animals, humans, and plants, and this has led to humans using such methods more frequently out of greed.

Standard: TE.BT.7

Students will be able to make ethical decisions on health and safety of biotechnologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.BT.7.A: Understand ethics relating to health and safety in biotechnologies.			**TE.BT.7.A.a.6:** Debate an ethical dilemma associated with biotechnology by identifying its components.

Standard: TE.BT.8

Students will understand how biotechnology ties into ancestry and criminology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.BT.8.A: Examine the role genetics plays in biotechnology concepts.	**TE.BT.8.A.b.1:** Research the molecular basis for heredity.	**TE.BT.8.A.i.1:** Compare and contrast the structure and function of DNA and RNA.	**TE.BT.8.A.a.1:** Perform a restriction digest, and analyze the results with gel electrophoresis.
	TE.BT.8.A.b.2: State why DNA and proteins are needed by living organisms.	**TE.BT.8.A.i.2:** Identify the major components and outline the process of DNA replication.	**TE.BT.8.A.a.2:** Extract and purify DNA and RNA. Isolate, maintain, quantify, and store cell cultures.
	TE.BT.8.A.b.3: Define how genetics are passed on from generation to generation.	**TE.BT.8.A.i.3:** Explain the structures of DNA and RNA and how genotype influences phenotypes.	**TE.BT.8.A.a.3:** Perform electrophoresis techniques, and interpret electrophoresis fragmentation patterns.
		TE.BT.8.A.i.4: Identify DNA sequencing techniques.	**TE.BT.8.A.a.4:** Explain how the chemical structure of DNA applies to gel electrophoresis.

Strand: Broad Based (BB)

Standard: TE.BB.1

Students will demonstrate an understanding of career opportunities within Career and Technology Education and Science, Technology, Engineering, and Mathematics.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.1.A: Research and identify the education, salary, and job outlook of careers.	**TE.BB.1.A.b.1:** Describe the levels of education necessary, the salary levels, and the job outlook for careers in science, technology, engineering, mathematics (STEM) or pathway of personal interest.	**TE.BB.1.A.i.1:** Locate and evaluate various postsecondary options and pathways of education, training, apprenticeship, or certification for careers in a science, technology, manufacturing, or engineering pathway of personal interest.	**TE.BB.1.A.a.1:** Examine or participate in activities or inquiries of postsecondary education or training of careers in a science, technology, manufacturing, or engineering pathway of personal interest.
	TE.BB.1.A.b.2: Compare personal interests and aptitudes with job requirements and characteristics of chosen careers.	**TE.BB.1.A.i.2:** Examine and compare the job outlook and salaries and understand the range and scope of related career paths within the industries and companies that would employ careers of personal interest.	**TE.BB.1.A.a.2:** Compare and contrast the various levels within careers of interest, and identify the different levels of education and training within those career strands, for example, engineer vs. technician, graphic designer vs. creative designer.
TE.BB.1.B: Investigate and identify in-demand foundational skills necessary for the future of occupational-specific work.	**TE.BB.1.B.b.1:** Research and identify the necessary foundational skills predicted for chosen careers in a science, technology, manufacturing, or engineering pathway, such as project management, analytical skills, and computational thinking.	**TE.BB.1.B.i.1:** Describe and practice the necessary foundational skills predicted for chosen careers in a science, technology, manufacturing, or engineering pathway, such as project management, analytical skills, or computational thinking.	**TE.BB.1.B.a.1:** Apply and demonstrate the necessary foundational skills predicted for chosen careers in a science, technology, manufacturing, or engineering pathway, such as project management, analytical skills, or computational thinking.

Standard: TE.BB.2

Students will analyze the core concepts of technology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.2.A: Analyze and use technological systems.	**TE.BB.2.A.b.1:** Compare and contrast systems found in nature and others made by humans.	**TE.BB.2.A.i.1:** Identify inputs, processes, outputs, and, at times, feedback components for technological systems.	**TE.BB.2.A.a.1:** Describe how systems can fail because of design flaws, defective parts, poorly matched parts, or they were used beyond their design capabilities.
	TE.BB.2.A.b.2: Identify that systems have parts or components that work together to accomplish a goal.	**TE.BB.2.A.i.2:** Explain how common energy power and transportation systems have provisions that detect, bypass, or compensate for failures within a system.	**TE.BB.2.A.a.2:** Describe the outputs of one subsystem given a prominent energy, power, and transportation system.
TE.BB.2.B: Analyze and use tools and materials.	**TE.BB.2.B.b.1:** Explain that tools are used to design, make, use, assess technology, and extend human capabilities such as holding, lifting, carrying, fastening, separating, and computing.	**TE.BB.2.B.i.1:** Students will describe how resources are the things needed to complete a task, including tools, machines, materials, information, energy, people, capital, and time.	**TE.BB.2.B.a.1:** Select appropriate resources and explain how trade-offs between competing values, such as availability, cost, desirability, and waste, influenced their decision.
	TE.BB.2.B.b.2: Recognize that materials have many different properties that are leveraged in making things.	**TE.BB.2.B.i.2:** Use appropriate tools to measure and lay out a piece of material within tolerances, including length, width, thickness, angles, circles, arcs, and volume.	**TE.BB.2.B.a.2:** Choose and perform the material processing operations of forming (bending, pressing, drawing, rolling); bonding (gluing, soldering, brazing, spot welding, gas welding, arc welding); fastening (screws, nuts and bolts, rivets, clips, pins, nails); and finishing (surface preparation, cleaning, treatment, and coating).

Standard: TE.BB.2

Students will analyze the core concepts of technology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.2.C: Analyze and use mechanisms.	**TE.BB.2.C.b.1:** Identify the types, functions, and applications of simple mechanical components, such as levers, linkages, cranks, cams, gears, pulleys and belts, and sprockets and chains).	**TE.BB.2.C.i.1:** Explain the relationship between the inputs and outputs of linear, rotary, and compound motion mechanisms in terms of direction, distance, and force.	**TE.BB.2.C.a.1:** Build, test, and troubleshoot simple linear, rotary, and compound mechanisms.
		TE.BB.2.C.i.2: Define mechanical concepts, such as force, work, power, torque, velocity, mechanical advantage, and gear ratio.	**TE.BB.2.C.a.2:** Given a linear, rotary, or compound motion mechanism, measure and calculate units such as work, power, torque, gear ratios, and mechanical advantage.
TE.BB.2.D: Analyze and use electricity and electronic systems.	**TE.BB.2.D.b.1:** Describe atomic structure, the components of the atom, their charges, and their importance to electronics technology.	**TE.BB.2.D.i.1:** Define basic electrical concepts, including voltage, direct and alternating current, resistance, power, polarity, conductor, insulator, series circuit, parallel circuit, series-parallel circuit, inductance, capacitance, continuity, digital, and analog.	**TE.BB.2.D.a.1:** Describe the role of thermal, optical, and mechanical transducers in sending electrical control signals to modify how a system performs.
		TE.BB.2.D.i.2: Measure current, voltage, and resistance in series, parallel, and series-parallel circuits and components.	**TE.BB.2.D.a.2:** Perform a voltage drop test, and describe the relationship between voltage, current, and resistance with a multimeter.

Standard: TE.BB.2

Students will analyze the core concepts of technology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.2.D: Analyze and use electricity and electronic systems.		**TE.BB.2.D.i.3:** Locate and identify shorts to power and ground, opens, and high resistance problems in circuits and components.	**TE.BB.2.D.a.3:** Inspect and test components such as switches, connectors, relays, solid-state devices, and conductors, and take appropriate action.
TE.BB.2.E: Analyze, explain, and use control systems.	**TE.BB.2.E.b.1:** Discuss that an open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.	**TE.BB.2.E.i.1:** Explain how control systems sense what is happening in a system, compare it to what people want to happen within the system, and trigger subsystems that will make needed adjustments.	**TE.BB.2.E.a.1:** Identify the multiple controls that sense information from a number of areas, evaluate the system, and act accordingly, given a flawed, complex system.
	TE.BB.2.E.b.2: Discuss that controls are mechanisms or particular steps that people perform using information about the system that causes systems to change.	**TE.BB.2.E.i.2:** Explain how quality control is a planned process to ensure that a product, service, or system meets established criteria.	**TE.BB.2.E.a.2:** Select and perform an appropriate maintenance function in the process in order for the product or system to continue functioning properly, to extend its life, or to upgrade its capability, given a flawed product or system.
TE.BB.2.F: Identify and analyze structures.	**TE.BB.2.F.b.1:** Identify and correlate human-made structures that were inspired by structures that occur in nature.	**TE.BB.2.F.i.1:** Identify and describe basic types of structures—such as mass, bearing wall, and framed—as they relate to their function.	**TE.BB.2.F.a.1:** Calculate and define the different loads acting on structures, such as static, dynamic, stress, strain, compression, and tension.

Standard: TE.BB.2

Students will analyze the core concepts of technology.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.2.F: Identify and analyze structures.	**TE.BB.2.F.b.2:** Recognize that materials have properties that inspire their use in structures, for example, wood, plastic, aluminum, brick, concrete, cast iron, and steel.	**TE.BB.2.F.i.2:** Use scientific inquiry to test, collect data, and make conclusions about the performance of different materials and their application in the making of structures, for example, tensile, compression, shear testing.	**TE.BB.2.F.a.2:** Justify the application of structural materials and their trade-offs in the design of structures based on design requirements through optimization or the engineering design process.

Standard: TE.BB.3

Students will demonstrate an understanding of the purpose and necessity of practicing occupational safety in industry, manufacturing, a facility, and on a job site.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.BB.3.A: Analyze and demonstrate occupational health and safety precautions, procedures, and regulations.	**TE.BB.3.A.b.1:** Predict in a workplace environment the conditions and hazards that pose a risk for accidents and injuries, and discuss the importance of health and safety procedures in a workplace that keeps workers safe.	**TE.BB.3.A.i.1:** Recognize conditions, explain precautions, and how to safely handle material. Identify the different types of safety equipment commonly used in the career pathways.	**TE.BB.3.A.a.1:** Implement prevention methods and demonstrate the safety procedures and practices in various work environment settings and in operating equipment commonly used in the career pathways.
	TE.BB.3.A.b.2: Identify personal protective equipment (PPE) and personal and group safety precautions that are critical to worker well-being.	**TE.BB.3.A.i.2:** Describe and follow personal and group safety, health, and environmental standards in a training, educational, or workplace setting.	**TE.BB.3.A.a.2:** Assess and manage risks to health, safety, and the environment in a training, educational, or workplace setting.

Strand: Engineering (ENG)

Standard: TE.ENG.1

Students will explore engineering as a career field.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.1.A: Explore engineering as a career.	**TE.ENG.1.A.b.1:** Describe engineers as problem-solvers.	**TE.ENG.1.A.i.1:** Discuss methods that engineers use to solve problems.	**TE.ENG.1.A.a.1:** Identify current real-world engineering applications.
	TE.ENG.1.A.b.2: Describe how engineering can impact daily life.	**TE.ENG.1.A.i.2:** Research the history of engineering accomplishments.	**TE.ENG.1.A.a.2:** Explore the future of engineering in our civilization.
	TE.ENG.1.A.b.3: List the various types of engineering.	**TE.ENG.1.A.i.3:** Research each type of engineering job and its applications.	**TE.ENG.1.A.a.3:** Choose and explain the type of engineering of most interest.
TE.ENG.1.B: Understand how to pursue an engineering career.	**TE.ENG.1.B.b.1:** Understand the levels of education necessary for types of engineering careers.	**TE.ENG.1.B.i.1:** Research engineering schools and courses required.	**TE.ENG.1.B.a.1:** Choose an appropriate postsecondary school program.
	TE.ENG.1.B.b.2: Understand the outlook for future engineering careers.	**TE.ENG.1.B.i.2:** Research future job outlook for various types of engineering.	**TE.ENG.1.B.a.2:** Research companies you are interested in pursuing a career with to determine the local job outlook.
	TE.ENG.1.B.b.3: Understand the salaries for various types of engineering careers.	**TE.ENG.1.B.i.3:** Research data on salaries for various types of engineering.	**TE.ENG.1.B.a.3:** Research companies you are interested in pursuing a career with to determine local salaries.

