TN Department of Education | College, Career and Technical Education

May 2025

Career Cluster:

Architecture and Construction

Architectural & Engineering Design I

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H13
Prerequisite(s):	None
Primary Career Cluster:	**Architecture & Construction**
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H13
Prerequisite(s):	None
Credit:	1
Grade Level:	9
Elective Focus -Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 *Architectural & Engineering Design* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ 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/educators/career-and-technical-education/work-based-learning.html. .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	070, 157, 230, 470, 477, 531, 551, 552, 553, 554, 555, 556, 584, 585, 595, 596, 700, 705, 740, 760, 982, or any other Occupational License endorsement with ADDA certified drafter or Autodesk certification

Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Architectural Drafting, and Engineering Technology/Design.

Using Work-Based Learning (WBL) 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 2.1-2.4** | Invite a guest speaker.
- **Standard 3.1** | Have students participate in a workplace tour.
- **Standards 7.1-7.3** | Ask an industry representative to discuss why measurement and math are so important for the job.
- **Standard 8.1** | Have the students complete a project that is useful to a local employer. Ask the manager to help evaluate the projects.

Course Description

Architectural & Engineering Design I is a foundational course in the Architecture & Construction cluster for students interested in a variety of engineering and design professions. Upon completion of this course, proficient students will be able to create technical drawings of increasing complexity and utilize these skills to complete the design process and communicate project outcomes. Students will build foundational skills in freehand sketching, fundamental technical drawing, and related measurement and math. Standards in this course also include career exploration within the technical design industry, as well as an overview of the history and impact of architecture and engineering. In addition, students will begin compiling artifacts for inclusion in a portfolio, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Rules: Accurately read, interpret, and demonstrate adherence to **safety rules**, including but not limited to rules published by the Occupational Safety and Health Administration (OSHA), 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. Demonstrate how to properly inspect, use, and maintain **safe operating procedures** with tools and equipment**.** Incorporate safety procedures and complete safety tests with 100 percent accuracy.

2. Introduction to Architecture & Engineering Design

2.1 History of Architecture and Engineering: Investigate the **history and evolution of architecture and engineering** across a variety of civilizations. Identify **major innovations**, such as technological advances in materials or construction processes.

2.2 Contributions of Architects or Engineers: Research and summarize the **influences and contributions of a selected architect or engineer** giving **examples of the individual's completed work** to illustrate their impact on society.

2.3 Impact of Architects and Engineers: Investigate the **social, economic, and environmental impact of decisions** made by architects and engineers at the local, national, and global levels. Provide a detailed **description of the impacts of a specific discipline** citing links to relevant websites to illustrate the ideas presented.

2.4 Sustainable Design: Research the **principles of sustainable design**. Examine an **energy-efficient building** and determine whether the principles of sustainable design are illustrated in the design of the building. Assess whether the evidence presented is strong enough to support claims of sustainability.

3. Career Exploration

3.1 Professions in Architecture and Engineering: Research the **major professions in architecture and engineering**, such as civil engineering, mechanical engineering, industrial engineering, electrical engineering, engineering technician, architecture, and more. Cite supporting evidence from multiple sources, such as interviews with design professionals retrieved from industry magazines. Analyze career options in architecture and engineering.

3.2 Career Opportunities: Compile and analyze **real-time and projected labor market data** from public sources such as the U.S. Bureau of Labor Statistics to investigate **local and regional occupational opportunities and trends in architectural and engineering careers**. Analyze collected data comparing occupations by job availability, salaries, and benefits.

3.3 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSOs**, SkillsUSA and Technology Student Association, through an interactive activity, such as a classroom competition.

4. Design Process

4.1 Design Process: Research **design processes used by architects and engineers.** Drawing on multiple resources, examine **the steps to the design process,** synthesizing a range of perspectives on the process as practiced in a variety of architectural and engineering disciplines. Explain **why it is an iterative process** and always involves refinement.

4.2 Evaluate a Design: Evaluate an **existing design created by architects and/or engineers** using the design process such as a building, landscape, bridge, or product. Describe how the design team likely **progressed through each step of the design process** citing examples from design magazines and other resources. Examples should include design constraints encountered by the design team and criteria for measuring the effectiveness of the design.

5. Sketching

5.1 Use of sketching: Investigate the **use of sketching in the creative design process**. Drawing from resources, **explain the tools and techniques** used and when architects and engineers apply sketching in the design process.

5.2 Freehand Sketches: Create **freehand sketches**, including rough and refined sketches, demonstrating **techniques for sketching freehand lines and circles** while attending to **accurate proportions**. Produce **pictorial sketches** applying shading techniques. Simulate sketching techniques used by engineers and architects on job sites. Utilize **hand lettering techniques** to neatly add notes to the sketches.

5.3 Sketching Developing Design Concept: Develop **conceptual design ideas** using freehand sketching. For example, for a given design problem, generate, analyze, and refine sketches to develop **design solutions**. Create refined drawings based on sketches of a chosen design.

6. Fundamental Technical Drawing

6.1 Geometric Constructions: Interpret a **technical narrative** to understand the steps and tools needed to create **geometric constructions** such as bisecting a line, angle, or arc; using lines, circles, and arcs to draw a polygon such as a pentagon or hexagon; and constructing tangent and perpendicular relationships. Use geometric terms, illustrations, and supporting texts to describe the **steps of creating a geometric construction** with accuracy.

6.2 Single-View Drawings: Create accurate **manual single-view scale drawings** of advancing complexity, incorporating **symbols, notes, and dimensions**, using **appropriate layouts** within title blocks, drawing composition (including **line weight and line type**), **geometric construction techniques,** and **lettering techniques.**

6.3 Dimensioning Rules: Interpret and apply **dimensioning rules** to accurately **label dimensions** on drawings, including arranging dimensions using various **dimension styles** (such as aligned and angular) and avoiding redundancy.

6.4 Multi-View Drawings: Create accurate **multi-view scale drawings** of objects of advancing complexity using **orthographic projection**. Incorporate **symbols, notes, dimensions**, and **different types of lines**, such as hidden lines to show internal or hidden features. Demonstrate **procedures to establish a principal view of an object and project** from an existing view to create additional views.

6.5 Isometric Drawings: Building on the **knowledge of a single-view and multi-view drawing**, create **simple isometric drawings**, properly using **lines, labels, and dimensioning techniques.**

6.6 Computer-Aided Drawings (CAD): Interpret instructional material to use **CAD software** to create simple two-dimensional drawings, accurately incorporating symbols, dimensioning, and line types. Instructional material may include textbooks, manuals, websites, video tutorials, and more. Perform **basic operations** such as creating files, saving files, opening files, storing files, and printing. Set up the drawing environment by inserting title blocks, applying settings (ortho, snap, etc.), and assigning line weights, line types, and colors.

6.7 Comparing Techniques: Define the **differences in technique** among freehand sketching, manual drafting, and computer-aided drafting (CAD). Describe the **skills required** for each and **how each type is used** in the industry, citing specific examples.

6.8 Refine Drawings: Demonstrate the ability to **refine drawings based on critique** from peers, instructors, and self-evaluation.

7. Measurement and Math

7.1 Math: Apply **mathematics concepts to create drawings and solve design problems** in this course distinguishing which principles apply to a given design problem. Concepts should include, but are not limited to the following:

a. determining and applying the equivalence between fractions and decimals. For example, convert a decimal to a fraction to prepare a unit for measurement on a fractional scale to the precision of 1/16 of an inch;
b. working with units such as feet, inches, meters, centimeters, and millimeters, and determining appropriate units for a given construction task. For example, convert a dimension from centimeters to inches;
c. calculating perimeter, area, volume, and surface areas of objects employing related geometric terminology;
d. performing proportionate reasoning to estimate quantities, such as determining the appropriate scale for a drawing and a given sheet size; and
e. using basic rules of right triangles, such as the Pythagorean Theorem, to find missing lengths.

7.2 Measurement: Use **customary and metric measurement systems** to complete accurate **field measurements**. Determine the **appropriate units** and record accurate measurements of lengths and angles using **proper tools.** Tools should include but are not limited to fractional rule, metric rule, measuring tape, architect's scale, engineer's scale, dial caliper, and protractor.

7.3 Measurement in Drawings: Use **field measurements** to **create a drawing** accurately representing the **true layout**. For example, create a **scale drawing** of a simple mechanical device by taking field measurements of the device determining the appropriate scale, and using an engineer's scale to accurately draw the device.

8. Data Analysis and Artificial Development

8.1 Data Analysis in Architecture and Construction: **Research the use of data** in the architecture and construction career fields. Include data that is generated internally by businesses and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:

a. customer/client use of architectural products and services;
b. demographics of end users of architects;
c. community, state, and national statistics related to architects; and
d. data that must be reported to another construction activity.

8.2 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal impact of AI technologies** while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

9. Projects

9.1 Create Drawings: Use the design process to **create a solution for a given design problem**, selecting and creating appropriate drawings to explain the solution, including sketches and multiple views of two-dimensional scale drawings.

9.2 Course Project: Outline the creation of an **innovative product or architectural solution** utilizing math and measurement standards to solve a problem in school. Using the Engineering Design Process, outline the necessary steps for a product or architectural solution. For example, develop a digital storyboard. Document the design process to be added to a digital portfolio in a format such as an engineering design notebook.

10. Portfolio

10.1 Portfolio: Compile materials from coursework to **create a portfolio** connecting personal career preparation to concepts learned in this course including written descriptions of drawing types and learning outcomes. Continually review and revise documents using technology as needed.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - 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.

Architectural & Engineering Design II

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H14
Prerequisites:	*Architectural & Engineering Design I* (C17H13), *Algebra I* (G02X02, G02H00)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 second course in the *Architectural & Engineering Design* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ 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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	070, 157, 230, 470, 477, 531, 551, 552, 553, 554, 555, 556, 584, 585, 595, 596, 700, 705, 740, 760, 982, or any other Occupational License endorsement with ADDA certified drafter or Autodesk certification
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

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Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Architectural Drafting, and Engineering Technology/Design.

Using Work-Based Learning (WBL) 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.

- **Standard 2.1** | Invite a guest speaker.
- **Standards 3.1-3.8 |** Ask an industry representative to discuss the importance of technical drawing on the job.
- **Standard 5.1** | Invite a guest speaker.
- **Standards 6.1-6.4** | Complete an integrated project with a professional.
- **Standards 8.1-8.2** | Complete a project that is useful to a local employer or can be evaluated by the manager.

Course Description

Architectural & Engineering Design II is the second course in the *Architectural & Engineering Design* program of study. Students in this course build their skills in developing and representing design ideas using technical drawing and modeling techniques and apply the design process to solve design problems. Upon completion of this course, proficient students will be able to use computer-aided drafting (CAD) software to create multi-view, sectional view, auxiliary view, and three-dimensional drawings using industry-standard dimensioning and notation. Students will connect drawings with actual physical layouts by building models based on drawings, creating drawings based on objects and other physical layouts, and using software to create basic three-dimensional models. In addition, students will continue compiling artifacts for inclusion in a portfolio, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Rules: Accurately read, interpret, and demonstrate **adherence to safety rules**, including but not limited to rules published by the Occupational Safety and Health Administration (OSHA), 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. 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. Career Exploration

2.1 Postsecondary Options: Research **postsecondary institutions** (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer architecture or engineering programs. Evaluate the tentative career plan developed in the introductory course and **update the career plan** to reflect any new discoveries citing evidence from the research.

3. Advanced Technical Drawing

3.1 Two-Dimensional Drawings: Use **computer-aided drafting (CAD) software** to create **two-dimensional drawings** of advancing complexity, accurately incorporating symbols, notes, dimensioning, and line types to design drawings. Perform **software operations,** such as utilizing sheets/layouts for printing, scaling viewports in sheets/layouts for printing, printing drawings to proper scale, outputting drawings to electronic and paper media, and overlaying drawings on externally referenced drawings.

