

Principles of Engineering and Technology

Level: 2

Career Cluster: Advanced Manufacturing

Program: Engineering

Pathway(s): Engineering

Course Catalog Description

Introduces students to engineering concepts, safety practices, technical communication, and the design process through hands-on exploration of engineered systems and emerging technologies. Students analyze systems, apply problem-solving strategies, and develop collaborative projects that connect engineering skills to real-world applications and postsecondary pathways.

Summary

Provides students with a broad introduction to engineering pathways, professional expectations, and postsecondary opportunities while building foundational skills in safety, tool use, problem solving, technical communication, and engineering design. Through the study of engineered systems and emerging technologies, students examine how mechanical, electrical, and digital components function within complex systems, apply systems thinking and performance analysis, and develop solutions through research, prototyping, testing, and revision. The course also emphasizes collaboration, project management, ethical and professional practices, and culminates in an applied design challenge in which students synthesize their learning to create and present an engineering solution to an authentic problem.

Notes

Compared with the older course version, this updated Principles of Engineering and Technology document reflects a more comprehensive and intentionally organized course design. The previous version emphasized broad introductory competencies such as safety, general STEM awareness, engineering design process steps, and technical sketching, while the new version expands those ideas into clearly defined sections with objectives and sequenced student outcomes. New updates include stronger emphasis on engineered systems, systems thinking, testing and performance analysis, technical communication, collaboration and project management, and an applied engineering design project that culminates in authentic problem solving and presentation. The revised course also adds dedicated sections for leadership and work-based learning, strengthening connections to employability, postsecondary readiness, and real-world industry experiences. Overall, this version shifts from a basic introductory outline to a more structured, pathway-aligned course that better supports depth of learning, career readiness, and instructional planning.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in engineering by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

- 1) Identify employment opportunities in various fields with a focus in the area of engineering
 - a. Recognize the work typically performed, tools and technology used, and nature of work environments
 - b. Identify potential certifications within the careers
 - c. Find membership organizations associated with the careers
 - d. Understand the necessary education associated within the careers
- 2) Define professionalism within the context of engineering
 - a. Criticism and evaluation
 - b. Presentation
 - c. Assessment
- 3) Recognize laws, regulations, and ethics significant to the fields of engineering
- 4) Identify postsecondary opportunities offered in the state of Colorado
 - a. Technical college, community college, 4-year institutions
 - b. Certificates, associates, bachelor, and advanced degree opportunities

2. Safety, Tools, and Engineering Habits of Practice

Objective: *Students will demonstrate safe behaviors, apply classroom and lab procedures, and use tools and materials responsibly in engineering and technology learning environments.*

- 5) Identify classroom, lab, and equipment safety rules related to engineering and technology spaces.
- 6) Explain the purpose and proper use of safety equipment and protective procedures.
- 7) Demonstrate safe operating procedures when handling tools, devices, and classroom technologies.
- 8) Apply safety protocols consistently during design, prototyping, testing, and cleanup.
- 9) Inspect tools and equipment to determine whether they are safe and ready for use.
- 10) Analyze common safety risks in engineering labs and propose strategies to reduce those risks.
- 11) Evaluate personal and team work habits for adherence to safety expectations.

3. Engineering Design Process and Problem Solving

Objective: *Students will apply the engineering design process to define problems, generate solutions, test prototypes, and improve designs.*

- 12) Describe the stages of the engineering design process and the purpose of each stage.
- 13) Compare and contrast the engineering design process with the scientific method.
- 14) Define a design problem using criteria and constraints.
- 15) Generate multiple solution ideas through brainstorming, sketching, and ideation methods.

- 16) Select design solutions based on evidence, trade-offs, and feasibility.
- 17) Construct simple prototypes to test design ideas.
- 18) Measure performance data during testing and record findings accurately.
- 19) Analyze test results to determine strengths, weaknesses, and necessary improvements.
- 20) Revise designs based on feedback, data, and iterative testing.
- 21) Justify final design decisions using evidence from the design process.

4. Technical Sketching, Modeling, and Engineering Communication

Objective: *Students will create and communicate technical ideas using sketches, drawings, models, and engineering documentation.*

- 22) Create technical sketches to communicate engineering ideas clearly.
- 23) Interpret basic engineering drawings, diagrams, and visual models.
- 24) Use appropriate technical vocabulary when discussing designs and systems.
- 25) Produce engineering documentation such as design briefs, notebooks, plans, and portfolios.
- 26) Organize design evidence and project artifacts in a clear and professional format.
- 27) Develop written and visual explanations for engineering solutions.
- 28) Present design processes and outcomes to peers, instructors, or authentic audiences.
- 29) Evaluate the clarity and effectiveness of technical communication products.