Standard: TE.ENG.2

Students will understand and apply the engineering design process to solve problems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.2.A: Explain reasons for using an engineering design process.	**TE.ENG.2.A.b.1:** Explain that the design process is a purposeful method of planning practical solutions to problems.	**TE.ENG.2.A.i.1:** Understand that the engineering design process is an iterative multistep process that requires a failure analysis and a repeat of steps until a valid solution is developed.	**TE.ENG.2.A.a.1:** Apply the engineering design process to solve a unique problem.
	TE.ENG.2.A.b.2: Understand that a design process will vary by suitability for the specific application.	**TE.ENG.2.A.i.2:** Select a design process that is best suited for the specific design problem.	**TE.ENG.2.A.a.2:** Use the selected process from start to finish. Adapt the process as needed.
TE.ENG.2.B: Define the problem.	**TE.ENG.2.B.b.1:** Understand the voice of the customer.	**TE.ENG.2.B.i.1:** Summarize the requirements necessary to solve the problem.	**TE.ENG.2.B.a.1:** Communicate the requirements and scope of the problem in a written form.
	TE.ENG.2.B.b.2: Make observations to understand why an existing problem is failing.	**TE.ENG.2.B.i.2:** Record data from the failure of the existing problem.	**TE.ENG.2.B.a.2:** Draw a conclusion from observations and data to formulate the problem to be solved.
	TE.ENG.2.B.b.3: Define what constraints and criteria of a problem are.	**TE.ENG.2.B.i.3:** Understand how the criteria and constraints affect the possible solutions to the problem.	**TE.ENG.2.B.a.3:** Describe the criteria and constraints for a design problem.
	TE.ENG.2.B.b.4: Draw a sketch with known measurements for the problem environment.	**TE.ENG.2.B.i.4:** Improve the sketch to include unknown dimensions that need to be measured and integrated into the total sketch.	**TE.ENG.2.B.a.4:** Summarize the problem suitable for testing, and analyze further in the engineering design process.

Standard: TE.ENG.2

Students will understand and apply the engineering design process to solve problems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.2.C: Brainstorm ideas.	**TE.ENG.2.C.b.1:** Describe brainstorming and how it fits into the engineering design process.	**TE.ENG.2.C.i.1:** Create rough sketches for an idea that will shape plans for further research.	**TE.ENG.2.C.a.1:** Brainstorm multiple competing ideas and discuss their pros and cons with respect to the design problem.
TE.ENG.2.D: Conduct research.	**TE.ENG.2.D.b.1:** Conduct research using multiple credible sources.	**TE.ENG.2.D.i.1:** Identify topics to research that will affect your solution decisions.	**TE.ENG.2.D.a.1:** Apply research to influence solution design decisions.
TE.ENG.2.E: Explore possibilities.	**TE.ENG.2.E.b.1:** Conduct experiments to validate initial ideas.	**TE.ENG.2.E.i.1:** Compare and contrast aspects of your competing solutions.	**TE.ENG.2.E.a.1:** Describe how your solutions will satisfy the requirements of the problem.
TE.ENG.2.F: Create a design proposal.	**TE.ENG.2.F.b.1:** Explain the reason for choosing a particular solution.	**TE.ENG.2.F.i.1:** Describe how your solution will satisfy the requirements of the problem.	**TE.ENG.2.F.a.1:** Develop a written design proposal to present to the customer for approval to proceed.
TE.ENG.2.G: Fabricate a prototype or model. *(See ENG3 for more specific standards.)*	**TE.ENG.2.G.b.1:** Develop a plan for creating a prototype or model.	**TE.ENG.2.G.i.1:** Identify how your prototype or model will be tested.	**TE.ENG.2.G.a.1:** Create a prototype or model suitable for testing against the design requirements.
TE.ENG.2.H: Test and analyze the solution.	**TE.ENG.2.H.b.1:** Design tests that will demonstrate success or failure against the design requirements.	**TE.ENG.2.H.i.1:** Conduct tests and record data.	**TE.ENG.2.H.a.1:** Identify whether data received is valid and purposeful.
	TE.ENG.2.H.b.2: Summarize data to determine meaning.	**TE.ENG.2.H.i.2:** Utilize graphical and statistical methods of data analysis.	**TE.ENG.2.H.a.2:** Develop a conclusion using data-driven evidence that points to the success or failure of the solution.

Standard: TE.ENG.2

Students will understand and apply the engineering design process to solve problems.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.2.H: Test and analyze the solution.	**TE.ENG.2.H.b.3:** Identify aspects of the design solution that need improvement.	**TE.ENG.2.H.i.3:** Develop a plan to implement improvements to the design solution.	**TE.ENG.2.H.a.3:** Return to prior steps in the engineering design process to continue to find a new and better solution to solve the problem.
TE.ENG.2.I: Communicate results.	**TE.ENG.2.I.b.1:** Identify the validity of the results as compared to the requirements of the problem.	**TE.ENG.2.I.i.1:** Provide numerical and graphical evidence to support your conclusions.	**TE.ENG.2.I.a.1:** Discuss how that evidence demonstrates the success of your solution.
	TE.ENG.2.I.b.2: Describe what you would do differently if you had to solve the problem again or were given more time and resources.	**TE.ENG.2.I.i.2:** Discuss the rationale for making these improvements in relation to the design problem requirements.	**TE.ENG.2.I.a.2:** Develop the steps necessary to accomplish those improvements.
	TE.ENG.2.I.b.3: Develop an oral presentation of the results.	**TE.ENG.2.I.i.3:** Develop a written presentation of the results.	**TE.ENG.2.I.a.3:** Create a multimedia presentation of the results.

Standard: TE.ENG.3

Students will apply engineering process tools and methods.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.3.A: Apply time management methods.	**TE.ENG.3.A.b.1:** Discuss a plan for managing the engineering design process.	**TE.ENG.3.A.i.1:** Develop a time management plan that reflects due dates and deadlines.	**TE.ENG.3.A.a.1:** Utilize tools such as a Gantt chart to plan outcomes, identify issues, and predict failures to meet deadlines.
TE.ENG.3.B: Create decision matrices.	**TE.ENG.3.B.b.1:** Understand the purpose of a decision matrix when deciding which ideas to explore.	**TE.ENG.3.B.i.1:** Identify the attributes necessary to design a decision matrix.	**TE.ENG.3.B.a.1:** Create and utilize a decision matrix to determine design choices.
TE.ENG.3.C: Use statistical analysis.	**TE.ENG.3.C.b.1:** Understand the generation of statistics as related to the current problem.	**TE.ENG.3.C.i.1:** Generate data and graphically represent it in a form for analysis.	**TE.ENG.3.C.a.1:** Analyze statistical data to determine the success or failure of your design solution.
TE.ENG.3.D: Use graphical analysis.	**TE.ENG.3.D.b.1:** Understand the use of graphical representations to analyze data.	**TE.ENG.3.D.i.1:** Create a graphical representation from your data.	**TE.ENG.3.D.a.1:** Utilize graphical representation of data to inform decisions in your engineering design process.
TE.ENG.3.E: Write an engineering design process report.	**TE.ENG.3.E.b.1:** Understand the steps of the engineering design process.	**TE.ENG.3.E.i.1:** Create a written report documenting your engineering design process and how it pertains to the problem.	**TE.ENG.3.E.a.1:** Create a written report with various forms of evidence to support your solution to the problem.
TE.ENG.3.F: Use various software applications.	**TE.ENG.3.F.b.1:** Identify various software applications used in engineering design, including design, analysis, multimedia, etc.	**TE.ENG.3.F.i.1:** Develop strategies to learn various engineering software applications.	**TE.ENG.3.F.a.1:** Utilize various software applications to solve and document engineering problems.

Standard: TE.ENG.3

Students will apply engineering process tools and methods.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.3.G: Create simulations and models.	**TE.ENG.3.G.b.1:** Understand how simulations are a low-cost, low-risk method of testing your design solution.	**TE.ENG.3.G.i.1:** Develop strategies to resources, and learn various simulation systems.	**TE.ENG.3.G.a.1:** Utilize various simulations to analyze and solve an engineering problem.

Standard: TE.ENG.4

Students will attain the skills necessary to design and craft a prototype ready for testing and analysis.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.4.A: Use 3D design techniques.	**TE.ENG.4.A.b.1:** Demonstrate the skills necessary to create 3D drawings/models using computer software.	**TE.ENG.4.A.i.1:** Draw existing parts to create engineering quality drawings/models.	**TE.ENG.4.A.a.1:** Create quality engineering drawings/models for new, unique parts.
	TE.ENG.4.A.b.2: Understand the concept of creating assembly system drawings from individual parts.	**TE.ENG.4.A.i.2:** Apply joining techniques to create an assembly drawing that includes proper tolerances.	**TE.ENG.4.A.a.2:** Create an assembly drawing, exploded view, and parts list.
TE.ENG.4.B: Use 2D design techniques.	**TE.ENG.4.B.b.1:** Demonstrate the skills necessary to create 2D drawings using computer software.	**TE.ENG.4.B.i.1:** Draw existing parts to create engineering quality drawings.	**TE.ENG.4.B.a.1:** Create quality engineering drawings for new, unique parts.
TE.ENG.4.C: Construct a scale model.	**TE.ENG.4.C.b.1:** Understand the need to create scale models for prototypes.	**TE.ENG.4.C.i.1:** Calculate the real and scaled dimensions for an object.	**TE.ENG.4.C.a.1:** Create a scale model for a prototype object.