3.2 Multi-View Drawings: Use **CAD software** to create accurate **multi-view drawings** of objects of advancing complexity using **orthographic projection**, incorporating symbols, notes, dimensions, and line type, such as hidden lines to show internal or hidden features.

3.3 Pictorial Drawings: Use CAD software to create **pictorial drawings** of advancing complexity, such as **isometric, oblique, and perspective** drawings. Attend to detail by using proper angles and ensuring holes, cylinders, prisms, and other features are in proper alignment and relationship to each other. Incorporate **symbols, notes, dimensions, and line types** according to industry standards.

3.4 Sectional View Drawings: Create accurate **sectional view drawings** of advancing complexity (such as full, half, offset, broken-out, removed, and revolved sections), incorporating **symbols, notes, and dimensions**, using **appropriate layout** within title blocks, and **appropriate drawing composition**, including line weight and line type.

3.5 Auxiliary View Drawings: Create accurate **auxiliary view drawings** of advancing complexity, including depth, height, or width auxiliary views; partial auxiliary views; and auxiliary section views.

3.6 Drawings of Threads and Fasteners: Draw **detailed, schematic, and simplified drawings** of various **types of threads and fasteners**, including unified, square, and acme threads. Demonstrate the ability to accurately interpret **industry-standard thread notes** to calculate the **thread pitch** as well as layout and construct the drawing.

3.7 Set of Project Drawings: Produce a **complete set of project drawings** including a **completed assembly drawing** and an **exploded assembly drawing**. Supplement assembly drawings with appropriate representations of individual components and a **bill of materials** as needed for the project type. Fully describe the design by selecting the most **appropriate drawing type** for the given component, including **plan**, **section**, and **three-dimensional drawings**.

3.8 Refine Drawings: Demonstrate the ability to **refine drawings based on critique** from peers, instructors, and self-evaluation. Drawing on evidence from textbooks and other resources, evaluate the **effectiveness of a drawing** based on industry standards for technical drawing. Interpret and incorporate feedback when refining drawings.

4. Dimensioning

4.1 Annotate Drawings: Interpret **industry standards** to accurately apply **dimensions, notes, and symbols on CAD drawings**, including arranging dimensions, using various dimension styles and symbols, and avoiding redundancy. Demonstrate the ability to adjust **annotation styles and sizes** based on the drawing type and scale. Define **tolerance** and give examples of general **methods for noting tolerances** on drawings.

4.2 American National Standards Institute: Research the **American National Standards Institute** (ANSI) and describe the **goals of the organization** and the **impact it has on technical drawing,** particularly for dimensioning a drawing.

5. Introduction to Three-Dimensional Modeling

5.1 Three-Dimensional Modeling: Use **three-dimensional modeling software** to create a **simple three-dimensional mode**l. Interpret **instructional materials** to perform basic operations using three-dimensional modeling software. Instructional materials may include textbooks, instructional manuals, websites, video tutorials, and more.

6. Applications of Technical Drawing

6.1 Physical Model: Interpret **technical drawings** to build a **physical model** of a design. Select and use the **appropriate materials and tools** to safely measure components and construct the model. Upon completion, use the **technical drawings** to check the model for accuracy.

6.2 Use Field Measurements: Building on **techniques practiced in the introductory course,** continue to measure, record, and use field measurements to create **drawings of increasingly complex objects and layouts**. For example, create an accurate half-section drawing of an actual mechanical gear by measuring and examining the physical object to visualize and draw the section.

6.3 Three-Dimensional Model: Create **two-dimensional plans for a simple three-dimensional object** utilizing **drawing techniques** learned in the course, such as auxiliary drawing. Use the plans to build a **rough study model of the object**. Evaluate the model and revise the design based on collected test data. For example, create a two-dimensional drawing of a three-dimensional sheet metal design or package design as if the object were unfolded. Print the drawing on paper and construct a paper model of the object. Evaluate the model for inaccuracies and **identify opportunities to improve** the efficiency of materials or construction. Use these conclusions to **refine the design**.

6.4 Drawing and Model Comparisons: Understand **how designs are communicated** through different types of **two-dimensional** and **three-dimensional drawings**, **physical models,** and **virtual three-dimensional models** within various disciplines, such as architectural, civil, mechanical, electrical, and industrial design. Interpret symbols and notations within the context of each type.

7. Technology

7.1 Troubleshooting: Identify and demonstrate **basic troubleshooting strategies related to fundamental hardware and software problems**. Evaluate electronic media to diagnose and fix hardware and software problems encountered during the coursework. For example, consult software forums, tutorial videos, and other instructional materials to diagnose and correct a drawing that prints on paper differently than intended.

7.2 Impact of Technology: Explain **how technology has changed design** throughout history and identify **current transitions occurring in design media, technique, and focus**.

7.3 Emerging Technology: Identify and explain the implications of **emerging trends in technology** related to architectural hardware and software.

8. Projects

8.1 Project Plan: Develop a **project plan** and use the design process to create a solution for **moderately complex problem sets** utilizing both simple three-dimensional modeling techniques and detailed technical two-dimensional and three-dimensional scale drawings.

8.2 Alternate Designs: Choose between **alternate design solutions for a given design problem** and justify the choices. Demonstrate the ability to **pitch the idea** to the client in a presentation defending the design by pointing to specific features that meet the client's specifications.

8.3 Portfolio: Update **materials from coursework to add to the portfolio** that began in the introductory course. Continually reflect on coursework experiences, revise, and refine the career plan generated in the introductory course. Include written descriptions of drawing types and learning outcomes.

9. Data Analysis

9.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an **engineering design notebook** for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constratints such as cost, efficiency, and enviromental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital prsesentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentaion and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

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Architectural & Engineering Design III

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H10
Prerequisite(s):	*Architectural & Engineering Design II* (C17H14)*, Geometry* (G02X03, G02H11)
Credit:	1-2 credits (see Recommended Credit below)
Grade Level:	11-12
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 third course in the *Architectural & Engineering Design* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
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Teacher Endorsement(s):	070, 157, 230, 470, 477, 531, 551, 552, 553, 554, 555, 556, 584, 585, 595, 596, 700, 705, 740, 760, 982, or any other Occupational License endorsement with ADDA certified drafter or Autodesk certification
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

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- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Architectural Drafting, and Engineering Technology/Design.

Using Work-based Learning (WB) 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 2.1-2.8** | Complete an integrated project with a design professional.
- **Standards 3.1-3.5 |** Complete an integrated project with a mechanical professional.
- **Standards 4.1-5.3** | Complete a project useful to a local employer and have the manager help evaluate it.
- **Standards 6.1-6.3** | Ask an industry manager to talk about project management on the job.

Course Description

Architectural & Engineering Design III is the third course in the *Architectural & Engineering Design* program of study. In this advanced course, students will apply technical drawing and design skills developed in the previous courses to specific architectural and mechanical design projects and contexts. In the process, students will expand their problem-solving and critical-thinking skills by assessing the requirements of a project alongside the available resources to accomplish realistic planning. Upon completion of this course, proficient students will be able to employ methods of data collection and analysis to provide others with appropriate information for projects and to develop their designs. Students will also be able to engage with industry-specific technology to create visual representations of project outcomes. In addition, students will continue compiling artifacts for inclusion in a portfolio, which they will carry with them throughout the full sequence of courses in this program of study.

Recommended Credit

If all standards in the course are covered, the course is recommended for two credits. If only one credit is to be offered, the following two options are recommended:

1 Credit- Option A

Content	Standards
Safety	1.1, 1.2
Architectural Design	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8
Research Project	4.1
Design Project	5.1, 5.2, 5.3
Project Management	6.1, 6.2, 6.3
Portfolio	7.1

1 Credit- Option B

Content	Standards
Safety	1.1, 1.2
Mechanical Design	3.1, 3.2, 3.3, 3.4, 3.5
Research Project	4.1
Design Project	5.1, 5.2, 5.3
Project Management	6.1, 6.2, 6.3
Portfolio	7.1

Course Standards

1. Safety

1.1 Safety Rules: Accurately read, interpret, and demonstrate adherence to **safety rules**, including but not limited to rules published by the **Occupational Safety and Health Administration (OSHA)**, 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. Demonstrate how to properly **inspect, use, and maintain safe operating procedures** with tools and equipment. **Incorporate safety procedures** and complete the safety test with 100 percent accuracy.

2. Architectural Design

2.1 Civil Drawings: Interpret **civil drawings used to describe a site**, including recognizing **symbols** used to describe topography. For example, in teams, interpret a topographic survey drawing to construct a model (physical or virtual) of a building site. Use the model to influence **the design of the building** and the **building's placement** on the site.

2.2 Site Analysis: Perform a **site analysis** to make **design decisions for a building plan**, including interpreting existing site conditions and evaluating site surroundings. Determine the impact **environmental factors** such as climate, wind patterns, and the movement of the sun have on the design and site placement of the building. Summarize site analysis findings with drawings and supporting text.

2.3 Design Constraints: Synthesize the various **constraints affecting a building's design** to make and justify **design decisions.** Items to consider should include the following:

a. evaluating the building's program based on client needs. For example, appraise the requirements of the client such as total square footage and list of desired features (number of bedrooms, bathrooms, etc.);
b. accommodating the needs of people of all ages and physical abilities in compliance with the Americans with Disabilities Act (ADA); and
c. interpreting applicable building codes based on the project type. For example, determine the minimum number and spacing of exit doors for a given building occupancy size.

2.4 Planning and Diagramming Techniques: Research **planning and diagramming techniques** used by designers. Implement planning and diagramming techniques such **as bubble diagrams** and **traffic flow patterns** to design a **schematic site plan and floor plan** for a given building program.

2.5 Building Model: Create a **properly scaled model of a building** (physical or virtual) and study the model **in the context of the site layout**. Present the model along with supporting sketches and diagrams to an audience (such as the instructor and peers), explaining and **justifying design ideas** in a logical, coherent narrative. Gather feedback and use it to **refine the design.**

2.6 Comprehensive Set of Drawings: Incorporate **schematic design sketches, models, and peer feedback** to further develop **a building's design**. Communicate details of the design through appropriate drawing types, utilizing industry-standard drawing conventions and software. Create a **comprehensive set of drawings** including the following drawing types:

a. site plan,
b. floor plan,
c. interior and exterior building elevations,
d. foundation plan,
e. roof plan,
f. building system plans (such as an electrical plan),
g. door and window schedules, and
h. three-dimensional renderings (interior and exterior).

2.7 Sustainable Design: Research **sustainable design solutions and practices;** then provide **sustainable design recommendations** for a given design. Calculate a rating for **energy responsiveness** using a **sustainable building guideline**.

2.8 Wall Section: Examine a **wall section drawing** for a specific building. Identify, define, and explain the **function and purpose of each component**, including wall insulation, flashing, and the structure of the cornice.

3. Mechanical Design

3.1 Three-Dimensional Models: Create **three-dimensional models of machine parts** of increasing complexity utilizing **parametric modeling software**. Perform software operations including the following:

a. utilizing basic software tools such as extruding and cutting, and navigating around the object;
b. applying and modifying geometric constraints and dimensions to capture and alter the design geometry of a part;
c. creating drawing layouts with dimensioned views of parametric solids, arranging a drawing sheet according to industry standards;
d. printing drawing layouts at appropriate scales; and
e. preparing multi-sheet working drawings and assembly drawings according to industry standards.

3.2 Field Measurements: Modify **drawings based on field measurements**. Building on techniques practiced in prior courses, continue to **measure, record, and use field measurements** to create **drawings of increasingly complex objects and layouts**.