5. Foundations of Engineered Systems and Emerging Technologies

Objective: *Students will explain how engineered systems operate and examine the components, functions, and real-world applications of emerging technologies.*

- 30) Identify the major components of an engineered system, including structural, mechanical, electrical, control, and sensor elements.
- 31) Describe how mechanical, electrical, and digital subsystems interact within an engineered product or technology.
- 32) Explain how control, feedback, and system integration support the function of engineered technologies.
- 33) Classify different types of engineered systems based on purpose, design, and use case.
- 34) Investigate real-world applications of emerging technologies in fields such as manufacturing, transportation, infrastructure, energy, healthcare, and communications.
- 35) Analyze how materials, power, environmental conditions, and design choices affect system performance.
- 36) Evaluate the benefits and limitations of emerging technologies in solving real-world problems.
- 37) Discuss legal, ethical, and privacy considerations associated with the use of emerging technologies.

6. Systems Thinking, Testing, and Performance Analysis

Objective: *Students will analyze engineered systems, interpret data, and evaluate how system components affect overall performance.*

- 38) Describe an engineering product or technology as a system composed of interdependent parts.

- 39) Analyze how changes to one component can impact the performance of the full system.
- 40) Collect and organize data from tests, trials, or simulations.
- 41) Interpret qualitative and quantitative data to determine system effectiveness.
- 42) Compare multiple design solutions using performance criteria.
- 43) Diagnose design flaws or system failures using evidence from testing.
- 44) Recommend modifications that improve efficiency, function, reliability, or safety.
- 45) Evaluate whether a final product meets project criteria and constraints.

7. Collaboration, Project Management, and Professional Skills

Objective: *Students will collaborate effectively, manage projects responsibly, and demonstrate professional behaviors used in engineering environments.*

- 46) Demonstrate effective teamwork and respectful communication during collaborative design work.
- 47) Assign roles and responsibilities within a project team.
- 48) Develop project timelines and action plans that support successful completion of tasks.
- 49) Monitor progress toward project milestones and deadlines.
- 50) Use feedback from peers and instructors to improve products and processes.
- 51) Resolve design disagreements and team challenges using evidence-based decision-making.
- 52) Demonstrate accountability, persistence, and adaptability throughout the design process.
- 53) Reflect on individual contributions and growth in professional skills.

8. Applied Engineering Design Project

Objective: *Students will synthesize course knowledge to design, test, refine, and present an engineering solution to an authentic problem.*

- 54) Define an authentic engineering problem or design challenge.
- 55) Research user needs, criteria, constraints, and technical considerations relevant to the challenge.
- 56) Develop multiple design concepts and select a preferred solution.
- 57) Construct a prototype, model, simulation, or design representation.
- 58) Test the proposed solution using established criteria and collected evidence.
- 59) Analyze results and revise the design to improve performance.
- 60) Compile a portfolio of design artifacts, notes, data, and reflections.
- 61) Deliver a formal presentation that explains the problem, process, solution, evidence, and recommendations.
- 62) Defend design decisions using technical reasoning and supporting data.

9. Leadership

Objective: *Students will develop leadership knowledge and skills by demonstrating responsibility, initiative, communication, collaboration, ethical decision-making, and participation in activities that support personal growth, team success, and career readiness.*

- 63) Demonstrate responsibility, initiative, and dependability in individual and team settings.
- 64) Apply effective communication skills when leading discussions, presenting ideas, and collaborating with others.

- 65) Practice ethical decision-making and demonstrate integrity in academic, project, and workplace-related situations.
- 66) Set personal, academic, and career goals and reflect on progress toward achieving them.
- 67) Demonstrate leadership skills by facilitating teamwork, encouraging participation, and supporting group success.

10. Work-Based Learning

Objective: *Students will engage in work-based learning experiences that connect classroom knowledge to real-world applications by exploring careers, interacting with industry professionals, practicing employability skills, and reflecting on how workplace experiences inform future education and career goals.*

- 68) Identify the purpose and value of work-based learning experiences such as job shadows, internships, clinical experiences, school-based enterprises, or industry projects.
- 69) Demonstrate professional behaviors and employability skills during authentic workplace experiences.
- 70) Interact appropriately with industry professionals, mentors, or community partners using professional communication and workplace etiquette.
- 71) Connect work-based learning experiences to classroom content, technical skills, and career pathway goals.
- 72) Reflect on workplace experiences to evaluate personal strengths, areas for growth, and next steps for education or career planning.

11. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

[CO CTE Academic Standards Resources](#) (Rubrics, integration strategies, etc)
[CDE Colorado Academic Standards Online](#) (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the [Colorado Academic Standards](#) page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Principles of Engineering and Technology

Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders.	Engineering team projects, defined team roles, and collaborative problem-solving/design reviews.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences.	Students communicate design solutions, present engineering concepts/results, and explain technical decisions.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts.	Students read and interpret technical engineering texts, safety documentation, and design specifications.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts.	Students use discipline-specific engineering vocabulary and professional technical language.

Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational and explanatory texts.	Students produce engineering documentation, design briefs, and explanations of processes/results.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process.	The course requires drafting, revising, refining, and producing polished engineering documents.
Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources.	Students research engineering concepts, evaluate data/constraints, and apply findings to design challenges.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Engineering Career Explorer O NET Online (engineering careers job outlook skills pathways)
<https://www.onetonline.org>
- Explore STEM Careers NASA STEM (STEM careers engineering workforce pathways)
<https://www.nasa.gov/stem>
- Career Planning Tools CareerOneStop (career exploration certifications education pathways)
<https://www.careeronestop.org>
- Engineering Pathways TryEngineering (engineering careers student exploration professional organizations)
<https://tryengineering.org>

2. Safety, Tools, and Engineering Habits of Practice

- OSHA Workplace Safety OSHA (safety standards hazard prevention workplace safety)
<https://www.osha.gov>
- Engineering Lab Safety Flinn Scientific (lab safety procedures equipment safe use)
<https://www.flinnsci.com>
- Safety Training Resources CareerSafe (workplace safety training risk management OSHA basics)
<https://www.careersafeonline.com>
- Lab Safety Guidelines Science Buddies (lab safety practices engineering classroom safety)
<https://www.sciencebuddies.org>

3. Engineering Design Process and Problem Solving

- Engineering Design Process NASA STEM (engineering design steps problem solving iteration)
<https://www.nasa.gov/stem/engineering-design-process>
- Design Thinking Toolkit IDEO Design Kit (design thinking ideation prototyping problem solving)
<https://www.designkit.org>
- TeachEngineering Design Lessons (engineering design activities projects problem solving)
<https://www.teachengineering.org>
- Engineering Design Overview Science Buddies (design process criteria constraints testing iteration)
<https://www.sciencebuddies.org>

4. Technical Sketching, Modeling, and Engineering Communication

- Engineering Drawing Basics Engineering Toolbox (technical drawing sketching communication conventions)
<https://www.engineeringtoolbox.com>

- Technical Sketching Tutorials YouTube Learn Engineering (technical sketching visualization communication skills)
<https://www.youtube.com/c/LearnEngineering>
- Technical Writing Resources Purdue OWL (technical writing reports engineering communication)
<https://owl.purdue.edu>
- Engineering Notebook Guide Science Buddies (engineering notebook documentation design process communication)
<https://www.sciencebuddies.org>

5. Foundations of Engineered Systems and Emerging Technologies

- Engineering Systems Overview MIT OpenCourseWare (engineered systems mechanical electrical digital systems)
<https://ocw.mit.edu>
- Emerging Technologies NASA Technology Transfer (emerging technologies engineering innovation applications)
<https://technology.nasa.gov>
- Engineering Systems Basics Engineering Toolbox (systems components functions engineering applications)
<https://www.engineeringtoolbox.com>
- Technology Applications TeachEngineering (engineering systems real world applications emerging technologies)
<https://www.teachengineering.org>

6. Systems Thinking, Testing, and Performance Analysis

- Systems Thinking Resources Waters Center for Systems Thinking (systems thinking feedback loops engineering systems)
<https://waterscenterst.org>
- Data Analysis Tools CODAP (data analysis visualization engineering testing data interpretation)
<https://codap.concord.org>
- Engineering Simulation PhET Interactive Simulations (simulation testing analysis engineering concepts)
<https://phet.colorado.edu>
- Performance Testing Resources Science Buddies (testing data collection engineering performance analysis)
<https://www.sciencebuddies.org>

7. Collaboration, Project Management, and Professional Skills

- Project Management Basics Project Management Institute PMI (project management teamwork planning execution)
<https://www.pmi.org>
- Collaboration Skills SkillsYouNeed (teamwork communication professional skills collaboration)
<https://www.skillsyouneed.com>

- Project Planning Tools Smartsheet (project planning scheduling task management engineering projects)
<https://www.smartsheet.com/project-management>
- Workplace Skills Resources CareerOneStop (professional skills communication teamwork employability)
<https://www.careeronestop.org>

8. Applied Engineering Design Project

- Engineering Design Challenge Resources TeachEngineering (engineering challenges project based learning design application)
<https://www.teachengineering.org>
- Prototyping Resources Autodesk Education (CAD prototyping modeling design solutions)
<https://www.autodesk.com/education>
- CAD Modeling Platform Tinkercad (3D modeling prototyping engineering design tools)
<https://www.tinkercad.com>
- Engineering Project Ideas Science Buddies (engineering design challenges project ideas testing solutions)
<https://www.sciencebuddies.org>