Standard: TE.ENG.4

Students will attain the skills necessary to design and craft a prototype ready for testing and analysis.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.4.D: Select proper materials to construct a prototype model.	**TE.ENG.4.D.b.1:** Identify various materials used in creating prototypes.	**TE.ENG.4.D.i.1:** Discuss the properties and uses of various materials.	**TE.ENG.4.D.a.1:** Select the proper materials for creating a prototype.
TE.ENG.4.E: Use drafting techniques.	**TE.ENG.4.E.b.1:** Create various types of sketches of engineering design problems and prototype specifications.	**TE.ENG.4.E.i.1:** Understand and utilize the standards for various types of engineering design documents.	**TE.ENG.4.E.a.1:** Create professional standardized engineering drawings for your solution to an engineering design problem.
TE.ENG.4.F: Create engineering documents.	**TE.ENG.4.F.b.1:** Understand the importance of standardized engineering documents.	**TE.ENG.4.F.i.1:** Create standardized engineering documents that include dimensions and tolerances.	**TE.ENG.4.F.a.1:** Create and utilize standardized engineering documents as a part of your engineering design process.
TE.ENG.4.G: Create code for operating prototype manufacturing equipment.	**TE.ENG.4.G.b.1:** Understand how equipment uses code to manufacture an object.	**TE.ENG.4.G.i.1:** Create the code necessary to operate manufacturing equipment.	**TE.ENG.4.G.a.1:** Create a finished part using the equipment and functional coding.
TE.ENG.4.H: Use additive manufacturing to create a prototype model.	**TE.ENG.4.H.b.1:** Discuss the process of additive manufacturing.	**TE.ENG.4.H.i.1:** Set up and operate equipment for additive manufacturing.	**TE.ENG.4.H.a.1:** Create an object using additive manufacturing.
TE.ENG.4.I: Use subtractive manufacturing to create a prototype model.	**TE.ENG.4.I.b.1:** Discuss the process of subtractive manufacturing.	**TE.ENG.4.I.i.1:** Set up and operate equipment for subtractive manufacturing.	**TE.ENG.4.I.a.1:** Create an object using subtractive manufacturing.
TE.ENG.4.J: Evaluate equipment capabilities.	**TE.ENG.4.J.b.1:** Identify future technologies for creating prototypes.	**TE.ENG.4.J.i.1:** Research applications, costs, and timelines for procuring new technologies.	**TE.ENG.4.J.a.1:** Purchase and develop new equipment and technologies.

Standard: TE.ENG.4

Students will attain the skills necessary to design and craft a prototype ready for testing and analysis.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.4.K: Use various types of tools to create a prototype model.	**TE.ENG.4.K.b.1:** Understand the purpose of various hand and power tools as well as their safe use.	**TE.ENG.4.K.i.1:** Demonstrate the safe and effective use of hand and power tools.	**TE.ENG.4.K.a.1:** Use hand and power tools to create a prototype of your engineering design solution.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.A: Apply civil and environmental engineering knowledge and skills.	**TE.ENG.5.A.b.1:** Define the parts of a structure.	**TE.ENG.5.A.i.1:** Describe how materials, their orientation, and forces contribute to the stability of a structure.	**TE.ENG.5.A.a.1:** Design and create a prototype structure.
	TE.ENG.5.A.b.2: Understand the origins of structural loads.	**TE.ENG.5.A.i.2:** Calculate the structural loads from various sources.	**TE.ENG.5.A.a.2:** Design a structure to support various types of load cases.
	TE.ENG.5.A.b.3: Define concrete and its uses.	**TE.ENG.5.A.i.3:** Explore the forces and various mixes that create applicable concrete applications.	**TE.ENG.5.A.a.3:** Create and test a concrete mix.
	TE.ENG.5.A.b.4: Define a steel beam and column and their uses.	**TE.ENG.5.A.i.4:** Explore the types of steel, shapes, and forces that create various structural applications.	**TE.ENG.5.A.a.4:** Create a structural prototype model that uses steel beams/columns to create a stable structure.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.A: Apply civil and environmental engineering knowledge and skills.	**TE.ENG.5.A.b.5:** Define reinforced concrete and its applications.	**TE.ENG.5.A.i.5:** Describe the relation between the forces and the advantages of a reinforced concrete beam.	**TE.ENG.5.A.a.5:** Create a prototype beam using reinforced concrete and test its properties.
	TE.ENG.5.A.b.6: Classify soil types from unknown samples.	**TE.ENG.5.A.i.6:** Identify properties of soil and their building applications.	**TE.ENG.5.A.a.6:** Build prototype structures and test their properties using various soil types.
	TE.ENG.5.A.b.7: Understand hydrology and how water behaves on the surface in the natural world.	**TE.ENG.5.A.i.7:** Determine surface water systems and existing solutions to solve hydrology-related problems.	**TE.ENG.5.A.a.7:** Utilize knowledge and applications of hydrology to solve a unique engineering problem.
	TE.ENG.5.A.b.8: Understand hydrogeology and how water behaves below ground in the natural world.	**TE.ENG.5.A.i.8:** Determine groundwater systems and existing solutions to hydrogeology-related problems.	**TE.ENG.5.A.a.8:** Utilize knowledge and applications of hydrogeology solutions to solve a unique engineering problem.
	TE.ENG.5.A.b.9: Identify types of transportation methods to move items.	**TE.ENG.5.A.i.9:** Describe transportation systems and how they interact to move items.	**TE.ENG.5.A.a.9:** Design a transportation system to move items.
	TE.ENG.5.A.b.10: Understand the water cycle.	**TE.ENG.5.A.i.10:** Identify how the water cycle affects various situations.	**TE.ENG.5.A.a.10:** Create unique solutions to problems in relation to extreme water events.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.A: Apply civil and environmental engineering knowledge and skills.	**TE.ENG.5.A.b.11:** Describe the process of water purification and wastewater management.	**TE.ENG.5.A.i.11:** Identify existing systems for water purification and wastewater management.	**TE.ENG.5.A.a.11:** Create and build a system for water purification and wastewater treatment.
	TE.ENG.5.A.b.12: Understand climate change and its causes and effects on the environment.	**TE.ENG.5.A.i.12:** Identify engineering solutions to problems related to climate change.	**TE.ENG.5.A.a.12:** Design unique engineering solutions to problems related to climate change.
TE.ENG.5.B: Apply mechanical engineering knowledge and skills.	**TE.ENG.5.B.b.1:** Describe the six simple machines.	**TE.ENG.5.B.i.1:** Understand how each machine works and the advantages and disadvantages of each.	**TE.ENG.5.B.a.1:** Utilize simple machines in a unique engineering design problem.
	TE.ENG.5.B.b.2: Describe the uses of various types of gears.	**TE.ENG.5.B.i.2:** Select proper gears for various situations.	**TE.ENG.5.B.a.2:** Utilize gears in a unique engineering design problem.
	TE.ENG.5.B.b.3: Understand the nature of forces and how they affect engineering problems.	**TE.ENG.5.B.i.3:** Create a free body diagram to analyze the forces in an engineering problem.	**TE.ENG.5.B.a.3:** Utilize your analysis of forces to create a unique solution to an engineering design problem.
	TE.ENG.5.B.b.4: Understand the definition of work, and identify work applications.	**TE.ENG.5.B.i.4:** Calculate the values of work in various problems.	**TE.ENG.5.B.a.4:** Utilize your analysis of work to create a unique solution to an engineering design problem.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.B: Apply mechanical engineering knowledge and skills.	**TE.ENG.5.B.b.5:** Understand the definition of energy, and identify its many forms.	**TE.ENG.5.B.i.5:** Describe the energy transfer and creation in a system.	**TE.ENG.5.B.a.5:** Create a system that manages energy transfer and creation.
	TE.ENG.5.B.b.6: Understand the definition of mechanical advantage.	**TE.ENG.5.B.i.6:** Calculate the mechanical advantage in various systems.	**TE.ENG.5.B.a.6:** Utilize the best mechanical advantage in the solution of a design problem.
	TE.ENG.5.B.b.7: Understand the definition of efficiency in a mechanical system.	**TE.ENG.5.B.i.7:** Calculate the efficiencies in a mechanical system.	**TE.ENG.5.B.a.7:** Utilize the best efficiencies in the solution of a design problem.
	TE.ENG.5.B.b.8: Understand the merging of electronics and mechanics in engineering applications.	**TE.ENG.5.B.i.8:** Identify mechatronic systems in engineering applications.	**TE.ENG.5.B.a.8:** Create mechatronic systems in a unique engineering design problem.
	TE.ENG.5.B.b.9: Identify various types of materials used in engineering.	**TE.ENG.5.B.i.9:** Compare and contrast applications of various materials used in engineering.	**TE.ENG.5.B.a.9:** Select the best materials for various applications used in engineering.
	TE.ENG.5.B.b.10: Understand the nature of fluid mechanics and various types of systems.	**TE.ENG.5.B.i.10:** Analyze various fluid mechanics systems to determine their best applications.	**TE.ENG.5.B.a.10:** Create a fluid mechanics system in a unique engineering design problem.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.C: Apply electrical engineering knowledge and skills.	**TE.ENG.5.C.b.1:** Describe the methods of controlling electricity.	**TE.ENG.5.C.i.1:** Analyze an existing process to determine the methods of controlling electricity.	**TE.ENG.5.C.a.1:** Select methods of controlling electricity for a new design.
	TE.ENG.5.C.b.2: Understand the parts and their operation on a printed circuit board (PCB).	**TE.ENG.5.C.i.2:** Analyze an existing PCB to determine its function and structure.	**TE.ENG.5.C.a.2:** Design and create a new PCB to perform a specific function.
	TE.ENG.5.C.b.3: Understand the definition of automation.	**TE.ENG.5.C.i.3:** Identify applications of automation in an existing application.	**TE.ENG.5.C.a.3:** Select methods of automation for a new application.
	TE.ENG.5.C.b.4: Understand the uses of a microcontroller and its components.	**TE.ENG.5.C.i.4:** Construct and program a microcontroller for an existing situation.	**TE.ENG.5.C.a.4:** Implement a microcontroller in a new design application.
	TE.ENG.5.C.b.5: Understand the use and purpose of robotics systems.	**TE.ENG.5.C.i.5:** Design and build a robotic system from existing parts and plans for given tasks.	**TE.ENG.5.C.a.5:** Design and build a new, unique robot to perform specific tasks.
	TE.ENG.5.C.b.6: Define artificial intelligence (AI).	**TE.ENG.5.C.i.6:** Understand the practical applications of artificial intelligence (AI).	**TE.ENG.5.C.a.6:** Experiment with artificial intelligence (AI) solutions in various technical design applications.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.D: Apply aerospace engineering knowledge and skills.	**TE.ENG.5.D.b.1:** Understand the nature of flight through Bernoulli's principle.	**TE.ENG.5.D.i.1:** Describe and diagram forces affecting an aircraft in flight.	**TE.ENG.5.D.a.1:** Design and create a fixed-wing vehicle.
	TE.ENG.5.D.b.2: Understand and identify various flight controls for fixed-wing aircraft.	**TE.ENG.5.D.i.2:** Describe how individual flight controls influence the movement of an entire aircraft.	**TE.ENG.5.D.a.2:** Design and create a fixed-wing aircraft that can change its movement using various flight controls.
	TE.ENG.5.D.b.3: Understand and identify various flight controls for rotary aircraft.	**TE.ENG.5.D.i.3:** Describe how individual flight controls influence the movement of a rotary aircraft.	**TE.ENG.5.D.a.3:** Design and create a rotary aircraft that can change its movement using various flight controls.
	TE.ENG.5.D.b.4: Compare the concepts of unpowered and powered flight.	**TE.ENG.5.D.i.4:** Identify the mechanisms to power fixed-wing aircraft and the effect on the forces involved.	**TE.ENG.5.D.a.4:** Create a powered fixed-wing aircraft.
	TE.ENG.5.D.b.5: Describe the forces used in rocketry.	**TE.ENG.5.D.i.5:** Identify design aspects and control systems that influence the movement of a rocket.	**TE.ENG.5.D.a.5:** Calculate the parameters necessary to design a rocket for specific situations.
	TE.ENG.5.D.b.6: Construct a rocket for a specific purpose.	**TE.ENG.5.D.i.6:** Prepare a rocket and launch site for a safe launch.	**TE.ENG.5.D.a.6:** Safely launch a rocket for a specific purpose.
	TE.ENG.5.D.b.7: Describe the history of space exploration.	**TE.ENG.5.D.i.7:** Discuss the engineering applications that resulted from space exploration activities.	**TE.ENG.5.D.a.7:** Discuss the future of space exploration and technologies.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.D: Apply aerospace engineering knowledge and skills.	**TE.ENG.5.D.b.8:** Understand the design challenges for a vehicle traveling in space.	**TE.ENG.5.D.i.8:** Design a vehicle capable of traveling in space.	**TE.ENG.5.D.a.8:** Create a prototype model for a vehicle capable of traveling in space.
	TE.ENG.5.D.b.9: Understand the navigational challenges of traveling in space.	**TE.ENG.5.D.i.9:** Identify existing navigational technologies involved in space travel.	**TE.ENG.5.D.a.9:** Explore future navigational technologies.
	TE.ENG.5.D.b.10: Understand the uses of satellites.	**TE.ENG.5.D.i.10:** Describe the forces involved in satellite movement.	**TE.ENG.5.D.a.10:** Explore the future of satellite technology and applications.
	TE.ENG.5.D.b.11: Understand the definition of an unmanned aerial system.	**TE.ENG.5.D.i.11:** Describe the forces involved in unmanned aerial vehicles.	**TE.ENG.5.D.a.11:** Design an unmanned aerial vehicle.
	TE.ENG.5.D.b.12: Understand the controls of an unmanned aerial vehicle.	**TE.ENG.5.D.i.12:** Obtain the necessary training and certifications to pilot an unmanned aerial vehicle.	**TE.ENG.5.D.a.12:** Safely pilot an unmanned aerial vehicle.
	TE.ENG.5.D.b.13: Identify the applications of unmanned aerial systems.	**TE.ENG.5.D.i.13:** Describe the future technologies and applications of unmanned aerial systems.	**TE.ENG.5.D.a.13:** Design and construct an unmanned aerial system vehicle.
	TE.ENG.5.D.b.14: Understand how weather affects flight.	**TE.ENG.5.D.i.14:** Explore the strategies of an aircraft used to fly safely in various weather conditions.	**TE.ENG.5.D.a.14:** Create a flight plan that takes the weather into account.