3.3 Assembly Model: Compile **parametric models of individual machine parts** to create a **model of a simple assembly**. Perform **advanced software operations** such as animating the model to illustrate **how the assembly operates**.

3.4 Schematic Design: Utilize the **design process** to create **a schematic design solution for a mechanical design problem**. Identify the criteria and constraints and produce a virtual or physical model of the solution, utilizing software tools where appropriate. Test and evaluate the solution by performing **an analysis of the model and gathering feedback from peers**.

3.5 Schematic Design: Incorporate **schematic design models, peer feedback, and test results** to further develop a design. Communicate **details of the design** through **appropriate drawing types**, utilizing **industry-standard drawing conventions and software**. Derive working drawings (**detail and assembly drawings including parts lists**) from the three-dimensional models created using parametric modeling software. Attend to details when explaining the design, including the following:

a. specifying and depicting threads, fasteners, and other hardware involved in a mechanical assembly;
b. applying appropriate geometric dimensioning and tolerancing based on industry standards, including understanding tolerance relationships between mating parts, interpreting geometric tolerancing symbols in a drawing, and using tolerancing in drawings; and
c. selecting and creating appropriate section drawings, noting tolerances, hidden surfaces, and other mechanical details.

4. Research Project

4.1 Research Project: Employ basic methods of **data collection and analysis** to compile information for projects. Use available **research methods** when **project planning** and **problem-solving**. Synthesize research to present **appropriate precedents for the development of a project** and articulate logical rationale for the use of chosen precedents.

5. Design Project

5.1 Schematic Designs for Project: Use the **design process** to create **schematic designs employing discipline-appropriate representational media**, such as sketches, technical drawings, and preliminary models for a given **problem set**. Prepare and present schematic designs to peers and others, citing research to justify design solutions. **Note constructive feedback** received and use it to **refine the design**.

5.2 Drawings, Models, and Presentation Boards: Drawing on results from the schematic design phase, create **discipline-appropriate drawings** based on **industry standards, a three-dimensional model of the design, and presentation boards**. Present **final design conclusions** to members of the profession as well as peers; employ **design decision justifications** as would an architect or engineer delivering a pitch to a prospective client.

5.3 Comprehensive Set: Compile **working drawings in a comprehensive set,** including a bill of materials with allowable material alternatives. Demonstrate the ability to properly select the drawing scale, select the views, layout drawings, and organize the drawing set according to industry standards.

6. Project Management

6.1 Project Management: Examine how architects and engineers conduct **project management processes**, including but not limited to setting interim goals, tracking progress, and coordinating with construction professionals and clients. Compare and contrast **components of project management models** gathered from textbooks, online resources, and actual case studies of major or local design professionals.

6.2 Project Management Strategies: Utilize **project management strategies** to create and implement **a work plan to complete projects according to schedule.**

6.3 Report: Apply **the basic steps of traditional project delivery**, outlining who and what is involved in each step. Compare texts to describe **alternatives to traditional project delivery methods**, such as the design-build method used in construction.

7. Portfolio

7.1 Portfolio: **Update the portfolio** to reflect the cumulative total of all projects undertaken across the program of study. Continually reflect on coursework experiences and revise and refine the career plan generated in the introductory course. Include written descriptions of drawing types and learning outcomes.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - 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.

Foundations of Interior Design

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H12
Prerequisite(s):	None
Credit:	1
Grade Level:	9
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses. In addition, this course satisfies the *Fine Arts* requirement for graduation.
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 *Interior Design* program of study.
Aligned Student Organization(s):	Family, Career and Community Leaders of America (FCCLA): http://www.tennesseefccla.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/educators/career-and-technical-education/work-based-learning.html. .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	050, 051, 154, 450, 954
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Investigation, Job Interview, Leadership, and Interior Design.

Using Work-Based Learning (WBL) 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 2.1-2.3** | Invite a guest speaker.
- **Standard 3.1-3.2** | Visit a local company and discuss trends in design with those employees.
- **Standard 4.1-4.2** | Visit a local company and discuss career options with employees.
- **Standard 6.1-6.3** | Complete a project that is used by local industry or evaluated by local industry managers.

Course Description

Foundations of Interior Design is the first course in the *Interior Design* program of study intended to prepare students for careers in residential and commercial interior design. Standards in this course include career exploration of various options within the interior design industry as well as an overview of the history of architecture and design. Projects will involve individual and team assignments. Upon completion of this course, proficient students will be able to analyze and demonstrate the elements and the principles of design and apply these concepts using sketching techniques in the creation of perspective floor plans.

Course Standards

1. Safety

1.1 Safety: Demonstrate the ability to comply with **personal and environmental safety practices** associated with interior design applications, such as the use of adhesives, hand tools, machines, and appropriate handling and storage methods in accordance with local, state, and federal safety and environmental regulations.

a. Inspect, maintain, and employ safe operating procedures with tools and equipment.
b. Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting accidents and observed hazards, and regarding emergency response procedures.
c. Maintain a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

2. History of Architecture and Interior Design

2.1 History of Architecture: Synthesize research from textbooks, interior design magazines, and professional journals covering **significant time periods in the development of architecture** from the beginning of civilization to the present.

2.2 History of Interior Design: Research the **influences of major interior designers or architects and their contributions to the design industry**. Include the designers' names, major contributions, and examples of their works.

2.3 History of Furniture Styles: Identify and compare **distinguishing features of furniture styles from the medieval period to the present**. Classify the historical features based on the construction features, design elements, materials, and functions.

3. Trends in Design

3.1 Trends in Interior Design: Research **trends in interior design** using trade journals, design magazines, and internet sources. Create an annotated display that visually illustrates current trends in flooring, window treatments, appliances, kitchen and bathroom design, colors, and lighting.

3.2 Sustainable Design: Research the **principles of green design, responsible design, and sustainable design**. Evaluate **the cost, benefits, and challenges posed by using green design**. Compare traditional products to environmentally responsible products.

3.3 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal impact of AI technologies**, while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

4. Career Investigation

4.1 Interior Design Careers: Identify and analyze **career pathways within the Interior Design program of study.** Cite supporting evidence from textbooks, interior design magazines, and professional journals to summarize the essential knowledge and skills required for these careers. Complete one or more **career aptitude surveys** and analyze the results. Identify the relationships between personal career aptitudes and careers in interior design. Careers may include, but are not limited to, the following:

a. interior designers,
b. textiles designers, and
c. industrial designers.

4.2 Opportunities: Compile and analyze **real-time and projected labor market data** from public sources such as the **U.S. Bureau of Labor Statistics** to investigate **local and regional occupational opportunities and trends in the interior design industry**. Synthesize collected data to develop a graphic illustration comparing occupations by education requirements, job availability, salaries, and benefits.

4.3 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSO**, Family, Career and Community Leaders of America, through an interactive activity, such as a classroom competition.

5. Principles and Elements of Design

5.1 Elements of Design: **Analyze the elements of design** in the context of interior design by evaluating their effect and application in interiors, furnishings, and accessories.

a. Line
b. Shape/form
c. Space /size/stability
d. Value
e. Color
f. Texture

5.2 Principles of Design: Illustrate the **principles of design** by creating an informational artifact that represents the **selection and arrangements of interiors, furnishings, and accessories** using those principles.

a. Unity
b. Harmony
c. Balance
d. Rhythm/repetition
e. Contrast/variety
f. Dominance/emphasis
g. Gradation

5.3 Color Schemes: Drawing on the **application of color theory in interior design,** analyze **the color wheel** to identify **techniques that achieve desired hues, values, intensities, and color schemes**. Demonstrate the ability to **coordinate colors** to **create unity** in furnishings, backgrounds, and accessory samples in various color schemes.

5.4 Color Impacts: Research the **psychological characteristics of colors**, comparing and contrasting the **differences in warm and cool color palettes**. Illustrate and describe in a written narrative **how color is measured in hue, value, and intensity,** and **how these properties combine to produce specific psychological characteristics**. Produce examples that demonstrate how and why color hues may be used in certain areas of a floor plan.

6. Traffic Patterns and Floor Plans

6.1 Space Planning and Traffic Patterns: Examine the **guidelines for space planning and traffic patterns in residential structures**. Create a list of typical rooms in a residence describing the desired characteristics and space requirements for each.

6.2 Floor Plan: Assemble a design of a room using hand sketch techniques to **create a floor plan**, including outlining space planning guidelines and traffic patterns. Write a narrative describing the room's design concept highlighting where the principles and elements of design and color theory have been applied.

6.3 Using Drawings to Draft Floor Plan: Analyze examples of **dimensional floor plans** and **architectural blueprint symbols** and explain how interior designers use them throughout the design process. Demonstrate the ability to **consult and interpret blueprints** in order to aid in the drafting of hand sketches of floor plans**.** Compile the sketches completed in the course with other artifacts for inclusion in a design portfolio, such as an engineering design notebook, to be updated throughout the program of study.

7. Interior Design Portfolio

7.1 Portfolio: **Create a portfolio**. Gather examples of professional portfolios from contemporary interior designers, retrieved from designers' webpages, CVs, or postsecondary design schools. List the items that are often included in an interior design portfolio. Write a short paper describing the benefits of keeping a professional portfolio.

8. Data Analysis

8.1 Data Analysis in Architecture and Construction: **Research the use of data** in the architecture and construction career fields. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:

a. customer/client use of interior design products and services;
b. demographics of interior design end users;
c. community, state, and national statistics on interior design; and
d. data that must be reported to another construction activity.

Standards Alignment Notes

*References to other standards include:

- FACS: National Standards for Family and Consumer Sciences Education, Second Edition: National Association of State Administrators of Family and Consumer Sciences
- P21: Partnership for 21st Century Skills

- 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.

Residential Interior Design

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H11
Prerequisite(s):	*Foundations of Interior Design* (C17H12)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 second course in the *Interior Design* program of study.
Aligned Student Organization(s):	Family, Career and Community Leaders of America (FCCLA): http://www.tennesseefccla.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	050, 051, 154, 450, 954
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Investigation, Job Interview, Leadership, and Interior Design.

Using Work-Based Learning (WBL) 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 3.1-3.3** | Invite a guest speaker.
- **Standards 4.1-4.4** | Ask an industry representative to discuss the interior environment.
- **Standards 5.1-5.2** | Ask an industry representative to discuss project management in interior design.
- **Standard 6.1** | Ask an industry representative to discuss textiles.
- **Standards 7.1-7.3** | Create a presentation board to be evaluated by local industry managers.

Course Description

Residential Interior Design is the second course in the *Interior Design* program of study intended to prepare students for careers in residential and commercial interior design. Students will engage in the development of board presentation techniques for residential spaces using textile samples and three-dimensional sketches. Upon completion of this course, proficient students will be able to use manual drafting tools and computer-aided drafting software to create original floor plans, perspective drawings, and color renderings.

Course Standards

1. Safety

1.1 Safety: Demonstrate the ability to comply with **personal and environmental safety practices associated with interior design applications**, such as the use of adhesives, hand tools, machines, and appropriate handling and storage methods in accordance with **local, state, and federal safety and environmental regulations**.

a. Inspect, maintain, and employ safe operating procedures with tools and equipment.
b. Adhere to responsibilities, regulations, and Occupational Safety and Health Administration (OSHA) policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.

2. Design Software

2.1 Design Software: Operate various **design software and computer-aided drafting (CAD) programs**. Demonstrate basic operations such as the following:

a. open or save a new file or existing file,
b. navigate the various menu bars,
c. use basic commands to create two-dimensional computer-generated floor plans, and
d. use basic commands to create three-dimensional computer-generated renderings.

