TN Department of Education | College, Career and Technical Education

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Principles of Engineering and Technology

Primary Career Cluster:	Science, Technology, Engineering, and Mathematics (STEM)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C21H04
Prerequisite(s):	None
Credit:	1
Grade Level:	9
Focus Elective Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *STEM* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the first course in the *Engineering* and *Technology* programs of study.
Aligned Student Organization(s):	SkillsUSA: http://www.tnskillsusa.com Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/career-and-technical-education/work-based-learning.html.
Promoted Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 125, 126, 127, 128, 129, 157, 210, 211, 212, 213, 214, 230, 232, 233, 413, 414, 415, 416, 417, 418, 449, 470, 477, 519, 531, 595, 596, 700, 740, 760, 982
Required Teacher Certifications/Training:	Teachers who have never taught this course must attend training provided by the Department of Education.
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html Best for All Central: https://bestforall.tnedu.gov/

Approved April 10, 2015; Amended January 25, 2018; Amended Nov. 2021

Course-At-A-Glance

There is no one way to create meaningful learning experiences for students. There are best practices available that data and students say impact long-term student learning. One of those best practices is to put student learning in context with their experiences.

Career and Technical Student Organizations (CTSOs) provide an opportunity for students to display their learning in the classroom and through regional, state, and/or national competition. Work-based Learning (WBL) consists of sustained and coordinated work-based activities that relate to the course content. These activities should occur at every level through a program of study. Below is a listing of possible CTSO connections and WBL activities for this course. This listing is intended to be an idea starter and not a comprehensive listing.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

Putting the classroom learning into real life experiences is often what creates a meaningful learning experience for students, one that lasts beyond the exam and course. CTSOs are a great resource to create this type of learning for your students. They are also a great resource to showcase your students learning through regional, state, and national competitions. Possible connections for this course include the following. This is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management
- Participate in contests that highlight job skill demonstration; interviewing skills; community service activities, extemporaneous speaking, and job interview
- Participate in leadership activities such as National Leadership and Skills Conference, National Week of Service, 21st Century Skills

For more ideas and information, visit Tennessee SkillsUSA at http://www.tnskillsusa.com and Technology Student Association (TSA): http://www.tntsa.org

Using Work-based Learning in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.2**| Invite an industry rep to discuss safety protocols.
- **Standards 2.1-2.3**| Invite an Professional Engineer to discuss the importance of engineering.
- **Standards 3.1-3.3** | Complete an integrated project with an industry professional.
- **Standards 4.1-4.3** | Visit a work site that uses the equipment and have students see how its operated.
- **Standards 5.1** | Invite a math teacher to discuss measurement.
- **Standards 6.1** |Do a project can be used by a local industry.

For more ideas and information, visit https://www.tn.gov/education/career-and-technical-education/work-based-learning.html.

Course Description

Principles of Engineering and Technology is a foundational course in the STEM cluster for students interested in learning more about careers in engineering and technology. This course covers basic skills required for engineering and technology fields of study. Upon completion of this course, proficient students are able to identify and explain the steps in the engineering design process. They can evaluate an existing engineering design, use fundamental sketching and engineering drawing techniques, complete simple design projects using the engineering design process, and effectively communicate design solutions to others.

Program of Study Application

This is the first course in both the *Engineering* and the *Technology* programs of study. For more information on the benefits and requirements of implementing these programs in full, please visit the STEM website at https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html.

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read and interpret safety rules**, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply.

1.2 Safety Equipment: Identify and explain the **intended use of safety equipment** available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy.

2. Introduction to Engineering & Technology

2.1 STEM Defined: Research the **definition of each term within STEM**: Science, Technology, Engineering, and Mathematics. Use these definitions and additional print and electronic resources (such as textbooks, National Science Teacher Association's STEM Classroom newsletters, or the websites of organizations like *STEM Connector*) to **develop a written argument** describing why science, mathematics, and technology are different than engineering, yet each influences engineering. Incorporate proper citation conventions used in STEM fields (MLA, APA, or other) to cite sources of information retrieved.