Standard: TE.ENG.5

Students will gain knowledge and applications of various engineering disciplines.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.5.E: Apply other areas of engineering knowledge and skills.	**TE.ENG.5.E.b.1:** Understand the career field of systems engineering.	**TE.ENG.5.E.i.1:** Describe how systems engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.1:** Use systems engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.2: Understand the career field of computer engineering.	**TE.ENG.5.E.i.2:** Describe how computer engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.2:** Use computer engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.3: Understand the career field of chemical engineering.	**TE.ENG.5.E.i.3:** Describe how chemical engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.3:** Use chemical engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.4: Understand the career field of manufacturing engineering.	**TE.ENG.5.E.i.4:** Describe how manufacturing engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.4:** Use manufacturing engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.5: Understand the career field of biomedical engineering.	**TE.ENG.5.E.i.5:** Describe how biomedical engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.5:** Use biomedical engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.6: Understand the career field of nuclear engineering.	**TE.ENG.5.E.i.6:** Describe how nuclear engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.6:** Use nuclear engineering skills to solve an engineering design problem.
	TE.ENG.5.E.b.7: Understand the career field of military engineering.	**TE.ENG.5.E.i.7:** Describe how military engineering skills can be used in the engineering design process.	**TE.ENG.5.E.a.7:** Use military engineering skills to solve an engineering design problem.

Standard: TE.ENG.6

Students will understand and apply entrepreneurial skills to develop a new business.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.6.A: Understand and use the product development cycle.	**TE.ENG.6.A.b.1:** Understand invention and innovation as creative ways to turn ideas into real things.	**TE.ENG.6.A.i.1:** Describe and understand the similarities and differences between inventions and innovations.	**TE.ENG.6.A.a.1:** Describe how many technological problems require a multidisciplinary approach.
	TE.ENG.6.A.b.2: Understand the product development cycle.	**TE.ENG.6.A.i.2:** Describe how the engineering design process fits into the product development cycle.	**TE.ENG.6.A.a.2:** Use the product development cycle to create a new, unique product.
	TE.ENG.6.A.b.3: Understand intellectual property and its purpose.	**TE.ENG.6.A.i.3:** Describe the process of obtaining a patent.	**TE.ENG.6.A.a.3:** Discuss current issues with intellectual property in the global economy.
TE.ENG.6.B: Use marketing concepts in the product development cycle.	**TE.ENG.6.B.b.1:** Understand the "voice of the customer" and why it is important to the process.	**TE.ENG.6.B.i.1:** Identify the voice of the customer from various case studies and scenarios.	**TE.ENG.6.B.a.1:** Conduct research to determine the voice of the customer for a new product.
	TE.ENG.6.B.b.2: Understand market research and its importance to the process.	**TE.ENG.6.B.i.2:** Describe examples of market research and the methods used.	**TE.ENG.6.B.a.2:** Conduct an analysis of an existing product market.
TE.ENG.6.C: Use sales concepts in the product development cycle.	**TE.ENG.6.C.b.1:** Understand a sales plan and its importance to the process.	**TE.ENG.6.C.i.1:** Describe examples of sales plans and the methods used.	**TE.ENG.6.C.a.1:** Develop a sales plan for a new product.
	TE.ENG.6.C.b.2: Understand how cost and price decisions are made.	**TE.ENG.6.C.i.2:** Analyze costs for an existing product and determine an effective price.	**TE.ENG.6.C.a.2:** Develop the costs associated with a new product and determine an effective price.

Standard: TE.ENG.6

Students will understand and apply entrepreneurial skills to develop a new business.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.6.D: Use logistics concepts in the product development cycle.	**TE.ENG.6.D.b.1:** Identify appropriate materials and sources for purchasing.	**TE.ENG.6.D.i.1:** Describe the various sources for materials and determine the costs for each for an existing product.	**TE.ENG.6.D.a.1:** Identify and select sources of materials for a new product.
	TE.ENG.6.D.b.2: Identify appropriate manufacturing processes.	**TE.ENG.6.D.i.2:** Discuss the advantages and disadvantages of various manufacturing processes.	**TE.ENG.6.D.a.2:** Identify and select manufacturing processes for a new product.
	TE.ENG.6.D.b.3: Understand the make-or-buy decision in manufacturing.	**TE.ENG.6.D.i.3:** Conduct a make-or-buy decision for an existing project with given data.	**TE.ENG.6.D.a.3:** Gather information and conduct a make-or-buy decision for a new product.
	TE.ENG.6.D.b.4: Understand the use of a bill of materials.	**TE.ENG.6.D.i.4:** Create a bill of materials from an existing product.	**TE.ENG.6.D.a.4:** Create a new bill of materials for a new product.
TE.ENG.6.E: Use manufacturing concepts in the product development cycle.	**TE.ENG.6.E.b.1:** Understand the difference between creating a prototype and manufacturing large quantities of a product.	**TE.ENG.6.E.i.1:** Identify various manufacturing processes to manufacture a large quantity of an existing product.	**TE.ENG.6.E.a.1:** Select various manufacturing processes to manufacture a large quantity of a new product.
	TE.ENG.6.E.b.2: Understand lean, efficiency-based processes in manufacturing.	**TE.ENG.6.E.i.2:** Identify lean manufacturing processes and methods to demonstrate continuous improvement.	**TE.ENG.6.E.a.2:** Apply lean manufacturing processes to continuously improve a manufacturing operation.
	TE.ENG.6.E.b.3: Understand the designs needed for packaging.	**TE.ENG.6.E.i.3:** Identify methods of packaging with various materials and processes.	**TE.ENG.6.E.a.3:** Design packaging for a new product.

Standard: TE.ENG.6

Students will understand and apply entrepreneurial skills to develop a new business.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ENG.6.E: Use manufacturing concepts in the product development cycle.	**TE.ENG.6.E.b.4:** Understand the need for quality control in a manufacturing process.	**TE.ENG.6.E.i.4:** Identify methods of quality control for an existing manufacturing operation.	**TE.ENG.6.E.a.4:** Create a quality inspection plan for a new product manufacturing operation.
	TE.ENG.6.E.b.5: Understand the integration of skilled trades and engineering careers in manufacturing.	**TE.ENG.6.E.i.5:** Identify the skills necessary to manufacture a product and which careers are best suited for those processes.	**TE.ENG.6.E.a.5:** Develop a manufacturing personnel plan based on skill sets and associated careers.
TE.ENG.6.F: Use distribution concepts in the product development cycle.	**TE.ENG.6.F.b.1:** Understand the transportation and distribution challenges in moving a product to customers.	**TE.ENG.6.F.i.1:** Identify various transportation and distribution methods for an existing product.	**TE.ENG.6.F.a.1:** Develop a transportation and distribution plan for a new product.

Strand: Environmental Technology (ET)

Standard: TE.ET.1

Students will understand industrial processes and controls used in the production, preservation, and sustainability of natural resources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.1.A: Analyze the environmental technology industry.	**TE.ET.1.A.b.1:** Identify careers in the environmental technology field.	**TE.ET.1.A.i.1:** Understand and explain how environmental technologies are related to other industries and careers.	**TE.ET.1.A.a.1:** Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
	TE.ET.1.A.b.2: Understand the levels of education required for careers related to environmental technology.	**TE.ET.1.A.i.2:** Research and identity industry certifications relevant to the environmental technology field.	**TE.ET.1.A.a.2:** Research responsibilities and training or education requirements for a specific job in the environmental technology field.
TE.ET.1.B: Understand industrial processes and the technologies implemented to monitor and manage environmental quality.	**TE.ET.1.B.b.1:** Explain why humans depend on the Earth's resources for needs (food, shelter, water) and wants (entertainment).	**TE.ET.1.B.i.1:** Explore how resources are used and processed for human survival.	**TE.ET.1.B.a.1:** Perform a life cycle assessment of a product or service.
	TE.ET.1.B.b.2: Categorize resources into land, air, and water.	**TE.ET.1.B.i.2:** Investigate and model environmental air, water, and land quality and management technologies.	**TE.ET.1.B.a.2:** Evaluate the effectiveness of current and emerging environmental control and quality management technologies.

Standard: TE.ET.1

Students will understand industrial processes and controls used in the production, preservation, and sustainability of natural resources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.1.C: Understand the need for conservation, preservation, and sustainability on a home, local, state, national, and global scale.	**TE.ET.1.C.b.1:** Define environmental conservation, stewardship, sustainability, and management.	**TE.ET.1.C.i.1:** Examine the design and application of sustainable technologies and processes.	**TE.ET.1.C.a.1:** Design or redesign a product, system, or process utilizing sustainable design principles.
	TE.ET.1.C.b.2: Define green technology.	**TE.ET.1.C.i.2:** Discuss the advantages and impacts of various green technologies on a local and global scale.	**TE.ET.1.C.a.2:** Design or redesign a product, system, or process utilizing green technology principles.

Standard: TE.ET.2

Students will understand the relationship between the natural environment and energy harnessing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.2.A: Understand the supply and demand of energy needs and the current and emerging technologies in the energy sector.	**TE.ET.2.A.b.1:** Identify energy as the ability to do work and list its many forms.	**TE.ET.2.A.i.1:** Discuss availability, cost, efficiency, benefits, and impacts of nonrenewable and renewable energy sources.	**TE.ET.2.A.a.1:** Analyze the efficiency and carbon footprint of energy sources.
	TE.ET.2.A.b.2: Explain that potential and kinetic energy exist all around us.	**TE.ET.2.A.i.2:** Discuss ways in which humans harness, store, and transmit different forms of energy.	**TE.ET.2.A.a.2:** Analyze how control systems are used in the harnessing, storing, and transmission of energy.