3. Residential Floor Plans

3.1 Create Scale Drawings and Models: Demonstrate proficiency in **basic concepts of scale drawings** by creating simple **two-dimensional drawings** with the use of **manual drafting tools and computer-aided drafting software**. Create a floor plan for a selected room, indicating furniture, built-ins, and architectural features measured and drawn to scale.

a. Develop two-dimensional drawings by using proper sketching techniques and measurement systems (i.e., including fractions, decimals, United States customary units, and metric units).
b. Create and assemble a three-dimensional model for a residential living space, demonstrating effective use space planning.
c. Produce a clear and coherent written analysis of the model in terms of the room's design and space concept. Assess how the purpose of the space shapes the content and functionality of the room design.

3.2 Create Computer-Aided Drawings: Demonstrate **quick-sketching techniques** to design rooms, and then create the **computer-aided drawings** using **design presentation software** such as Photoshop, SketchUp, Revit, or AutoCAD.

3.3 Create Renderings: Using an instructor-approved software program, draw basic **three-dimensional scale drawings** to create renderings of a range of residential rooms (living

room, adult and child bedrooms, kitchen, utility, bath, home office, etc.) that illustrate the **principles of interior design**. Describe each drawing and highlight the design principles illustrated in each.

4. Interior Environment

4.1 Components of Interior Design: Analyze the various **components of the interior environment**, assessing the credibility and accuracy of the sources in illustrating the principles of interior design. Integrate the information retrieved to guide the development of a **three-dimensional drawing or model**, then create a **presentation for a prospective client** outlining the **appropriateness of selected components**, including but not limited to the following:

a. types of flooring,
b. lighting,
c. wall and surface finishes, and
d. accessories.

4.2 Structural Elements: Evaluate the **architectural structural elements** to describe the options, features, and possible design applications of the following:

a. windows,
b. doors,
c. cabinetry,
d. fixtures, and
e. other relevant features.

4.3 Window Treatments: Compare and contrast different **types of window treatments**, such as **curtains or drapes, blinds, shades, cornices, swags, and valances, and determine the appropriate window treatment based on window type and customer requirements. Explain** how the choice for a given **window treatment impacts privacy, light control, and energy efficiency** against practical considerations, such as **feasibility of installment, cost, and weather conditions** specific to a particular climate.

4.4 Furniture: Interpret manufacturing specifications when establishing **guidelines for selecting furniture**, taking into account needs, styles, budget, durability, safety, and environmental impact. Evaluate claims made by manufacturers and customer reviews to **analyze furniture selections in terms of their suitability for clients in design scenarios**.

5. Project Management

5.1 Project Budget: Create an outline that illustrates the **basic components of project budgets** commonly used in interior design proposals (e.g., itemized budgets, non-itemized budgets, fixed budgets, and flexible budgets). Implement outline components to generate a **comprehensive budget, including walls and floors, lighting, focal furniture pieces, and labor costs for a residential living space.**

5.2 Residential Project Management Process: Examine how businesses in the interior design industry conduct **project management processes in residential settings**. Compare and contrast **components of project management models** gathered from case studies of major or local designers. Generate a **project management template** that addresses the objectives required for designing a residential living space.

6. Textiles

6.1 Natural and Man-Made Fibers and Textiles: Research and create a chart of **natural and manmade fibers, and the textiles made from them**, as they are used in residential applications such as draperies, carpets, and upholstery. Describe in the chart the **principle characteristics, best applications for the fibers/textiles, care guidelines, and any associated environmental or safety concerns**. Expand the chart to prepare a more detailed guide including samples to be used in presentations to clients.

6.2 Textile Manufacturing Regulations: Research the **Textile Fiber Products Identification Act** that defines and regulates the labeling of textile products, the **Flammable Fabrics Act, the Care Labeling Rule, and the Wool Products Labeling Act** that specifies regulations about the labeling of products containing wool. Evaluate the **necessity of such laws**. Summarize the key points of each of the acts.

7. Presentation Boards

7.1 Presentation Board Characteristics: Research how interior design companies create **presentation boards**. Citing examples, identify **characteristics of effective presentation boards**. Drawing on the research, compile a list of **materials required for a presentation board** showcasing one room in a residential setting.

7.2 Presentation Board Elements: Assemble a **presentation board that incorporates a collage of color samples, fabric, and flooring, mounted with the color elevation rendering** that orderly and logically presents a particular theme in color or style of design. Evaluate these elements visually and tactually to determine the **most effective combination** that will meet the needs of the client.

7.3 Presentation Board Defense: Produce a clear and coherent **verbal defense of the presentation board** that explains the principles of design, justifies the choice of samples, and includes a complete cost analysis of the project. Capture the presentation on video or other media along with photographs to include in the design portfolio with the written paper.

8. Interior Design Portfolio

8.1 Portfolio: **Update materials, photographs, and sketches from coursework to add to the portfolio** begun in the foundations course. Include descriptions of the creative thought process behind each project included.

9. Team Project

9.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an **engineering design notebook** for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- FACS: National Standards for Family and Consumer Sciences Education, Second Edition: National Association of State Administrators of Family and Consumer Sciences
- P21: Partnership for 21st Century Skills
    - 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.

Commercial Interior Design

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H20
Prerequisite:	*Residential Interior Design* (C17H11)
Credit:	1
Grade Level:	11
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 third course in the *Interior Design* program of study.
Aligned Student Organization(s):	Family, Career and Community Leaders of America (FCCLA): http://www.tennesseefccla.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/educators/career-and-technical-education/work-based-learning.html .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	050, 051, 154, 450, 954
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

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Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Investigation, Job Interview, Leadership, and Interior Design.

Using Work-based Learning (WB) 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 2.1-2.2** | Integrate a project with a professional.
- **Standard 3.1 |** Invite a guest speaker.
- **Standards 3.2-3.7** | Have the students complete a project that is useful to a local employer. Ask the manager to help evaluate the projects.
- **Standards 5.1-5.4** | Ask an industry representative to discuss textiles.
- **Standards 6.1-6.2** | Ask an industry manager to discuss project management.
- **Standards 7.1-7.3** | Take the students to a real project meeting to observe a presentation board being presented to a client.

Course Description

Commercial Interior Design is the third course in the *Interior Design* program of study intended to prepare students for careers in residential and commercial interior design. Important components in this course include developing an understanding of specifications for commercial design, building technology, building codes, product applications, and product testing research and development. Students will work individually and in teams to make presentations to prospective commercial clients and defend their designs and presentation boards. Upon completion of this course, proficient students will be able to create three-dimensional pictorial representations of objects by way of size, shape, shading, and color using industry-standard software programs.

Course Standards

1. Safety

1.1 Safety: Demonstrate the ability to comply with **personal and environmental safety practices** associated with **interior design applications**, such as the use of adhesives, hand tools, machines, and **appropriate handling and storage methods in accordance with local, state, and federal safety and environmental regulations**.

a. Inspect, maintain, and employ safe operating procedures with tools.
b. Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting accidents and observed hazards, and regarding emergency response procedures.

2. Design Software

2.1 Computer-Aided (CAD) Software: Use **computer-aided software tools** to **design floor plans or create perspective drawings** using appropriate symbols, abbreviations, and callouts to indicate the placement of windows, doors, electrical outlets, plumbing, and other structures.

2.2 Textures, Color, and Finishes: Apply **textures, color, and finishes to elevations and perspective drawings.** Use layers and overlays to demonstrate alternate designs of the same structures.

3. Commercial Design

3.1 Commercial Design: Research and compare the **fields of residential interior design** to **commercial interior** design**.** Explain the **differences and similarities** between residential and commercial interior design careers.

3.2 Interiors of Commercial Spaces: Review and evaluate **design interiors of commercial spaces** presented in diverse formats such as design books and building magazines. After review, create and continuously log sketches and gather sample pictures of appealing furniture layouts, window treatments, accessories, and floorings for inclusion in future design projects. Compile sketches and sample pictures into a **personal design book** along with a brief paragraph to accompany each sketch. Describe what aspects of the design are appealing and why.

3.3 Exterior of Commercial Spaces: Research the various materials used in the **exterior rendering**. Design a **commercial building rendering** by sketching the exterior with a three-dimensional design program. Then sketch **the exterior facade**, attending to appropriate representations for metal, wood, brick, glass, or any combination of exterior materials. Compile the sketches and other artifacts for inclusion in the design portfolio. Analyze the **material's durability, practicality, cost-effectiveness, and sustainability**.

3.4 Floor Plans: Research the **placement of furniture and the arrangement of interiors** for commercial spaces. Generate floor plans that incorporate **effective commercial space planning techniques**.

3.5 Traffic Flow and Space Utilization: Research **space requirements, traffic flow, and design features** necessary for a commercial space. Create a **rendering and assembly of a three-dimensional interior design for the space** demonstrating **effective use of principles and elements of design** learned in previous courses. The design should be specific to a particular venue, such as the following:

a. hospitality venues (i.e., restaurants, hotels, event spaces),
b. offices,
c. spas or fitness centers, and
d. retail space.

3.6 Field Verification: Research **field verifications in the context of client project analysis** and produce a synthesis of **how interior designers incorporate field verification data** to best meet the client's needs. Prepare a written plan or proposal for conducting field verification analysis for the commercial venue selected in standard 3.4 including a proposed timeline with key deliverables to present to a mock client.

3.7 Conduct Field Verification: Conduct an **original field verification analysis** to determine materials, layout, space distribution, and interior wall arrangement needed for the commercial venue project in standard 3.4.

4. Policies and Regulations

4.1 Regulations and Policies: Research relevant **legislation, regulations, zoning laws, and building codes regulating environmental, health, and safety requirements** for specific commercial facilities. Explain the **minimum compliance requirements and benchmarks** needed to achieve an energy-efficient building designation.

4.2 Americans with Disabilities Act (ADA): Research how **Universal/Barrier-Free design principles** impact commercial design. Identify **modifications** that are necessary to furnishings, floor plans, materials, and fixtures to accommodate the needs of people of all ages and physical abilities in compliance with the Americans with Disabilities Act.

5. Textiles

5.1 Fibers and Textiles: Research **natural and manmade fibers,** and the **textiles made from them**, as they are used in commercial applications such as **draperies, carpets, and upholstery**. Identify the **principle characteristics, best applications for the fibers/textiles, care guidelines,** and any associated **environmental or safety concerns**.

5.2 Fabric Tests: Research ***ASTM D4850 -13*** for standard terminology relating to **fabrics and fabric test methods**. Limit the search to textiles used in interior furnishings. Summarize the

broad classifications of tests performed on textiles, the standards that organizations have developed **methods for testing each characteristic**, and any additional information that describes the **test method, application, reliability**, and **interpretation of the results.**

5.3 Wyzenbeek and Martindale Tests: Differentiate between the **Wyzenbeek and Martindale Abrasion Tests.** Develop **guidelines for choosing fabrics for specific residential or commercial applications** that indicate the number of double rubs (Wyzenbeek) or cycles (Martindale) a fabric should withstand.

5.4 Testing: Apply the **scientific method** to develop a **protocol to test for some characteristics of fabric, upholstery, or carpet materials,** such as fade resistance, durability, or shrink resistance. Follow the protocol and laboratory test fabric samples.

6. Project Management

6.1 Budgets: Identify the **basic components of project budgets** commonly used in **commercial interior design proposals** (e.g., itemized budgets, non-itemized budgets, fixed budgets, and flexible budgets). Generate a **comprehensive budget** including walls and floors, lighting, focal furniture pieces, and labor costs for a commercial office space.

6.2 Commercial Design Project Management: Examine how commercial designers conduct **project management processes,** including but not limited to, adhering to local building codes, obtaining building permits, and coordinating with construction professionals and clients. Compare and contrast **components of project management models** gathered from case studies of major or local commercial designers. Generate a **project management template** that addresses the **objectives required for designing a commercial office space**.