2.2 Historical Events: In teams, create an **artifact illustrating important events in history**, in a given time period, that specifically involve engineering. Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable.

2.3 Contributions of Engineering: As a team, develop a written **explanation of how society benefits from the contributions of engineers** in at least three different engineering

disciplines. Provide detailed descriptions of each discipline and describe the specific benefits derived from each. For example, describe how civil engineers improve the efficiency and safety of transportation networks through the construction of bridges, highways, and other public infrastructures. Documents should contain links to relevant websites to illustrate the ideas presented.

3. Engineering Design Process

3.1 Engineering Design Process: There are **different versions of the engineering design process**. For example, examine the following framework endorsed by the International Technology and Engineering Educators Association (ITEEA):

a. Identify the problem
b. Identify criteria and specify constraints
c. Brainstorm possible solutions
d. Research and generate ideas
e. Explore alternative solutions
f. Select an approach
g. Write a design proposal
h. Develop a model or prototype
i. Test and evaluate
j. Refine and improve
k. Create or make a product
l. Communicate results

Citing this framework or other variations as approved by the instructor, compare and contrast what is involved at each step of the engineering design process. Explain why it is an iterative process and always involves refinement.

3.2 Large Scale Engineering Design: In teams, evaluate an existing **large-scale engineering design using the engineering design process**. Produce a report on the chosen design, and assume the role of the engineering design team that produced the design. Document constraints that may have been faced by the design team, criteria for measuring the effectiveness of the design, and progress through each step of the engineering design process. Create and deliver a presentation appropriate for a career and technical student organization (CTSO) event.

3.3 Design Activity: Complete a **simple design activity** and **apply the engineering design process** to produce a model that an engineer would test. Define criteria for determining an effective design, describe **constraints on the design**, and document each step in an engineering notebook. At the completion of the design process, **present the model** to the class and critique the design of other classmates.

4. Fundamental Sketching and Engineering Drawing

4.1 Sketching vs. Drafting: Define the **differences in technique among freehand sketching, manual drafting, and computer-aided drafting** (CAD), and describe the skills required for each. Create a two-dimensional orthographic (multiview) drawing incorporating labels, notes, and dimensions, using sketching/geometric construction techniques. Apply basic

dimensioning rules and properly use different types of lines (e.g., object, hidden, center). The orthographic projections should include principle views of a simple object from top, front, and right sides.

4.2 Isometric Drawings: Building on the knowledge of a two-dimensional drawing, create **simple isometric (3-D pictorial) drawings**, properly using lines (e.g., object, hidden, center), labels, and dimensioning techniques.

4.3 2D and 3D Drawings: Use CAD software to **create simple two-dimensional and three-dimensional drawings,** accurately incorporating labels, notes, dimensioning, and line types to design drawings. Perform basic operations such as creating, saving files, opening files, storing files, and printing.

5. Introduction to Measurement

5.1 Measurement Devices: Use physical **measurement devices typically employed in engineering to collect and build a dataset**. For example, calipers may be used to measure the width of pens in the classroom, generating a dataset. Tools should include, but are not limited to, fractional rule, metric rule, dial caliper, and micrometer.

6. **Class Project**

6.1 Design Process Challenge: As a class, **identify a problem in the school or community that can be solved by an engineer**. Follow the design process to solve the problem. The class will collaboratively develop a paper following the format of a typical technical report (see components of the report below). Upon completion of the report, create and deliver a presentation for a CTSO event using appropriate citation conventions learned in the course. Refine the report as would a team of engineers by incorporating feedback from the presentation.
The technical report should include, but is not limited to:

a) Background
b) Problem definition
c) Design constraints
d) Methodology
e) Data analysis (e.g., charts, graphs, calculations)
f) Results/Problem solution (including engineering drawings)
g) Conclusions and recommendations for future research

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.