Standard: TE.ET.2

Students will understand the relationship between the natural environment and energy harnessing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.2.A: Understand the supply and demand of energy needs and the current and emerging technologies in the energy sector.	**TE.ET.2.A.b.3:** Identify why humans, tools, and machines need energy to do work.	**TE.ET.2.A.i.3:** Illustrate and create models of energy technologies.	**TE.ET.2.A.a.3:** Compare advanced models of energy technologies that are solutions for an energy-related problem.

Standard: TE.ET.3

Students will understand the impact human habitation and progression have on the natural environment.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.3.A: Develop awareness and understanding of the impact human decision-making and technological advancements have on the environment we occupy.	**TE.ET.3.A.b.1:** Explore the relationship between the environment and humans.	**TE.ET.3.A.i.1:** Identify how the natural environment impacts human behavior, influences culture, and directs decision-making.	**TE.ET.3.A.a.1:** Conceptualize global stewardship and innovative technologies used in environmental preservation.
	TE.ET.3.A.b.2: Explore eras of human existence on Earth and the technologies of the time.	**TE.ET.3.A.i.2:** Analyze industrial advancements and impacts on the environment at home, local, state, national, and global levels.	**TE.ET.3.A.a.2:** Develop a technological solution for impacting environmental conservation and sustainability.

Standard: TE.ET.3

Students will understand the impact human habitation and progression have on the natural environment.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ET.3.A: Develop awareness and understanding of the impact human decision-making and technological advancements have on the environment we occupy.	**TE.ET.3.A.b.3:** Define refuse, reduce, reuse, recycle, and repurpose.	**TE.ET.3.A.i.3:** Examine how the materials of a product impact its production, delivery, and disposal.	**TE.ET.3.A.a.3:** Develop a technological solution to reduce, reuse, recycle, or repurpose a product, material, or waste in a personal or industrial setting.

Strand: Information and Communication Technologies (ICT)

Standard: TE.ICT.1

Students will explore careers in information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.1.A: Analyze the information and communication technologies industry.	**TE.ICT.1.A.b.1:** Identify careers in the information and communication technologies field.	**TE.ICT.1.A.i.1:** Understand and explain how information and communication technologies are related to other industries and careers.	**TE.ICT.1.A.a.1:** Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
	TE.ICT.1.A.b.2: Understand the levels of education required for careers related to information and communication technologies.	**TE.ICT.1.A.i.2:** Research and identity industry certifications relevant to the information and communication technology fields.	**TE.ICT.1.A.a.2:** Research responsibilities and training or education requirements for a specific job in the information and communication field.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.A: Analyze the communication process, the different forms and purposes of communication, and how communication may change in the future.	**TE.ICT.2.A.b.1:** Define communication technology.	**TE.ICT.2.A.i.1:** Explain how information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.	**TE.ICT.2.A.a.1:** Predict how information and communication systems allow information to be transferred in the future.
	TE.ICT.2.A.b.2: Discuss how technology enables people to communicate by sending and receiving information.	**TE.ICT.2.A.i.2:** Diagram how communication systems are made up of a source, encoder, transmitter, receiver, decoder, and destination.	**TE.ICT.2.A.a.2:** Assess how information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.
	TE.ICT.2.A.b.3: Identify symbols that can be used when communicating, such as a logo.	**TE.ICT.2.A.i.3:** Analyze how the use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.	**TE.ICT.2.A.a.3:** Predict how communication systems could evolve in the future to facilitate understanding in a common language.
	TE.ICT.2.A.b.4: Classify the types of communication we use daily.	**TE.ICT.2.A.i.4:** Illustrate how the communication we use daily has grown through the years.	**TE.ICT.2.A.a.4:** Predict how communication will change in the future.
	TE.ICT.2.A.b.5: Discuss how communications can be used to influence how you see the world.	**TE.ICT.2.A.i.5:** Evaluate how information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.	**TE.ICT.2.A.a.5:** Assess how communications can be used to manipulate people.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.A: Analyze the communication process, the different forms and purposes of communication, and how communication may change in the future.	**TE.ICT.2.A.b.6:** Create a communication message that informs.	**TE.ICT.2.A.i.6:** Create a communication message for entertainment.	**TE.ICT.2.A.a.6:** Create a persuasive communication message.
TE.ICT.2.B: Demonstrate knowledge and skills by utilizing graphic design, editing, and creation software.	**TE.ICT.2.B.b.1:** Identify different types of media, such as photos, video, audio, and graphic images.	**TE.ICT.2.B.i.1:** Understand that different types of media are stored in unique file types.	**TE.ICT.2.B.a.1:** Understand the differences, advantages, and disadvantages between raster and vector images.
	TE.ICT.2.B.b.2: Understand that photos, images, audio, video, and text can be used from a variety of sources.	**TE.ICT.2.B.i.2:** Be able to import or acquire photos, images, audio, video, and text.	**TE.ICT.2.B.a.2:** Be able to convert one file format to another file format.
	TE.ICT.2.B.b.3: Identify devices or programs that can create different types of media.	**TE.ICT.2.B.i.3:** Identify and use the correct software to create, edit, or view files based on their file type.	**TE.ICT.2.B.a.3:** Identify and use industry-standard file types when sharing files.
	TE.ICT.2.B.b.4: Save files with the appropriate compression, resolution, and file formats.	**TE.ICT.2.B.i.4:** Be able to create and use file naming and file management structures to save and organize files.	**TE.ICT.2.B.a.4:** Export files in multiple formats for use on a variety of platforms.
	TE.ICT.2.B.b.5: Describe animation.	**TE.ICT.2.B.i.5:** Be able to create an animation or add special effects to a video using frame-by-frame animation.	**TE.ICT.2.B.a.5:** Be able to create an animation or add special effects to a video using keyframes, effects, or transformation settings or by rotoscoping.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.B: Demonstrate knowledge and skills by utilizing graphic design, editing, and creation software.	**TE.ICT.2.B.b.6:** Be able to create and edit a video or audio production.	**TE.ICT.2.B.i.6:** Be able to add transitions and effects to a video or audio production.	**TE.ICT.2.B.a.6:** Combine multiple video, audio, and graphics files into a single production.
TE.ICT.2.C: Analyze and use various technologies related to photographic media.	**TE.ICT.2.C.b.1:** Describe what a photograph is.	**TE.ICT.2.C.i.1:** Explain how a photograph can be different from a picture.	**TE.ICT.2.C.a.1:** Describe how light-sensitive materials are used to capture photographs.
	TE.ICT.2.C.b.2: Capture a photograph.	**TE.ICT.2.C.i.2:** Use scene modes, flash, or other adjustments to effectively capture a photo.	**TE.ICT.2.C.a.2:** Capture a photograph by adjusting the exposure controls of a camera.
	TE.ICT.2.C.b.3: Be able to identify and explain the principles of composition as related to photography.	**TE.ICT.2.C.i.3:** Analyze how a photograph could be improved or changed by using the photographic principles of composition.	**TE.ICT.2.C.a.3:** Capture a photograph using the principles of composition.
	TE.ICT.2.C.b.4: Discuss how photographs can be manipulated or edited.	**TE.ICT.2.C.i.4:** Edit, combine, or manipulate a photograph.	**TE.ICT.2.C.a.4:** Edit, combine, or manipulate photographs using photo-editing software and nondestructive editing techniques.
TE.ICT.2.D: Identify, apply, and analyze the elements and principles of design.	**TE.ICT.2.D.b.1:** Identify common components of the page: text, Illustrations, and photographs.	**TE.ICT.2.D.i.1:** Create a layout that includes text, illustrations, and photographs.	**TE.ICT.2.D.a.1:** Create a layout that meets a client's and publisher's or printer's specifications.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.D: Identify, apply, and analyze the elements and principles of design.	**TE.ICT.2.D.b.2:** Identify the principles of balance, contrast, alignment, rhythm, repetition, movement, harmony, emphasis, and unity.	**TE.ICT.2.D.i.2:** Apply the principles of balance, contrast, alignment, rhythm, repetition, movement, harmony, and emphasis to an existing project.	**TE.ICT.2.D.a.2:** Create a project that incorporates the principles of balance, contrast, alignment, rhythm, repetition, movement, harmony, and emphasis.
	TE.ICT.2.D.b.3: Identify the elements of design: color, line, shape, texture, size, and value.	**TE.ICT.2.D.i.3:** Apply the elements of design—color, line, shape, texture, size, and value—to an existing project.	**TE.ICT.2.D.a.3:** Create a project that uses the elements of design: color, line, shape, texture, size, and value.
	TE.ICT.2.D.b.4: Identify the different classifications and styles of type.	**TE.ICT.2.D.i.4:** Be able to identify and adjust the properties of type.	**TE.ICT.2.D.a.4:** Create projects with type to help effectively communicate a message.
	TE.ICT.2.D.b.5: Identify camera shot types in video.	**TE.ICT.2.D.i.5:** Identify camera movement in video.	**TE.ICT.2.D.a.5:** Create a project that incorporates videos with multiple camera movements and shot types.
TE.ICT.2.E: Analyze and use various technologies to produce printed graphic communication products.	**TE.ICT.2.E.b.1:** Identify printed materials we come into contact with daily.	**TE.ICT.2.E.i.1:** Identify what type of printing produced a specific product.	**TE.ICT.2.E.a.1:** Predict how printing will change in the future.
	TE.ICT.2.E.b.2: Describe common printing processes: flexography, gravure, letterpress, offset lithography, screen printing, sublimation, digital, etc.	**TE.ICT.2.E.i.2:** List and identify common products produced by each printing process.	**TE.ICT.2.E.a.2:** Discuss advantages and disadvantages of each printing process.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.E: Analyze and use various technologies to produce printed graphic communication products.	**TE.ICT.2.E.b.3:** Design a printed product.	**TE.ICT.2.E.i.3:** Design and produce a printed project using the appropriate and best printing process.	**TE.ICT.2.E.a.3:** Set up, operate, clean, and maintain printing equipment.
	TE.ICT.2.E.b.4: Identify printing colors.	**TE.ICT.2.E.i.4:** Identify how many colors a given design would need to print.	**TE.ICT.2.E.a.4:** Create a multicolored product in various production processes.
	TE.ICT.2.E.b.5: Identify commonly used finishing and binding processes: cutting, padding, stapling, stitching, punching, folding, and collating.	**TE.ICT.2.E.i.5:** Select and use the appropriate finishing or binding equipment to complete a printing project.	**TE.ICT.2.E.a.5:** Set up, operate, clean, and maintain finishing equipment.
TE.ICT.2.F: Analyze and select various technologies to design and develop websites.	**TE.ICT.2.F.b.1:** Discuss and identify the different types of information that can be accessed through the internet.	**TE.ICT.2.F.i.1:** Discuss and identify the different types of websites: social media, content/media sharing, news media, business, web tools, etc.	**TE.ICT.2.F.a.1:** Develop a plan for a website.
	TE.ICT.2.F.b.2: Create and format text.	**TE.ICT.2.F.i.2:** Create links, use graphics, and multimedia.	**TE.ICT.2.F.a.2:** Create and format a table.
	TE.ICT.2.F.b.3: Create and publish a website using a web-based design tool.	**TE.ICT.2.F.i.3:** Create a website using HTML.	**TE.ICT.2.F.a.3:** Create a website using software in design and code view.