7. Presentation Boards

7.1 Materials: Identify **materials required for a presentation board** featuring a commercial setting. Incorporate a wide range of material samples. Evaluate these elements visually and tactually to determine the most effective combination that will meet the needs of the client.

7.2 Select Materials: Analyze the **material samples** to select those suitable for a **specific type of commercial design setting.** Create the presentation board in a collage of color samples, fabric, and flooring, mounted with the color elevation rendering that orderly and logically presents a **particular theme in color or style of design**.

7.3 Presentation Boards: Produce a **clear and coherent verbal defense of the presentation board** as well as a written narrative that explains the principles of design, justifies the choice of samples, and includes a complete cost analysis of the project.

8. Interior Design Portfolio

8.1 Portfolio: Update materials, photographs, and sketches from coursework to add to the portfolio that began in the Foundation of Interior Design course. Include descriptions of the creative thought process behind each project.

Standards Alignment Notes

*References to other standards include:

- TN Scientific Research Standards 1, 2, 3, 4, and 5 may provide additional insight and activities for educators.
- P21: Partnership for 21st Century Skills
    - 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.

Advanced Interior Design

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H19
Prerequisite:	*Commercial Interior Design* (C17H20)
Credit:	1
Grade Level:	12
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 fourth and final course in the *Interior Design* program of study.
Aligned Student Organization(s):	Family, Career and Community Leaders of America (FCCLA): http://www.tennesseefccla.org/
Coordinating Work-Based Learning:	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	050, 051, 154, 450, 954
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note 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 demonstrations. These include Career Investigation, Job Interview, Leadership, and Interior Design.

Using Work-based Learning (WBL) 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.

- **Standard 2.1** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.3 |** Invite a guest speaker.
- **Standards 4.1-4.4, 6.2** | Have the students complete a project that is useful to a local employer. The employer can critique the student's work.
- **Standards 5.2-5.3, 7.1-7.3** | Complete a project to be used by local industry or evaluated by local industry managers.
- **Standards 8.1-9.3** | Integrate projects with a professional.

Course Description

Advanced Interior Design is an applied knowledge course intended to prepare students for careers in the interior design industry. This course places special emphasis on an internship opportunity and a hands-on capstone projectUpon completion of this course, proficient students will create a design for a specific space and purpose, either residential or commercial, applying skills and knowledge from previous courses and industry-specific technologies.

Course Requirements

This capstone course aligns with the requirements of the Work-Based Learning Framework (established in Tennessee State Board High School Policy), with the Tennessee Department of

Education's Work-Based Learning Policy Guide, and with state and federal Child Labor Law. As such, the following components are course requirements:

Course Standards

1. Personalized Learning Plan

1.1. Personalized Learning Plan: A student will complete a Personalized Learning Plan that identifies their **long-term goals**, demonstrates how the **Work-Based Learning (WBL) experience aligns with their elective focus** and/or high school plan of study, addresses how the student plans to **meet and demonstrate the course standards**, and addresses **employability skill attainment** in the following areas:
   a. application of academic and technical knowledge and skills (embedded in course standards),
   b. career knowledge and navigation skills,
   c. 21st-century learning and innovation skills, and
   d. personal and social skills.

2. Safety

2.1. Safety: Demonstrate the ability to comply with **personal and environmental safety practices** associated with interior design applications, such as the use of adhesives, hand tools, machines, and appropriate handling and storage methods in accordance with local, state, and federal safety and environmental regulations.
   a. Inspect, maintain, and employ safe operating procedures with tools and equipment.
   b. Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting accidents and observed hazards, and regarding emergency response procedures.

3. Professional Practices of Interior Design

3.1. Professional Practices: Research **job descriptions, career information, and online job boards** such as the IIDA Career Center for the general employability skills and character traits most often mentioned or desired for interior design professionals. Compile a class list of **professional practice skills and attributes.** Possible skills include:
   a. collaboration,
   b. honesty,
   c. respect,
   d. communication, and
   e. responsibility.

3.2. Incorporate Professional Practices: Collect Codes of Ethics from various interior design professional organizations such as the American Society of Interior Designers (ASID) and the International Interior Design Association (IIDA) and compare them for areas of commonality. **Incorporate ethical standards into professional practice.** Synthesize principles from the

codes investigated to create a **personal code of ethics for use as a designer**; include the code in the design portfolio.

3.3. Licensing Requirements: Access electronic resources, including the websites of professional organizations, to identify **voluntary and required credentials and licensing requirements** for interior designers. Understand the credentials available and the requirements for obtaining and maintaining the credentials. Determine the licensing requirements to become a certified interior designer.

4. Resource Management

4.1. Project Plan: Identify **common principles of successful project management.** Drawing on the project management templates developed in previous courses, estimate a **detailed project plan for a potential interior design project.** The project plan should include at minimum the following: a schedule or Gantt chart outlining deliverables; a tracker for progress toward goals; a time management component to log hours worked for those involved; a spreadsheet for analyzing cost and performance; and a document to coordinate tradesmen and other labor.

4.2. Project Budget Create a list of the **components of a project budget.** Estimate a **budget for a potential project** in a spreadsheet program. Each budget should include at minimum columns for **estimated costs, actual costs, and differences**.

4.3. Interior Design Company: Create a **name and logo for an original interior design company.** Apply **concepts and templates from word processing programs** to create one or more of the following business necessities: business stationery, invoices, sample rates, specific project cost estimates, and business cards.

4.4. Business Plan: Research different **types of business structures**, including but not limited to sole proprietorship, partnership, s-corporation, and limited liability company. Write a **business plan** explaining the type of business, organizational design, the steps in establishing the business, and the legal parameters affecting the business. Identify the **target market**; describe in the plan how the particular suite of design services offered by the proposed company will be marketed to the intended consumers.

5. Communication

5.1. Communication: Practice **effective verbal, nonverbal, written, and electronic communication skills** for working with clients while demonstrating the ability to listen attentively, speak courteously and respectfully, discuss client's ideas/vision, resolve obstacles in design, and respond to client objections or complaints to the client's satisfaction.

5.2. Presentation of Project: Analyze **different designs for an interior design project** for a client, supported by **graphic renderings and written appraisals** of the work. Justify why

each would be appropriate given the **client's specifications**, while also noting the **drawbacks and compromises** to each one based on client needs.

5.3. Presentation of Options: Recommend design **features of alternative designs** for a given project. Select one design over another that will **suit the venue and satisfy the client**. Demonstrate the ability to pitch the idea to the client in a **mock bid** defending the design by pointing to specific features that meet the client's specifications.

6. Obstacles in Design

6.1. Design Obstacles: Define design obstacles and prepare a **list of potential obstacles** encountered in **residential or commercial venues**, such as environmental concerns, budget constraints, or marketability. Use research from design magazines and technical manuals to suggest **design solutions** that effectively deal with these obstacles.

6.2. Presentation Board: Develop a **presentation board** to share with a client. Compose a **design narrative** to accompany the presentation board. Integrate multiple sources of information, such as original field verification analyses, to make informed design decisions, solve design obstacles, and present the findings clearly and coherently as a verbal or written report.

7. Internship (Optional)**

7.1. Internship: **Participate in an internship.** If available, participation in an interior design internship is encouraged. Internship placements are approved at the discretion of the instructor based on local availability and the instructor's assessment of the internship's quality.

7.2. Employability Skills Maintain a professional image by applying the **employability skills and attitudes** explored in Standard 2. Analyze how skills and attitudes impacted assignments completed on the job.

7.3. Internship Presentation Upon conclusion of the internship, critique strengths and weaknesses by showcasing **highlights, challenges, and lessons learned** from the experience. The presentation will be included in the student's portfolio.

8. Capstone Project

8.1. Client Presentation Create a **comprehensive design for a specific space and purpose**, either residential or commercial, applying skills and knowledge from previous courses. Students should be able to visit the site to make **measurements** and complete **field verification**. Create a **client presentation** to include the following:

a. project plan,
b. statement of how the design meets applicable codes and regulations,

c. presentation board(s) and 3-D models of the project,
d. drawings that incorporate principles and elements of design correctly,
e. select appropriate finishing and materials, and
f. comprehensive cost estimate based on researched prices.

9. Portfolio

9.1. Write a Resume Research **formats and styles of resumes** commonly used by interior design professionals. Use templates or online resume builders to create a **personal resume**.

9.2. Update Portfolio Update the portfolio to reflect the **cumulative total of all portfolio projects** undertaken across the program of study. Compile **information, sketches, and photographs** from each course project work. Include floor plans, drawings, and materials used. Include technical drawings that demonstrate the ability to use industry-specific technology such as such as Photoshop, SketchUp, Revit, or AutoCAD. Select projects from coursework that **showcase qualifications as an interior design student**. Upon completion of this course, the following artifacts will reside in the student portfolio:

a. resume,
b. career and professional growth plan,
c. personal code of ethics,
d. communication exercises,
e. example sketches showing the best work from any course,
f. residential interior design project board,
g. commercial interior design project board, and
h. capstone project.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
  - 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.

Fundamentals of Construction

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H15
Prerequisite(s):	None
Credit:	1
Grade Level:	9
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 *Residential & Commercial Construction, Structural Systems,* and *Mechanical, Electrical, & Plumbing (MEP) Systems* programs of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	501, 502, 522, 523, 524, 527, 532, 553, 554, 555, 556, 567, 575, 580, 584, 585, 592, 598, 701, 702, 703, 705, 706, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

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CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.3** | Invite a guest speaker.
- **Standards 4.1-4.2** | Visit a local company and discuss career options with those employees.
- **Standards 5.1-6.1** | Ask an industry representative to discuss how important measurement and math is in construction.
- **Standards 9.1-9.3** | Ask an industry representative to discuss the impact of drawings and specifications on the job.
- **Standard 10.1** | Complete a project that is used by local industry or evaluated by local industry managers.

Course Description

Fundamentals of Construction is a foundational course in the Architecture & Construction cluster covering essential knowledge, skills, and concepts required for careers in construction. Upon completion of this course, proficient students will be able to describe various construction fields and outline the steps necessary to advance in specific construction careers. Students will be able to employ tools safely and interpret construction drawings to complete projects demonstrating proper measurement and application of mathematical concepts. Standards in this course also include an overview of the construction industry and an introduction to building systems and materials.

Students will begin compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in their selected program of study.

Course Standards

1. Safety

1.1 Safety Rules: Identify **safety hazards on a job site** and demonstrate **practices for safe working conditions**. Accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to 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 Practices: Define and demonstrate adherence to **industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety** to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures when operating tools and equipment**, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: Follow **procedures to work safely around materials**. Adhere to responsibilities for employees in material safety as outlined by the **Hazard Communication Standard** (HazCom), such as locating and interpreting **material safety data sheets (MSDS**). Demonstrate **safe procedures to move materials** by planning the movement, properly lifting, stacking, storing materials, and selecting proper materials-handling equipment.

2. History of Architecture and Construction

2.1 History of Architecture and Construction: Investigate the **evolution of architecture and construction** across a variety of civilizations throughout history. Identify **major architectural and construction innovations**, such as technological advances in materials or construction processes.

3. Introduction to the Construction Industry

3.1 Construction Industry: Analyze the **organization of the modern construction industry**. Distinguish among the **various personnel** involved in the industry and explain the **roles of each in the construction process**, including but not limited to the owner, developer, architects, engineers, building officials, contractors, suppliers, unions, and professional craftsmen. Describe the **basic steps of traditional building delivery for a construction projec**t, from pre-design to post-construction, outlining who and what is involved in each step.

3.2 Construction Regulations: Research **basic regulations affecting today's construction industry**.

a. Investigate and report on the process for securing a building permit for a selected location in the community.
b. Explain what a building code is and where to find published local building codes. Write persuasively to defend why a particular building code is necessary.