9. Leadership

- Overcoming Obstacles (communication decision making goal setting leadership skills)
<https://www.overcomingobstacles.org/>
- Lead4Change (student leadership empathy teamwork communication service learning)
<https://lead4change.org/>
- National Youth Leadership Council Resource Library (student leadership youth voice service learning leadership development)
<https://nylc.org/resource-library/>
- Wharton Global Youth Program Teamwork and Communication (teamwork communication leadership roles collaboration lesson)
https://globalyouth.wharton.upenn.edu/wp-content/uploads/lesson_plans/teamwork-and-communication.pdf

10. Work-Based Learning

- Chicago Public Schools Work Based Learning Toolkit (job shadow internship site visit career day employer engagement)
<https://www.cps.edu/academics/work-based-learning/toolkit/>
- Oregon State University Job Shadows (job shadow career exploration workplace observation professional questions)
<https://career.oregonstate.edu/explore-careers/job-shadows>
- Great Plains Technology Center Work Based Learning (work based learning internships apprenticeships mentoring career preparation)
<https://www.greatplains.edu/wbl>



Technology Student Association – National Competitive Events

Prepared Presentation

Objective: *Students will prepare and deliver an oral presentation with a digital slide deck on a contemporary STEM topic aligned with TSA Prepared Presentation competition requirements.*

- Research the annual TSA Prepared Presentation theme and connect it to science, technology, engineering, or mathematics.
- Develop a focused presentation that clearly communicates a central message related to the annual theme.
- Create a digital slide deck that enhances the presentation without distracting from the speaker.
- Organize content into a clear introduction, body, and conclusion.
- Practice professional speaking skills, including pacing, eye contact, vocal delivery, and transitions.
- Deliver the presentation within the required three-to-five-minute time limit.
- Evaluate presentations using TSA criteria for content, organization, delivery, slide deck quality, and connection to the theme.

Resources

- Technology Student Association – Prepared Presentation competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- National Speech & Debate Association – Public speaking resources
<https://www.speechanddebate.org/>
- Canva – Presentation design tools
<https://www.canva.com/>
- Google Slides – Digital slide deck creation
<https://www.google.com/slides/about/>



Technology Student Association – National Competitive Events

Technology Bowl

Objective: Students will build broad knowledge of TSA, STEM concepts, technology standards, and engineering-related content to compete in the TSA Technology Bowl written test and team question/response format.

- Study TSA history, competitive events, leadership concepts, and technology-content standards.
- Build foundational knowledge across science, technology, engineering, and mathematics topics.
- Work as a three-person team to prepare for individual testing and team-based competition.
- Complete practice questions that require accuracy, recall, reasoning, and quick decision-making.
- Analyze missed questions to identify gaps in technology, engineering, and TSA knowledge.
- Practice head-to-head question/response procedures for semifinal-style competition.
- Evaluate team performance using accuracy, collaboration, preparation, and communication criteria.

Resources

- Technology Student Association – Technology Bowl competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- Technology Student Association – About TSA
<https://tsaweb.org/about>
- Standards for Technological and Engineering Literacy
<https://www.iteea.org/stel.aspx>
- Khan Academy – Science and engineering foundations
<https://www.khanacademy.org/science>



Technology Student Association – National Competitive Events

Biotechnology Design

Objective: *Students will research, design, document, and present a biotechnology solution that addresses the annual TSA Biotechnology Design challenge through an interactive display, documentation portfolio, and presentation/interview.*

- Research the annual TSA Biotechnology Design theme and define the biotechnology problem, need, or issue being addressed.
- Investigate possible biotechnology solutions and explain why the selected solution is more effective than alternatives.
- Apply the engineering design process to plan, model, test, revise, and communicate the proposed biotechnology solution.
- Create an interactive display that clearly explains the problem, solution, supporting information, and environmental, economic, social, or ethical impacts.
- Prepare a documentation portfolio that includes the problem definition, selected solution, rejected alternatives, real-life applications, sketches, graphs, logs, images, multimedia printouts, work log, and cited resources.
- Develop a multimedia presentation that supports the display and helps communicate the design solution to judges.
- Present and defend the biotechnology solution during the semifinal presentation/interview using TSA criteria for communication, creativity, documentation, display quality, and technical understanding.

Resources

- Technology Student Association – Biotechnology Design competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- National Human Genome Research Institute – Biotechnology resources
<https://www.genome.gov/>
- National Center for Biotechnology Information – Science and biotechnology resources
<https://www.ncbi.nlm.nih.gov/>
- BioBuilder Educational Foundation – Biotechnology design and synthetic biology learning resources
<https://biobuilder.org/>