Standard: TE.ICT.2

Students will analyze, select, and use information and communication technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.ICT.2.F: Analyze and select various technologies to design and develop websites.	**TE.ICT.2.F.b.4:** Demonstrate the management of a website.	**TE.ICT.2.F.i.4:** Demonstrate content management and knowledge, such as testing site integrity, testing site on different browsers, timely updates, etc.	**TE.ICT.2.F.a.4:** Contrast and select the appropriate technologies to build a website, such as Java, ASP, XML, PHP, and CSS).

Strand: Manufacturing (MFG)

Standard: TE.MFG.1

Students will explore careers in manufacturing.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.1.A: Analyze the manufacturing industry.	**TE.MFG.1.A.b.1:** Identify careers in the manufacturing field.	**TE.MFG.1.A.i.1:** Understand and explain how manufacturing technologies are related to other industries and careers.	**TE.MFG.1.A.a.1:** Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
	TE.MFG.1.A.b.2: Understand the levels of education required for careers related to manufacturing.	**TE.MFG.1.A.i.2:** Research and identity industry certifications relevant to manufacturing fields.	**TE.MFG.1.A.a.2:** Research responsibilities and training or education requirements for a specific job in manufacturing.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.A: Identify, select, and safely use tools, machines, products, and systems for specific tasks.	**TE.MFG.2.A.b.1:** Discuss health safety in the workplace.	**TE.MFG.2.A.i.1:** Identify health and safety procedures in the workplace that keep workers safe.	**TE.MFG.2.A.a.1:** Audit workplace procedures to optimize safety and performance.
	TE.MFG.2.A.b.2: Recognize tools, machines, and materials.	**TE.MFG.2.A.i.2:** Safely perform job-related tasks.	**TE.MFG.2.A.a.2:** Use appropriate tools, materials, and machines to repair a malfunctioning system.
	TE.MFG.2.A.b.3: Recognize the characteristics of length, volume, weight, area, and time.	**TE.MFG.2.A.i.3:** Explore both customary and metric systems of measurement and conversions.	**TE.MFG.2.A.a.3:** Select and apply the appropriate units and scales for situations involving measurement.
TE.MFG.2.B: Create and communicate advantageous business solutions related to manufacturing.	**TE.MFG.2.B.b.1:** Introduce critical thinking skills to make educated decisions and solve problems.	**TE.MFG.2.B.i.1:** Students will describe the benefits of lean manufacturing and how it impacts production systems.	**TE.MFG.2.B.a.1:** Students will implement lean manufacturing concepts to reduce waste and increase productivity.
	TE.MFG.2.B.b.2: Learn basic methods of verbal, written, and graphical communication as it relates to manufacturing.	**TE.MFG.2.B.i.2:** Practice appropriate problem-solving approaches and critical thinking skills to on-the-job issues and tasks.	**TE.MFG.2.B.a.2:** Apply methodical problem-solving models, which include input, process, outcome, and feedback components.
	TE.MFG.2.B.b.3: Students identify the basics of lean manufacturing.	**TE.MFG.2.B.i.3:** Comprehend and engage in communication methods to convey ideas, concepts, and requirements to other individuals and teams.	**TE.MFG.2.B.a.3:** Design and publish documents using advanced publishing software and graphic programs to defend and promote results.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.C: Demonstrate respect and cooperation for individual and cultural differences in the attitudes and feelings of others.	**TE.MFG.2.C.b.1:** Learn how to cooperate with others in ways that show respect for individual and cultural differences and for the attitudes and feelings of others.	**TE.MFG.2.C.i.1:** Learn how to cooperate with others in ways that show respect for individual and cultural differences and for the attitudes and feelings of others.	**TE.MFG.2.C.a.1:** Learn how to cooperate with others in ways that show respect for individual and cultural differences and for the attitudes and feelings of others.
	TE.MFG.2.C.b.2: Recognize characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and manufacturing settings.	**TE.MFG.2.C.i.2:** Practice demonstrating characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and manufacturing settings.	**TE.MFG.2.C.a.2:** Consistently demonstrate characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and manufacturing settings.
		TE.MFG.2.C.i.3: Participate in the student organization SkillsUSA competitive career development events to enrich academic skills, encourage career choices, and contribute to employability.	**TE.MFG.2.C.a.3:** Medal at a SkillsUSA competitive career development event to enrich academic skills, encourage career choices, and contribute to employability.
			TE.MFG.2.C.a.4: Identify various strategies to conflict resolution and their importance for a variety of situations.
			TE.MFG.2.C.a.5: Recognize how to bring together projects individually and in teams for effective performance and the achievement of objectives.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.D: Select, use, and identify manufacturing processes, such as casting, forming, machining, joining, computer-controlled manufacturing (CNC), and treating/coating.	**TE.MFG.2.D.b.1:** Learn how processing systems convert natural materials into products.	**TE.MFG.2.D.i.1:** Demonstrate the ability to identify, program, and use an automated system to complete a given task.	**TE.MFG.2.D.a.1:** Demonstrate the ability to operate, troubleshoot, and maximize production using an automated system.
	TE.MFG.2.D.b.2: Discuss how automated equipment, such as computer numerical control (CNC) equipment, impacts manufacturing.	**TE.MFG.2.D.i.2:** Identify manufactured goods as durable and nondurable.	**TE.MFG.2.D.a.2:** Demonstrate the ability to choose a material with the correct durability for the task at hand.
	TE.MFG.2.D.b.3: Manufacturing processes include designing products, gathering resources, and using tools to separate, form, and combine materials in order to produce products.	**TE.MFG.2.D.i.3:** Identify the manufacturing process, including the design, development, manufacture, and service of products and systems.	**TE.MFG.2.D.a.3:** Demonstrate the interchangeability of parts, which increases the effectiveness of the manufacturing processes.
TE.MFG.2.E: Select, use, and identify manufacturing systems.	**TE.MFG.2.E.b.1:** Explore manufacturing systems that produce products in quantity.	**TE.MFG.2.E.i.1:** Explore the differences between consumable and reusable manufacturing materials.	**TE.MFG.2.E.a.1:** Describe the benefits and constraints when selecting ecologically friendly materials.
	TE.MFG.2.E.b.2: Identify that manufacturing processes can impact the environment.	**TE.MFG.2.E.i.2:** Identify that manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning.	**TE.MFG.2.E.a.2:** Recognize that manufacturing systems may be classified into types, such as customized production, batch production, and continuous production.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.E: Select, use, and identify manufacturing systems.	**TE.MFG.2.E.b.3:** Discuss essential components of a manufacturing system.	**TE.MFG.2.E.i.3:** Define the purposes of marketing.	**TE.MFG.2.E.a.3:** Use marketing to establish a product's identity, conduct research on its potential, advertise it, distribute it, and sell it.
		TE.MFG.2.E.i.4: Identify the subcomponents of a manufacturing system.	**TE.MFG.2.E.a.4:** Use a manufacturing system to produce a product.
TE.MFG.2.F: Select and understand manufacturing technologies.	**TE.MFG.2.F.b.1:** Learn manufacturing enterprises exist because of a consumption of goods.	**TE.MFG.2.F.i.1:** Define harvesting, drilling, and mining processes.	**TE.MFG.2.F.a.1:** Recognize servicing keeps products in good operating condition.
	TE.MFG.2.F.b.2: Learn that manufactured products are designed.	**TE.MFG.2.F.i.2:** Discuss how technologies are used to modify or alter chemical substances.	**TE.MFG.2.F.a.2:** Recognize technologies provide a means for humans to alter or modify materials and to produce products.
	TE.MFG.2.F.b.3: Products are produced of materials to benefit our lives—to make our lives safer, easier, and more enjoyable.	**TE.MFG.2.F.i.3:** Describe the relationship between materials and manufacturing.	**TE.MFG.2.F.a.3:** Recognize that materials have different qualities and may be classified as natural, synthetic, or mixed. Identify their effects on our world.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.G: Analyze and use GMAW, GTAW, SMAW, and oxy-acetylene welding.	**TE.MFG.2.G.b.1:** Discuss how metal is joined together.	**TE.MFG.2.G.i.1:** Analyze the different processes needed to fuse metal together, such as MIG, TIG, oxy-acetylene, Arc, etc.	**TE.MFG.2.G.a.1:** Demonstrate the ability to choose proper welding supplies given the process.
	TE.MFG.2.G.b.2: Discuss dangerous situations and the importance of safety in welding processes.	**TE.MFG.2.G.i.2:** Identify various types of metal, both ferrous and nonferrous.	**TE.MFG.2.G.a.2:** Identify different types of welding machines.
		TE.MFG.2.G.i.3: Identify the importance of safety and the different types of safety equipment needed for different welding processes.	**TE.MFG.2.G.a.3:** Demonstrate appropriate use of welding blueprint symbols and codes used in industry.
		TE.MFG.2.G.i.4: Demonstrate basic welding joints and processes used to weld them.	**TE.MFG.2.G.a.4:** Demonstrate safety and choose the proper safety equipment given the process being used, such as oxy-acetylene, GMAW, SMAW, GTAW, etc.
		TE.MFG.2.G.i.5: Discuss how robotics and automation play a role in manufacturing.	**TE.MFG.2.G.a.5:** Identify different types of welding joints and be able to demonstrate the ability to perform the welds, such as butt, corner, edge, lap, and tee.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.MFG.2.G: Analyze and use GMAW, GTAW, SMAW, and oxy-acetylene welding.			**TE.MFG.2.G.a.6:** Identify the different types of welding positions, and be able to demonstrate the ability to perform the welds: flat, horizontal, vertical, and overhead.
TE.MFG.2.H: Analyze and use various materials and manufacturing cutting operations.	**TE.MFG.2.H.b.1:** Discuss dangerous situations and the importance of safety with manufacturing cutting processes.	**TE.MFG.2.H.i.1:** Identify the importance of safety and different types of safety equipment needed for different materials and manufacturing cutting processes.	**TE.MFG.2.H.a.1:** Demonstrate the proper use and proper way to set up and close down oxy-acetylene equipment and check for leaking gasses.
		TE.MFG.2.H.i.2: Compare and contrast different metal and manufacturing cutting operations.	**TE.MFG.2.H.a.2:** Demonstrate the proper safety and use of plasma cutting equipment.
		TE.MFG.2.H.i.3: Demonstrate different metal and manufacturing cutting operations.	**TE.MFG.2.H.a.3:** Demonstrate how to use oxy-acetylene and plasma-cutting equipment.
		TE.MFG.2.H.i.4: Discuss how robotics and automation play a role in manufacturing cutting operations.	**TE.MFG.2.H.a.4:** Compare the pros and cons of plasma cutting with oxyacetylene cutting manufacturing operations and analyze other cutting operations used in the industry.

Standard: TE.MFG.2

Students will be able to select and use manufacturing technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.MFG.2.H: Analyze and use various materials and manufacturing cutting operations.			**TE.MFG.2.H.a.5:** Analyze the metallurgical effects that heat has on metal during the cutting process, forming, and heat treating.