3.3 Impact of Construction: Investigate the **social, economic, and environmental impact of construction work** at the local, national, and global levels. Analyze **current and emerging trends** in the construction industry such as LEED certification and green building design critically examining each source consulted for its validity and reasoning.

4. Career Exploration

4.1 Construction Professions: Research the **major professions and trades within construction**, such as electrician, carpenter, mason, plumber, HVAC technician, cost estimator, and construction manager. Analyze the **aptitudes and training needed** for at least three careers of interest. For example, outline the typical steps needed to become a journeyman electrician, such as completing postsecondary training and obtaining on-the-job training through an apprenticeship, and devise a tentative **career plan to reach employment goals**.

4.2 Employment Opportunities: Evaluate **job data and employment projections** in the construction industry from sources such as O*Net Online, synthesizing findings from each source. Determine **areas of largest growth** and discuss the **significance of construction to the national and global economy**. Articulate **why construction is considered a STEM field** citing the specific knowledge, skills, and abilities required to be successful in a variety of construction occupations.

4.3 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSO**, SkillsUSA, through an interactive activity, such as a classroom competition.

5. Introduction to Measurement

5.1 Measuring: Use **physical measurement devices** typically employed in construction to complete **accurate field measurements.** Determine the **appropriate units and record accurate measurements of lengths and angles.** Tools should include but are not limited to, fractional rule, metric rule, measuring tape, architect's scale, engineer's scale, dial caliper, micrometer, protractor, and square.

5.2 Dimensions: Interpret given **linear and angular dimensions** to accurately **set up layouts to complete a project.** For example, use an architect's scale to measure distance on a construction drawing, and then use a measuring tape to lay out cuts in dimensional lumber to an accuracy of 1/16 inch.

6. Construction Math

6.1 Math: Apply **mathematics concepts to solve construction problems** distinguishing which principles apply to a given construction problem. Concepts should include, but are not limited to the following:

a. operating with whole numbers, fractions, and decimals;
b. performing conversions between fractions, decimals, and percent. For example, convert a decimal to a fraction to prepare a unit for measurement on a fractional scale to the precision of 1/16 of an inch;
c. working with units such as feet, inches, meters, centimeters, and millimeters, and determining appropriate units for a given construction task. For example, determine how many pieces of 2 ft. 4 in. PVC pipe may be cut from a 10 ft. piece and how much pipe will be left over;
d. calculating the area of two-dimensional spaces. For example, calculate surface area and volume for three-dimensional objects employing related geometric terminology;
e. performing proportionate reasoning to estimate quantities; and
f. using basic rules of right triangles, such as the Pythagorean Theorem to find missing lengths.

7. Tools and Equipment

7.1 Identify Tools: Accurately identify a wide range of **hand and power tools** used in the construction trades, such as striking tools, cutting tools, torque-producing tools, leveling and squaring tools, grinding and shaping tools, clamping tools, and pulling and lifting tools. Explain **when each is used** and describe **the characteristics** that make each appropriate for a given task.

7.2 Use Tools and Equipment: Assess a variety of **situations requiring the use of hand tools,** power tools, and equipment. Select the **proper tool and accessories,** critique the **readiness of the tool,** use the **tool to accomplish the desired task**, and then return the tool and accessories to their proper storage. For example, demonstrate the ability to safely use a crosscut saw to cut a straight square to specified dimensions on dimensional lumber.

8. Introduction to Building Systems and Materials

8.1 Construction Materials: Compare and contrast the **properties and uses of basic construction materials** employed in building construction processes, such as aggregates, asphalt, concrete, steel, wood, and masonry materials.

8.2 Fasteners: Distinguish between the **various types of fasteners commonly used in construction,** such as nails, screws, and bolts, outlining the properties and uses of each type. Demonstrate the ability to accurately select and install the appropriate fastener in a variety of situations.

8.3 Building Systems: Identify and describe **major building systems** (e.g., foundation, structural, mechanical, electrical, and plumbing systems) to establish a basic knowledge of **their purpose, structure, and function**. Discriminate between the **different types of**

construction drawings related to these systems, analyze how those drawings are organized, and interpret the **common symbols** used in each.

9. Construction Drawings and Specifications

9.1 Construction Drawings: Inspect and interpret **construction drawings, diagrams, and written specifications for construction projects**. Explain **how pictorial representations relate to a physical layout**. Use an architect's scale and the given dimensions on a construction document to determine an unknown dimension. For example, interpret electrical schedules and single-pole or three-way light switch symbols in electrical plans to determine the types, quantities, and exact physical locations of the light switches to be installed in a construction project.

9.2 Specifications: Describe the **purpose of specifications in a construction document set.** Examine how specifications are organized according to the **Construction Specifications Institute's (CSI) *Master Format***. Select an assortment of building products and classify them according to the *Master Format*. Analyze actual specifications and create a list of items commonly included in a specification. Following CSI models and format, write a specification for a given component of a building project.

9.3 Create Drawings: Create **two-dimensional scale drawings** using **accepted dimensioning rules and measurement systems**. For example, as part of a project to build a simple structure, develop the complete drawings that specify the dimensional details for each step of the construction process, annotating all drawings such that another person could replicate the work.

10. Data Analysis and Artificial Intelligence

10.1 Data Analysis in Construction: **Research the use of data** in the construction career fields. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:

a. customer/client use of products and services in construction,
b. demographics of end users of construction projects,
c. community, state, and national statistics related to construction, and
d. data that must be reported to another activity that impacts construction.

10.2 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal implications of AI technologies** while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

11. Course Project

11.1 Course Project: Interpret **construction drawings** to determine the **correct materials, tools, and equipment needed to complete a basic construction project**. Plan and implement the steps needed to complete the project, attending to precise details and

employing safe practices throughout. For example, read and interpret a technical document to build a park bench or similar item as a team; complete construction of the item. Develop team roles and delegate tasks appropriately. Utilize a predetermined budget to choose materials. Document the design process to be added to a digital portfolio in a format, such as an engineering design notebook.

12. Portfolio

12.1 Portfolio: Compile important artifacts to **create a portfolio** connecting personal career preparation to concepts learned in this course. Continually update and reflect upon artifacts produced, including written products, to strengthen work samples over time using technology where appropriate.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for the NCCER Core Curriculum and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
    - 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.

Mechanical, Electrical, & Plumbing Systems

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H23
Prerequisite(s):	*Fundamentals of Construction* (C17H15)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 second course in the *Mechanical, Electrical, & Plumbing (MEP) Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html. .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	501, 502, 523, 527, 532, 567, 580, 592, 598, 701, 703, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Sheet Metal, Electrical Wiring, Plumbing, and Heating, Ventilation, Air Conditioning, and Refrigeration.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.3** | Visit a local company and discuss career options with those employees.
- **Standards 4.1-4.2** | Ask an industry representative to discuss construction industry principles and their impact on the job.
- **Standard 5.1** | Ask an industry representative to discuss the importance of math on the job.
- **Standards 6.1-9.4** | Complete a project that is used by local industry or evaluated by local industry managers.
- **Standard 10.1** | Ask an industry representative to discuss the impact of drawings and specifications on the job.
- **Standards 11.1-11.2** | Ask an industry representative to discuss the importance of project management.

Course Description

Mechanical, Electrical, & Plumbing Systems prepares students for electrical, plumbing, and HVAC careers by introducing students to the physical principles of these systems and the fundamental skills needed to work with them. Upon completion of this course, proficient students will be able to follow safety procedures and use tools to perform basic operations with electrical circuits, as well as demonstrate an understanding of fundamental concepts of electricity theory (i.e. Ohm's Law).

Students will be able to apply proper tools and procedures to perform basic operations with plastic piping, including measuring, cutting, and joining pipe. Furthermore, students will be able to apply mathematics concepts to solve HVAC, electrical, and plumbing problems. Standards in this course also include principles of the construction industry and business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards and Rules: Identify **safety hazards on a job site** and demonstrate **practices for safe working.** Accurately read, interpret, and demonstrate **adherence to safety rules**, including but not limited to 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**. Perform a **hazard assessment** for a given task, such as working on a ladder to install electrical components. Explain the steps necessary to safely perform the task outlining steps to take in case of an emergency.

1.2 Safety Practices: Continue to maintain **safety records** and demonstrate **adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE) as recommended by Occupational Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures when operating tools and equipment**, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: Follow **procedures to work safely around materials.** Adhere to **responsibilities for employees in material safety** as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). Demonstrate **safe procedures to move materials** by planning the movement, properly lifting, stacking, storing materials, and selecting proper materials-handling equipment.

2. Tools and Equipment

2.1 Tools: For each of the systems covered in this course**,** identify and select the **proper tools and accessories,** critique the **readiness of the tools,** use the **tools to accomplish the desired tasks,** and then return the tools and accessories to their proper storage. For example, demonstrate the ability to safely use a deburring tool to ream a pipe end and effectively clean and store the tool.

3. Tools and Equipment

3.1 Tools: For each of the systems covered in this course**,** identify and select the **proper tools and accessories,** critique the **readiness of the tools,** use the **tools to accomplish the desired tasks,** and then return the tools and accessories to their proper storage. For example, demonstrate the ability to safely use a deburring tool to ream a pipe end and effectively clean and store the tool.

4. Career Exploration

4.1 Career Opportunities: Compare and contrast **career opportunities within the HVAC, electrical, and plumbing industries.** Building on career exploration conducted in *Fundamentals of Construction*, produce a chart or other graphic comparing the skills, responsibilities, and personal characteristics of successful professionals in each of the three industries. Drawing on the research, create a **personnel profile** or a **mock job description** for one of these professionals citing the use of skills and characteristics during a typical day on the job.

4.2 Apprenticeship: Explain **apprenticeship** and reference data from the U.S. Department of Labor and other sources. Describe the **benefits of the apprenticeship approach of on-the-job training** paired with related training for individuals seeking construction careers.

4.3 Postsecondary Opportunities: Research **apprenticeships and postsecondary institutions** (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer construction-related programs. Identify the **entry requirements for a specific apprenticeship or postsecondary program of study** and the secondary courses that will prepare students to be successful in the program.

5. Construction Industry Principles

5.1 Construction Trades on the Project: Examine how the **roles and responsibilities among construction trades and professions** work in relation to completing a project. Describe **how electricians, plumbers, and HVAC technicians coordinate work with other construction personnel to complete a project**, including submitting bids for subcontracted work and requesting clarification through an RFI (request for information) process.

5.2 Building Code Enforcement: Explain **inspection procedures used to enforce building codes** during the construction of a residential or commercial building outlining the **roles and responsibilities of the building inspector and the contractor** and the **intervals at which inspections are performed.**

6. Construction Math

6.1 Use Math: Apply **mathematics concepts to solve HVAC, electrical, and plumbing problems** distinguishing which principles apply to a given problem. Concepts should include, but are not limited to the following:

a. operating with whole numbers, fractions, and decimals;

b. performing conversions between fractions, decimals, and percentages. For example, convert a decimal to a fraction to prepare a unit for measurement on a fractional scale to the precision of 1/16 of an inch;
c. working with units such as feet, inches, meters, centimeters, and millimeters, and determining appropriate units for a given construction task. For example, determine how many pieces of 2 ft. 4 in. PVC pipe may be cut from a 10 ft. piece and how much pipe will be left over;
d. calculating the area of two-dimensional spaces. Calculating surface area and volume for three-dimensional objects employing related geometric terminology;
e. performing proportionate reasoning to estimate quantities; and
f. using basic rules of right triangles, such as the Pythagorean Theorem to find missing lengths.

Additional Concepts include:

a. performing conversions between the metric system and the English system and among units within the metric system;
b. calculating the square and square root of numbers;
c. solving algebraic equations; and
d. calculating values associated with angles and triangles.

7. Electrical Systems

7.1 Electrical Shock Prevention: Describe **how different levels of electrical shock affect the human body**. Research current OSHA standards and other regulations specific to job-site electrical safety to identify **methods and equipment to reduce the risk of injury due to electrical shock.** Drawing on evidence from textbooks and OSHA standards, apply **lockout/tagout procedures** to ensure safe conditions for working on electrical systems. For example, perform a lockout/tagout on a circuit breaker.

7.2 Electrical Circuits and Materials: Examine **basic electrical circuits and components.** Explain the **difference between conductors and insulators.** Demonstrate understanding of the **layout and operation of electrical circuits**, such as series, parallel, and series-parallel circuits. Define voltage, resistance, current, and the units of measure associated with each. Describe the **relationship between voltage, resistance, and current as defined by Ohm's law**. Compare and contrast the instruments used to measure voltage, resistance, and current.

7.3 Voltage and Current: Apply **Ohm's law and Kirchhoff's laws** to **solving given problems in electrical circuits.** Defend the solution using supporting evidence that explains the cause-and-effect relationship between the laws and each of the following:

a. voltage,
b. current,
c. resistance, and
d. voltage drop.

For example, use Ohm's law to calculate the current flow of a circuit for an electric dryer with a given voltage and resistance.

7.4 Electrical Components: Building on the knowledge of **basic electrical circuits**, examine a **residential wiring system and explain the layout and the basic function of each component in the system** (e.g., service entrance, electric meter, service entrance panel, sub panel, circuit breakers, switches, receptacles, and conductors). Distinguish between **branch circuits and feeder circuits**. Describe the difference between **resistive and inductive loads in electrical circuits** and explain how physical laws apply. Study a residential wiring plan and identify **common electrical symbols** used. Explain a **simple residential electrical wiring plan** accurately describing the name and function of each component, how the components work together, and the impact of the physical laws on the circuit.

7.5 Conductors: Analyze the **composition and properties of conductors.** Explain **how the markings on a conductor relate to the physical properties of the conductor**, including the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses of the conductor. Inspect electrical charts and tables to determine the ampacity of a given conductor and to draw conclusions about the **relationships among the physical properties of a conductor**, such as size and ampacity. Explain **how color coding is used to distinguish among conductor purposes.** Interpret the meaning of color and markings on conductors.

7.6 Replace Devices: Determine the **procedures necessary to safely replace or install electrical devices in a device box**, such as a light fixture, receptacle, or switch. Draw on resources such as the device manufacturer's instructions and other instructional texts to determine the tools, steps, and safety procedures involved. Apply knowledge about conductors and electrical lockout/tagout procedures to safely complete **installations of a device in a device box**. Steps should include using test equipment to verify the power is off and connecting conductors to the proper terminals. For example, install a single-pole switch in a device box.

8. Plumbing Systems

8.1 Plumbing Safety: Examine **safety considerations specific to plumbers** by identifying **possible hazards on a job site.** Explain **how to work safely in and around confined spaces and trenches** as a journeyman plumber would to a plumber's helper.

8.2 Plumbing System: Describe the **movement of potable water and waste within the plumbing systems of a building** drawing **distinctions between water supply systems and drain, waste, and vent systems**. Explain how physical principles such as gravity and pressure apply within plumbing systems and how they contribute to the proper functioning and efficiency of the system. Illustrate why an understanding of these physical principles is important to a plumbing professional in the design, installation, maintenance, and repair of plumbing systems.

8.3 Plumbing Codes: Determine **common requirements found in plumbing codes** and explain why **the codes are necessary**; include the **importance of proper plumbing on human health**. Examine a health or safety issue involved with plumbing; then illustrate the problem and describe how it can be prevented or remedied with proper plumbing applications.

9. Piping

9.1 Pipe Fittings: Analyze the **parts of a pipe fitting** including the face, center, and back. Determine **fitting allowances** by using measuring and calculating techniques and by consulting manufacturer's tables. Calculate the **length of pipe needed for a given application** by implementing common pipe measuring techniques.

9.2 Plastic Piping: Compare and contrast the **material properties and uses of the various types of plastic piping**, including storing and handling, safety issues, and types of fitting and hanging equipment. Analyze the **use of plastic piping in plumbing systems and HVAC systems.** Describe the **factors influencing the decision to use plastic piping in a residence.** Demonstrate the ability to select the correct materials, tools, and PPE to complete plastic piping projects by creating a list of the items needed for a specific installation. For example, for a residential bathroom sink drain, create a basic list of the materials, tools, and equipment needed to install the drain.

9.3 Use Plastic Piping: Employ **tools and procedures to safely measure, cut, ream, and join plastic piping and fittings**. For example, accurately measure PVC pipe, use a miter box and handsaw to cut pieces of pipe, ream and chamfer the ends, and join the pipe using solvent cement.

10. Heating, Ventilation, and Air Conditioning Systems (HVAC)

10.1 HVAC Safety: Examine **safety considerations specific to HVAC technicians** by identifying **possible hazards on a job site.** Analyze the regulations that impact the work of HVAC technicians, such as the Clean Air Act and EPA guidelines. Summarize these regulations to an individual contemplating starting an HVAC business explaining key considerations and citing resources that the future business owner can consult.

10.2 HVAC System: Describe the **basic components included in an HVAC system**, **outlining the purposes of each**, citing textual resources such as blueprints, manuals, and manufacturers' specifications. Drawing on this evidence, describe **the impact of a well-tuned HVAC system on building energy efficiency as well as on human health and well-being**. Similarly, describe the **negative consequences that can arise due to a poorly functioning or improperly installed HVAC system.**

10.3 Heating: **Explain the fundamental concepts of heating and combustion**, including describing the **processes by which heat is transferred**. Illustrate the **differences in heat transfer by conduction, convection, and radiation** by performing experiments. Record observations, citing evidence that heat is being transferred, identify the heat source, note the direction heat is moving, and determine the type of heat transfer taking place.

10.4 Heat Transfer: Relate the **types of heat transfer to the various heating systems** used within a building. Examine the **basic layout of a heating system within a building**, such as a single-family residence, and note the **movement of heat, identifying areas of heat loss and heat gain.** Citing the principles of heat transfer, propose strategies the homeowner could use to conserve energy in the home.

11. Construction Drawings and Specifications

11.1 Drawings and Specifications: Inspect and interpret a full set of **construction drawings and specifications for a construction project** including civil, architectural, structural, mechanical, plumbing, electrical, and fire protection drawings and specifications. Read and interpret **different drawing types**, including plan view drawings, elevation view drawings, section drawings, detail drawings, and schedules. Explain the **relationship between different types of drawings, the importance of cross-referencing different types of drawings with one another, and cross-referencing drawings with specifications.** For example, explain how a floor plan, elevation, and detail drawing may all be used to inform the reader about the location of a given building component, such as a lighting fixture.

12. Business and Project Management

12.1 Communication: Describe **strategies used to promote collaboration, trust, and clear communication** among internal and external parties on a job site. Practice **effective verbal, nonverbal, written, and electronic communication skills** for working with colleagues, employers, clients, and other personnel while demonstrating the ability to listen attentively, speak courteously and respectfully, resolve obstacles in construction, and respond to criticism. For example, assume the roles of a construction business owner and a potential client, listen to the needs of a potential client, and respond to the potential client by email; explain the services provided by the company and the next steps needed to begin the project. Other role-playing could include a construction business owner and a potential subcontractor.

12.2 Reports: Log **daily activities completed during a project.** Document important facts concisely in a personal daily report as would a technician to a supervisor including daily progress, equipment and materials used, personnel involved, and other occurrences.

13. Portfolio

13.1 Portfolio: **Update materials from coursework to add to the portfolio** started in *Fundamentals of Construction*. Continually reflect on coursework experiences and revise and refine the career plan generated in the prior course. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

14. Team Project

14.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identify one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.

c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
  - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive module credit for NCCER and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
  - 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.

HVAC

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H17
Prerequisite:	*Mechanical, Electrical, & Plumbing Systems* (C17H23)
Credit:	1
Grade Level:	11-12
Elective Focus -Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 one of the third-year course options in the *Mechanical, Electrical, & Plumbing (MEP) Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html .
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	501, 502, 523, 532, 567, 592, 598, 701, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in

Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom
CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standard 3.1-3.2 |** Visit a local company and discuss construction industry principles with those employees.
- **Standard 4.1-11.3** | Complete a project that is used by local industry or evaluated by local industry managers.
- **Standard 12.1-12.2** | Ask an industry representative to discuss troubleshooting on the job.
- **Standard 13.1-13.2** | Ask an industry representative to discuss the impact of construction drawings and specifications on the job.
- **Standard 14.1-14.5** | Ask an industry representative to discuss the importance of project management.
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Course Description

HVAC prepares students for careers in residential and commercial heating, ventilation, air conditioning, and refrigeration. Upon completion of this course, proficient students will be able to demonstrate knowledge and skill in performing basic operations with HVAC systems, with emphasis on safety, tools, and equipment specific to HVAC. In addition, students will be able to explain the functions and components of heating, cooling, and air distribution systems. They will demonstrate basic techniques to prepare piping and tubing for HVAC systems including performing soldering and brazing. Students will understand proper refrigerant management in preparation for EPA Section 608 Technician Certification. They will read and interpret drawings, specifications, and diagrams to determine the materials needed to complete an HVAC project. Standards in this course also introduce basic troubleshooting and maintenance procedures and alternate power systems and expand on principles of the construction industry delving deeper into business and project

management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Rules: Identify **safety hazards on a job site** and demonstrate practices for safe working. **Accurately read, interpret, and demonstrate adherence to safety rules**, including but not limited to 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**. Recognize and employ **universal construction signs and symbols** such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Explain the need for **job site security** to prevent liability.

1.2 Safety Practices: Continue to maintain **safety records** and **demonstrate adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures when operating tools and equipment**, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: Follow **procedures to work safely around materials.** Adhere to **responsibilities for employees in material safety** as outlined by the **Hazard Communication Standard (HazCom)**, such as locating and interpreting material safety data sheets (MSDS). For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate **safe procedures to move materials** by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. Describe **hazards involved with HVAC work,** including working around refrigerants, oils, and gases.

2. Tools & Equipment

2.1 Tool and Equipment: Identify and select the **proper tools and accessories,** critique the **readiness of the tools,** use the **tools to accomplish the desired tasks**, and then return the tools and accessories to their proper storage. Research a **new technology** recently developed for the HVAC industry.

3. Construction Industry Principles

3.1 HVAC Work: Locate and assess **requirements for performing HVAC work** including local, state, and national requirements. Interpret **HVAC codes** and **determine inspection**

procedures and other **applicable portions of the law.** Visit the **Tennessee Contractor's Licensing Board's website** and analyze its **policies and requirements**. Explain **how such policies impact local construction businesses.**

3.2 Project Delivery Methods: Consult a variety of sources to **describe alternatives to traditional project delivery methods**, such as the design-build and construction management-related methods, distinguishing among the **roles and relationships of various construction personnel** in each scenario. Examine the **project delivery method** of an actual company. Develop a company profile with supporting graphics the company could share with a client describing the services provided and explaining the project delivery method used by the company.

4. HVAC and Electricity

4.1 Electricity in HVAC: Building on knowledge of electricity from *Mechanical, Electrical, and Plumbing Systems*, **describe the functions of electrical components used in HVAC systems**. Examine an **electrical diagram of an HVAC system** and interpret **symbols to describe the system** distinguishing between load devices and control devices. For example, annotate a basic HVAC electrical diagram to explain the purpose and function of each component in the overall system to an entry-level HVAC technician.