Strand: Power and Energy (PE)

Standard: TE.PE.1

Students will analyze, select, and use power and energy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.PE.1.A: Analyze the power and energy industries.	**TE.PE.1.A.b.1:** Identify careers in the power and energy field.	**TE.PE.1.A.i.1:** Understand and explain how power and energy technologies are related to other industries and careers.	**TE.PE.1.A.a.1:** Communicate specific career opportunities and their projected outlook, placement, responsibilities, training and education requirements, etc.
	TE.PE.1.A.b.2: Understand the levels of education required for careers related to power and energy.	**TE.PE.1.A.i.2:** Research and identity industry certifications relevant to the power and energy fields.	**TE.PE.1.A.a.2:** Research responsibilities and training or education requirements for a specific job in the power and energy fields.

Standard: TE.PE.1

Students will analyze, select, and use power and energy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.1.B: Discuss, analyze, and use energy systems.	**TE.PE.1.B.b.1:** Debate that energy comes in many forms.	**TE.PE.1.B.i.1:** Define and debate how energy is the ability to do work.	**TE.PE.1.B.a.1:** Analyze how energy cannot be created nor destroyed; however, it can be converted from one form to another.
	TE.PE.1.B.b.2: Discuss and put into practice how renewable and nonrenewable energy should not be wasted.	**TE.PE.1.B.i.2:** Debate how energy can be used to do work using various processes.	**TE.PE.1.B.a.2:** Categorize and organize energy into groups of major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.
	TE.PE.1.B.b.3: Research and identify types of green energy systems used in our world.	**TE.PE.1.B.i.3:** Research and analyze how power is the rate at which energy is converted from one form to another, the rate at which it is transferred from one place to another, or the rate at which work is done.	**TE.PE.1.B.a.3:** Identify and research developing future trends of energy systems, including trends that are environmentally responsible.
	TE.PE.1.B.b.4: Research and identify renewable and nonrenewable energy systems.	**TE.PE.1.B.i.4:** Examine and formulate how power systems are used to drive and provide propulsion to other technological products and systems.	**TE.PE.1.B.a.4:** Identify trends in energy impacting the world's renewable and nonrenewable energy systems.
	TE.PE.1.B.b.5: Research and identify types of energy systems used in our world.	**TE.PE.1.B.i.5:** Communicate that much of the energy used in our environment is not used efficiently.	**TE.PE.1.B.a.5:** Assess and practice how power systems must have a source of energy, a process, and loads.

Standard: TE.PE.1

Students will analyze, select, and use power and energy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.1.C: Analyze, use, and discuss machine and tool use relating to power and energy systems.	**TE.PE.1.C.b.1:** Research and identify tools used in energy systems.	**TE.PE.1.C.i.1:** Describe how machines and systems are used in energy systems to do work.	**TE.PE.1.C.a.1:** Communicate how future trends in new and developing tools used in power and energy systems use innovative design and techniques.
	TE.PE.1.C.b.2: Research and identify new machines used in power and energy systems.	**TE.PE.1.C.i.2:** Describe how emerging machine technology trends in developing power systems are needed for the future.	**TE.PE.1.C.a.2:** Demonstrate how the uses of new technology, tools, and machines are necessary for future trends in power and energy systems.
	TE.PE.1.C.b.3: Recognize and assess the need for safety in the use of new tools and machines.	**TE.PE.1.C.i.3:** Engage in safe procedures when using tools and equipment related to power and energy systems.	**TE.PE.1.C.a.3:** Demonstrate, practice, and follow proper safety procedures for tools and machines used in power and energy systems.
	TE.PE.1.C.b.4: Recognize and compare terms related to power and energy systems.	**TE.PE.1.C.i.4:** Define and practice the use of specific tools and technology related to power and energy systems, such as a multimeter and computer software programs.	**TE.PE.1.C.a.4:** Demonstrate and practice the practical and theoretical application of test equipment to identify voltage, current, and resistance in energy systems.

Standard: TE.PE.1

Students will analyze, select, and use power and energy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.1.D: Identify and analyze responsible and efficient management of energy resources.	**TE.PE.1.D.b.1:** Identify and assess efficient use of an energy system.	**TE.PE.1.D.i.1:** Explain how efficient use in energy systems saves time and resources.	**TE.PE.1.D.a.1:** Demonstrate and practice efficient use of energy in a related project or lab.
	TE.PE.1.D.b.2: Identify and assess renewable energy sources.	**TE.PE.1.D.i.2:** Collaborate on how the efficient use of renewable energy sources is necessary for society.	**TE.PE.1.D.a.2:** Develop and collaborate on tasks related to responsible use of energy systems or resources.
	TE.PE.1.D.b.3: Identify and assess nonrenewable energy sources.	**TE.PE.1.D.i.3:** Explain why the need for efficient use of nonrenewable energy sources is vital for the future.	**TE.PE.1.D.a.3:** Demonstrate and practice efficient use of energy resources related to power and energy technology.
	TE.PE.1.D.b.4: Identify and assess how quickly energy resources are consumed.	**TE.PE.1.D.i.4:** Communicate how tools and machines can be designed to be more efficiently used in energy systems.	**TE.PE.1.D.a.4:** Research and demonstrate how new and emerging technology will be developed for efficient use of energy resources.
	TE.PE.1.D.b.5: Collaborate and compare examples of careers related to work in power and energy systems.	**TE.PE.1.D.i.5:** Identify and discuss new trends in careers related to the power and energy fields.	**TE.PE.1.D.a.5:** Research, identify, and explain new and emerging careers in green energy management and power systems.

Standard: TE.PE.1

Students will analyze, select, and use power and energy technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.1.E: Develop necessary skills in problem-solving for future energy systems.	**TE.PE.1.E.b.1:** Identify problem-solving steps used to address real-world problems.	**TE.PE.1.E.i.1:** Justify problem-solving as the application of math and science to solve a problem through invention or innovation.	**TE.PE.1.E.a.1:** Demonstrate and practice the application of the design process to solve problems related to technology, power, and energy systems.
	TE.PE.1.E.b.2: Identify and research older technology used in energy systems.	**TE.PE.1.E.i.2:** Research and define new techniques used to solve problems in energy systems.	**TE.PE.1.E.a.2:** Explain and supply skills using new technology and tools to solve energy problems.
	TE.PE.1.E.b.3: Debate power and energy problems.	**TE.PE.1.E.i.3:** Maintain and produce a journal of problem-solving steps used in solving a real-world problem for energy and power.	**TE.PE.1.E.a.3:** Research and write a technical report on an energy problem and the steps used to solve the problem.
	TE.PE.1.E.b.4: Debate and identify a job skill and tools for use in energy systems, green and otherwise.	**TE.PE.1.E.i.4:** Research, identify, and select specific tools required to safely measure, test, and analyze traditional and green energy problems.	**TE.PE.1.E.a.4:** Demonstrate and practice the safe use of test equipment and tools required to properly diagnose problems for (green) energy systems.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.1:** Describe ions, electrolytes, and galvanic couples (found in dissimilar metals) as used in batteries.	**TE.PE.2.A.i.1:** Predict charges and identify battery plates as anode and cathode based on battery chemistry. (Use the OIL RIG mnemonic: **O**xidation **I**s **L**oss of electrons; **R**eduction **I**s **G**ain of electrons.)	**TE.PE.2.A.a.1:** Analogize corrosion between dissimilar metals and the discharging of batteries, and electroplating of dissimilar metals and the charging of batteries. Explain application of this concept in the use of sacrificial anodes to protect metal.
	TE.PE.2.A.b.2: Identify the open circuit voltage of a battery by recognizing it as a voltage adder. (Count cells to predict open circuit voltage.) Identify that the plate stacks act as a current adder. Calculate voltage and ampacity for batteries connected in series and parallel.	**TE.PE.2.A.i.2:** Articulate why open circuit voltage is a poor indicator of battery health or state of charge.	**TE.PE.2.A.a.2:** Describe the mechanism (capacitive) of surface charge of a battery. Remove surface charge by applying an electrical load.
	TE.PE.2.A.b.3: Contrast energy-favored spontaneous chemical reactions, such as battery discharge, from energy-disfavored nonspontaneous chemical reactions, such as battery charging.	**TE.PE.2.A.i.3:** Describe factors affecting the rate of chemical reactions: concentration, temperature, pressure, surface area, state of matter, and catalysts.	**TE.PE.2.A.a.3:** Compare and contrast design differences between starting batteries and deep cycle batteries in terms of optimizing the rate of chemical reactions.
	TE.PE.2.A.b.4: Measure specific gravity with a hygrometer.	**TE.PE.2.A.i.4:** Explain the operation of a hygrometer based on concepts of specific gravity and buoyancy. Correct hydrometer readings for changes in electrolyte temperature.	**TE.PE.2.A.a.4:** Explain why the specific gravity of electrolytes and electrolyte resistance to freezing changes with changes in the state of charge.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.5:** Express a battery's ampacity in cranking amps, cold cranking amps, and reserve capacity.	**TE.PE.2.A.i.5:** Estimate battery capacity in amp-hours using geometry to approximate the area under the power curve.	**TE.PE.2.A.a.5:** Calculate battery capacity in amp-hours using integral calculus to calculate the area under the power curve.
	TE.PE.2.A.b.6: Calculate battery energy density and specific energy.	**TE.PE.2.A.i.6:** Contrast energy density and specific energy of batteries with the same quantities for petroleum-based fuels.	**TE.PE.2.A.a.6:** Based on battery energy capacity and charge rate, calculate time to charge a propulsion battery. Based on the energy content of gasoline and an estimated flow rate of a gas pump, calculate the rate at which energy is being transferred. Compare and contrast fast charging with filling up with gas.
	TE.PE.2.A.b.7: Observe batteries for signs of internal faults, such as plate sulfation, off gassing, and internal short circuits.	**TE.PE.2.A.i.7:** Observe batteries for signs of external faults, such as corrosion, parasitic current leakage, etc.	**TE.PE.2.A.a.7:** Associate observed damage with adverse events, such as sulfation from excessive discharge, freeze damage due to being discharged, and electrolyte boiled off due to excessive charging voltage.
	TE.PE.2.A.b.8: Load test batteries to determine battery state of health.	**TE.PE.2.A.i.8:** Based on load test results, calculate the internal resistance of a battery.	**TE.PE.2.A.a.8:** Identify factors contributing to the internal resistance of a battery, such as plate surface area, electrolyte concentration, and temperature.
	TE.PE.2.A.b.9: Identify high voltage conductors in hybrid and electric vehicles based on industry standard color coding.	**TE.PE.2.A.i.9:** Address electrical fires by deenergizing the system using the master disconnect.	**TE.PE.2.A.a.9:** Describe the chemistry of battery hazards, including hydrogen off-gassing in lead acid batteries and runaway thermal events in lithium-ion batteries.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.10:** Describe the operation of hydrogen fuel cells.	**TE.PE.2.A.i.10:** Identify environmental advantages of hydrogen fuel cells.	**TE.PE.2.A.a.10:** Explain engineering challenges associated with hydrogen fuel cells. For example, every pound of hydrogen requires 100 pounds of container to store, including a pressure vessel, and the potential fire hazards associated with hydrogen.
	TE.PE.2.A.b.11: Explain the principle of alternating current electrical power generation through magnetic induction.	**TE.PE.2.A.i.11:** Describe factors affecting the amount of electrical power generated, such as speed of changes in fields, field excitation strength, and magnetic permeability of the rotor and stator.	**TE.PE.2.A.a.11:** Explain the operation of a voltage regulator in modulating field current to regulate output.
	TE.PE.2.A.b.12: Identify advantages and disadvantages of alternating current and direct current outputs of electric machines. Consider the ability to transform vs. the ability to charge a battery, for example.	**TE.PE.2.A.i.12:** Explain the engineering advantages of distributing electrical power in three phases.	**TE.PE.2.A.a.12:** Describe the operation of the half-wave rectifier, full-wave rectifier, and bridge rectifier in converting electrical power generated as AC to DC.
	TE.PE.2.A.b.13: Test alternator output voltage at rated load.	**TE.PE.2.A.i.13:** Estimate alternator-required torque input on the basis of electrical power out and rotational speed.	**TE.PE.2.A.a.13:** Visualize power quality faults with an oscilloscope. Observe, for example, excessive DC ripple voltage, AC sinusoidal waveform deviances, etc.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.14:** Describe external combustion engines used to turn generators or steam turbines, using coal, natural gas, geothermal, nuclear reactor, and solar-heated power boilers.	**TE.PE.2.A.i.14:** Articulate the advantages of cogeneration, such as a gas turbine turning a generator or waste heat firing a steam turbine to turn a generator.	**TE.PE.2.A.a.14:** Examine the Carnot efficiency of engines used in power generation. Identify cold reservoirs used by power plants, such as chill water from a lake or river, cooling towers, building heating loads, etc.
	TE.PE.2.A.b.15: Describe the operation of nonmotor means of turning generators, such as wind turbines and hydroelectric power plants.	**TE.PE.2.A.i.15:** Trace electrical energy back to its nuclear origins. For example, the sun is a nuclear reactor. Solar photovoltaic systems directly capture the sun's energy; wind and hydroelectric capture through weather effects; burning coal and natural gas releases solar energy stored through photosynthesis; and nuclear reactors exploit nuclear energy directly.	**TE.PE.2.A.a.15:** Describe and contrast the effects of emissions and non-emissions discharges of power plants as defined by the U.S. Environmental Protection Agency. Examine the role that carbon dioxide discharges play in global heating and change in the climate.
	TE.PE.2.A.b.16: Compare and contrast regenerative braking with nonregenerative braking.	**TE.PE.2.A.i.16:** Describe "slip" in an asynchronous electric motor and how this effect can be used to produce regenerative braking.	**TE.PE.2.A.a.16:** Describe control strategies used in hybrid vehicles to optimize the interface between internal combustion engines and electric machines. For example, electric motor launch assist allows for a smaller internal combustion engine.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.17:** Consider tradeoffs in efficiency and reliability of centralized versus decentralized electrical power generation. Describe cascading grid overcurrent failures.	**TE.PE.2.A.i.17:** Explain how Tesla's development of transformable alternating current technology fundamentally changed the electrical grid from Edison's earlier DC model. Describe how high-power semiconductors have renewed interest in DC electrical power distribution.	**TE.PE.2.A.a.17:** Compare and contrast the efficiency of electrical power distribution infrastructure with other means of energy distribution, such as natural gas pipelines, over-the-road shipping of petroleum, etc.
	TE.PE.2.A.b.18: Describe the limitations of photovoltaic arrays to generate electrical power based on the ambient solar irradiance of <1368 watts per square meter.	**TE.PE.2.A.i.18:** Recognize and identify solar photovoltaic arrays as voltage adders when wired in series and current adders when wired in parallel.	**TE.PE.2.A.a.18:** Contrast the power of a photovoltaic array in kilowatts with the monthly energy use of the building in kilowatt-hours. Explain how the bidirectional meter accumulates differences in power produced to power consumed.
	TE.PE.2.A.b.19: Plot a current-voltage (I-V) curve for a photovoltaic circuit. Approximate voltage, current, and power under maximum power conditions.	**TE.PE.2.A.i.19:** Describe the effects of solar irradiance, temperature, and air mass on photovoltaic power generation. State standard test conditions (STCs) for these quantities.	**TE.PE.2.A.a.19:** Explain the control strategy of the maximum power point tracking algorithm found in modern solar inverters.

Standard: TE.PE.2

Students will test, analyze, compare, and contrast energy sources.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.PE.2.A: Identify and explain sources of electrical power.	**TE.PE.2.A.b.20:** Explain the operation of inverters used to convert direct current produced by photovoltaic panels to the AC needed for a building.	**TE.PE.2.A.i.20:** Explain the operation of bidirectional electrical meters. Contrast the purchase of electricity from the grid at the retail rate with the sale of electricity at the wholesale rate back onto the grid.	**TE.PE.2.A.a.20:** Describe the importance of keeping solar PV inverters in phase with the grid. Explain the operation of anti-islanding technology and its importance to electrical safety.

Strand: Transportation, Distribution, and Logistics (TDL)

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.TDL.1.A: Show an awareness of transportation vehicles and the role they play in society.	**TE.TDL.1.A.b.1:** Identify that transportation systems allow people and goods to be moved from place to place.	**TE.TDL.1.A.i.1:** Explain how transporting people and goods involves a combination of individuals and vehicles.	**TE.TDL.1.A.a.1:** Summarize the vital role transportation plays in the operation of the six technology categories: construction, transportation, energy and power, communication, manufacturing, and biotechnology.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.TDL.1.A: Show an awareness of transportation vehicles and the role they play in society.	**TE.TDL.1.A.b.2:** Identify the transportation modes used to move people or goods from one place to another by road *(land)*, sea, air, rail, pipeline, and intermodal transportation.	**TE.TDL.1.A.i.2:** Explain intermodal transportation as the use of different modes of transportation, such as highways, air, railways, and waterways, as part of an interconnected system that can move people and goods easily from one mode to another.	**TE.TDL.1.A.a.2:** Identify how government regulations and technological trade-offs might influence the transportation modes used to move people and goods from one place to another.
		TE.TDL.1.A.i.3: Recognize that production and management processes, or logistics, are necessary for the entire transportation system to operate efficiently.	**TE.TDL.1.A.a.3:** Relate how the current and future design of advanced transportation systems depends on many innovative materials and processes.
			TE.TDL.1.A.a.4: Obtain certifications related to transportation systems, such as ASE and CDL, or complete a Youth Apprenticeship in a related transportation field, such as automotive, collision, or diesel.
TE.TDL.1.B: Analyze and explain what transportation vehicles are and how transportation vehicle systems work.	**TE.TDL.1.B.b.1:** Recognize that transportation vehicles & systems need to be properly maintained in order to prolong their useful life.	**TE.TDL.1.B.i.1:** Predict how a lack of maintenance can lead to degradation and premature failure.	**TE.TDL.1.B.a.1:** Interpret preventive maintenance schedules and recommended service intervals for vehicles and systems.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.TDL.1.B: Analyze and explain what transportation vehicles are and how transportation vehicle systems work.	**TE.TDL.1.B.b.2:** Explain that transportation vehicles have multiple components with different functions.	**TE.TDL.1.B.i.2:** Explain that transportation vehicles are made up of subsystems, such as structural, propulsion, suspension, guidance, control, and support systems, that must function together to work effectively.	**TE.TDL.1.B.a.2:** Describe various types of land vehicle construction, such as space frame, body-on-frame, and unibody.
	TE.TDL.1.B.b.3: Explain that malfunctioning components must be repaired or replaced to restore intended operation.	**TE.TDL.1.B.i.3:** Explain that a transportation system may lose efficiency or fail if one part is missing or malfunctioning or if a subsystem is not working properly.	**TE.TDL.1.B.a.3:** Identify vehicle structural parts and cosmetic parts.
			TE.TDL.1.B.a.4: Demonstrate knowledge of collision energy management principles.
			TE.TDL.1.B.a.5: Explain that all systems demand specific repair procedures in order to achieve the highest performance and efficiency in automotive, collision, or diesel areas.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.TDL.1.C: Develop the skill set necessary to diagnose, problem-solve, and repair transportation vehicles.	**TE.TDL.1.C.b.1:** Give examples of core content areas, including science, technology, engineering, and math, that are directly applicable to the transportation field.	**TE.TDL.1.C.i.1:** Use science, technology, engineering, and math (STEM) to solve problems related to the transportation field.	**TE.TDL.1.C.a.1:** Understand the applications of alternative power sources.
	TE.TDL.1.C.b.2: Recognize the six simple machines in common products.	**TE.TDL.1.C.i.2:** Use simple machines to construct transportation-related devices.	**TE.TDL.1.C.a.2:** Understand the basic principles of electrical, pneumatic, and hydraulic power and their applications.
	TE.TDL.1.C.b.3: Identify examples of safety related to the use of simple tools and equipment.	**TE.TDL.1.C.i.3:** Operate transportation-related tools and equipment in a safe manner.	**TE.TDL.1.C.a.3:** Understand the operating principles of internal and external combustion engines.
	TE.TDL.1.C.b.4: List careers related to the transportation field.	**TE.TDL.1.C.i.4:** Understand the application, operation, maintenance, and diagnosis of engines, including but not limited to two-stroke and four-stroke and their supporting subsystems.	**TE.TDL.1.C.a.4:** Complete a work order, including customer information, description of repairs, and billing information, in accordance with applicable rules, laws, and regulations.
		TE.TDL.1.C.i.5: Perform career research related to the transportation field.	**TE.TDL.1.C.a.5:** Understand how to maintain, diagnose, and repair vehicle electrical systems, both high-voltage and low-voltage.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	**Intermediate**	**Advanced**
TE.TDL.1.C: Develop the skill set necessary to diagnose, problem-solve, and repair transportation vehicles.		**TE.TDL.1.C.i.6:** Successfully put into practice SkillsUSA activities, such as leadership and career exploration.	**TE.TDL.1.C.a.6:** Understand the function and principles of automotive drivetrain, steering and suspension, brake, and tire and wheel components and systems in accordance with current national standards for various areas, such as Automotive Service Excellence (ASE) certification, Federal Motor Vehicle Safety Standards (FMVSS) issued by the National Highway Traffic Safety Administration (NHTSA).
			TE.TDL.1.C.a.7: Understand the principles of mechanical, electrical, hydraulic, and pneumatic power in relation to collision repair.
			TE.TDL.1.C.a.8: Understand the concepts, principles, and practices of estimating, damage analysis, repair, painting, and refinishing in the collision repair industry.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.TDL.1.C: Develop the skill set necessary to diagnose, problem-solve, and repair transportation vehicles.			**TE.TDL.1.C.a.9:** Demonstrate safe and proficient use of specialty tools and equipment related to servicing transportation vehicles and their systems.
			TE.TDL.1.C.a.10: Explain career preparation, career pathways, and the importance of on-the-job training as well as further education with regard to the transportation field.
			TE.TDL.1.C.a.11: Perform general engine maintenance, diagnosis, service, and repair related directly to current national standards required by the Automotive Service Excellence (ASE) certification for automotive, collision, and diesel.
			TE.TDL.1.C.a.12: Perform and document maintenance procedures in accordance with the recommendations of the manufacturer.

Standard: TE.TDL.1

Students will be able to select and use transportation technologies.

Learning Priority	Performance Indicators (By Learning Progression)		
	Beginning	Intermediate	Advanced
TE.TDL.1.C: Develop the skill set necessary to diagnose, problem-solve, and repair transportation vehicles.			**TE.TDL.1.C.a.13:** Successfully put into practice SkillsUSA leadership activities and take part in transportation competitive events, such as automotive, power equipment, collision, and diesel.
			TE.TDL.1.C.a.14: Earn an ASE Entry-Level Certification in motor vehicle/diesel repair or collision repair/finishing. Or complete a Youth Apprenticeship in a related repair career area.