5. Heating Systems

5.1 Heat Loss: Building on knowledge of heat transfer from *Mechanical, Electrical, & Plumbing Systems*, describe the **processes by which heat loss calculations** are made for a residence. Describe a variety of ways in which heat is lost and why it is important for HVAC professionals to know how to perform heat loss calculations. For a given residence, follow procedures to **perform a basic heat loss calculation** for a residence with a given u-value and location.

5.2 Gas Furnaces: Analyze various **types of gas furnaces** and explain **how they operate**. Describe the **equipment and controls** involved, the concept of combustion, the various gas fuels, and their combustion characteristics. **Explain the proper procedures for installing and maintaining gas furnaces.** Perform **basic maintenance tasks** on a gas furnace, including replacing air filters and measuring temperature.

5.3 Compare and Contrast Heating Systems: Compare and contrast **gas furnaces, hydronic heating systems, and electric heating systems** by analyzing the operating procedures and pros and cons of each system.

6. Cooling Systems

6.1 Cooling Systems: Describe the **relationship between temperature and pressure** and relate it to the **use of refrigerant in cooling systems.** Distinguish between **absolute**

pressure and gauge pressure. Summarize the **processes involved in the basic mechanical refrigeration cycle**, including the **changes of state that occur** and the **basic patterns of the refrigerant flow**. Analyze the **major components of cooling systems and how they function,** including compressors, condensers, evaporators, and controls. Draw evidence from textbooks, professional journals, and instructional websites to produce an explanation of the refrigerant cycle and the functioning processes of cooling systems.

6.2 Measuring Temperature: Utilize common measurement instruments including thermometers and gauge manifolds to **measure temperature and pressure in an operating cooling system.** Demonstrate the ability to calibrate a set of refrigerant gauges and thermometers, connect a refrigerant gauge manifold, and properly calculate subcooling and superheat on an operating system using the gauge manifold and a temperature probe.

7. Refrigerant Management

7.1 Refrigerants and the Environment: Building on knowledge from *Mechanical, Electrical, & Plumbing Systems*, describe the **impact of refrigerants on the environment and the laws and regulations that are in place to protect the environment**, such as the Montreal Protocol, the Clean Air Act, and EPA technician certification requirements. Distinguish among the **various types of refrigerants**, identifying the **properties and cylinder color codes of each type**. Read and interpret **safety precautions and regulations** impacting the recovery, containment, handling, and disposal of refrigerants, including EPA regulations, manufacturer's technical bulletins and MSDSs, and transportation requirements established by the U.S. Department of Transportation (DOT), analyzing how requirements are structured in the text. For example, evaluate the condition of a refrigerant container and determine if it meets DOT requirements, including proper labeling. Interpret unresolved or inadequately documented information.

7.2 Refrigerant Leak Testing: Describe the **strategies and equipment used to leak-test refrigerant circuits**. Apply the appropriate tools, equipment, and **procedures to safely pressurize a refrigerant system** in preparation for leak testing, and leak test the pressurized system.

7.3 Refrigerant Recycling and Recovery: Explain the **various procedures used to recover, recycle, and reclaim refrigerant from equipment.** Read and interpret technical documents to determine the **required recovery level of a given HVAC system**. Apply the appropriate tools, equipment, and procedures to **safely perform refrigerant-recovery techniques** while adhering to **applicable regulations**, including applying proper labeling and maintaining accurate records. Interpret and implement regulations surrounding the recycling, reclaiming, and disposing of refrigerant.

7.4 System Evacuation: Evaluate the **purpose and procedures of system evacuation of an air conditioning system**. Describe steps for selecting the appropriate tools to perform an evacuation for a given system. Compare and contrast common methods of evacuation, such

as deep vacuum and triple evacuation. **Apply the appropriate tools, equipment, and procedures to safely perform a system evacuation.**

7.5 Charge a Refrigerant Circuit: Explain and demonstrate **how to properly charge various types of refrigerant circuits** using different methods including by weight, by superheat, and by subcooling, safely employing the appropriate, tools, equipment, and procedures.

8. Air Distribution Systems

8.1 Air Distribution Systems: Describe the **physical principles involved in air distribution systems**, including pressure, velocity, and volume. Recognize the various types and properties of mechanical equipment that make up an air distribution system, including various blowers, fans, duct materials, grilles, registers, and dampers. **Analyze the design of a simple air distribution system (i.e., as found in a typical residence) and explain how the system functions** noting where physical principles can be observed. Create a visual display with supporting text to explain the functions of the system.

8.2 Ventilation: **Explain the purpose and importance of ventilation in modern HVAC systems.** Recommend how an HVAC technician could share with a client to illustrate the impact of proper ventilation on indoor air quality, including services provided by the technician, and steps the client can take to ensure high indoor air quality.

8.3 Energy Efficiency: Illustrate **how the design and proper installation of an air distribution system impacts the energy efficiency** of the system**.** Drawing on observations, supporting technical manuals, and resources such as those from the U.S. Green Building Council and EPA Energy Star, outline strategies to increase energy efficiency for the HVAC system in a given building, such as properly sealing the ducts, dampers, and vent locations.

8.4 Test Equipment: Utilize test equipment, including tachometers, manometers, and velometers to **analyze the performance of an air distribution system.** For example, collect measurements with a velometer, apply the information to calculate the airflow volume in a duct, and report the findings using appropriate units. Read and interpret equivalent length charts and required air volume and duct size charts.

9. Basic Copper & Plastic Piping

9.1 Plastic Piping: Distinguish among **different types of plastic pipe, fittings, and valves** for use in HVAC, and **select the correct support and spacing for HVAC plastic piping**. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of plastic pipe. Employ tools and procedures to **safely measure, cut, and join plastic piping and fittings** for HVAC**.**

9.2 Copper Tubing: Describe the **properties of various types of copper tubing** used for HVAC. Describe common fittings, hangers, and supports used in copper tubing. Demonstrate **how**

to measure, cut, and bend copper tubing for HVAC systems while preparing the tubing to be joined. Demonstrate **techniques for mechanically joining copper tubing**, including flared connections and compression connections. Prepare tubing for soldering and brazing by **swaging, deburring, and cleaning a tube**. Inspect completed joints by **safely performing leak testing procedures**.

10. Soldering & Brazing

10.1 Compare and Contrast Soldering and Brazing: Explain the **purpose and process of soldering and brazing for an HVAC professional** outlining **how the techniques work**. Compare and contrast **soldering and brazing, noting the uses, procedures, and equipment for each.** Distinguish among the **purposes, types, and uses of a variety of filler alloys and fluxes** used in soldering and brazing.

10.2 Tools and Equipment for Soldering and Brazing: Describe the **tools, equipment, and PPE used for soldering and brazing.** Explain the **safe operation of soldering and brazing equipment** including assembling, testing, lighting, and shutting down acetylene and oxyacetylene equipment. Safely set up and shut down an acetylene single tank and oxyacetylene equipment. Describe and demonstrate **procedures to safely prepare, solder, and braze copper tubing using various fittings.**

10.3 Conduct Soldering and Brazing: Implement safe **procedures to complete copper, brass, and steel tubing assemblies for a given layout.** Steps include measuring, cutting, and fitting assemblies; choosing the proper filler alloys and fluxes for the assigned job; demonstrating proper use of acetylene and oxyacetylene equipment; and pressure testing assemblies to determine the proper completion of assemblies.

11. Carbon Steel Piping

11.1 Steel Piping: Describe the **characteristics and uses of steel pipe** making note of the similarities and differences in steel piping, plastic piping, and copper tubing. Draw on evidence from textbooks and physical observations to support claims.

11.2 Steel Pipe Threads: Analyze the **classification and measurement of pipe threads**. Describe the **uses of different types of fittings used on steel pipe**. Employ **tools and procedures to safely measure, cut, thread, and ream steel pipe.**

11.3 Join Steel Piping: Explain and demonstrate the **methods of installing, connecting, and mechanically joining steel pipe**, including joining threaded pipe using fittings, pipe grooving methods, and assembling flanged steel pipe.

12. Basic Maintenance & Repair Process

12.1 HVAC Troubleshooting: Identify and demonstrate **basic troubleshooting strategies appropriate for evaluating HVAC systems, appliances, and devices**. For example, develop and implement a troubleshooting strategy to test and remedy an undercharged system.

12.2 HVAC Maintenance: Identify **routine maintenance procedures that should be performed on HVAC systems for a given building.** Describe a timeline of recommended maintenance procedures for a client justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of items to inspect, clean, and replace in order to keep an HVAC system running efficiently.

13. Construction Drawings & Specifications

13.1 Drawings and Specifications: Explain the **relationship between construction drawings and specifications**. Describe **how both the construction drawings and specifications provide information about the HVAC system for a building.** For example, examine construction drawings and specifications to determine the requirements for hangers and supports in a given HVAC piping system.

13.2 Request for Information: Describe **processes by which construction professionals obtain clarification from architects** regarding construction documents, such as by the use of **requests for information (RFI's).** Write a request for information (RFI), as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product.

14. Business & Project Management

14.1 Contracts: Describe **the components and purpose of a basic contract document for a residential project** determining the meaning of key terms and other industry-specific words. Recognize **the relationship and responsibilities of various parties to a contract.** Write a basic contract for a job, such as an HVAC service agreement for work done for a residential client.

14.2 Project Management: Establish and implement **specific goals to manage project assignments in a timely manner**, including organizing teams to effectively manage assignments, monitoring, and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing constructive feedback for improvement. Similarly, respond to constructive feedback from a team member to improve project outcomes and meet project goals.

14.3 Project Completion: Interpret **construction drawings and diagrams** to determine the **correct materials, tools, and equipment needed to complete an HVAC project.** Plan and implement **the steps needed to complete the project**, adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a material list, cost estimation, schedule, and inspection checklist for a project, applying the components of the documents to the given project.

14.4 Communication: Produce and **describe clear and coherent writing for communication in the HVAC industry.** Create a service order for a given HVAC project. Explain the service order to a peer as would a service technician to a client.

14.5 Reports: Utilize technology to write and share **periodical reports** (weekly, monthly, etc.) to provide others with information about progress during HVAC projects as would a project manager to a supervisor. Summarize activities in a **narrative form including overall progress in relationship to a previously planned schedule.**

15. Portfolio

15.1 Portfolio: Update materials from coursework to add to the portfolio started in *Fundamentals of Construction* and *Mechanical, Electrical, & Plumbing Systems*. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER HVAC Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
    - 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.

Electrical Systems

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H16
Prerequisite(s):	*Mechanical, Electrical, & Plumbing Systems* (C17H23)
Credit:	1
Grade Level:	11-12
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 one of the third year course options in the *Mechanical, Electrical, & Plumbing (MEP) Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	523, 532, 567, 580, 592, 701
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Building Maintenance, and Electrical Wiring.

Using Work-Based Learning (WBL) 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 1.1-1.4** | Include a safety briefing in a visit to an industry partner/job site.
- **Standard 3.1-3.2** | Visit a local company and discuss construction industry principles with those employees.
- **Standards 4.1-5.2** | Invite a guest speaker.
- **Standards 6.1-8.2** | Complete a project or work at a job site to be critiqued by the employer.
- **Standards 9.1-9.3** | Ask an industry representative to discuss the impact of construction drawings with an electrician on the job.
- **Standards 11.1-11.2** | Ask an industry representative to discuss the realities of basic troubleshooting.
- **Standards 13.1-13.5** | Complete a project that is used by local industry or evaluated by local industry managers.

Course Description

Electrical Systems prepares students for careers as electricians across a variety of residential and commercial environments. Upon completion of this course, proficient students will be able to implement safety procedures and tools to perform operations with device boxes, conduits, raceway systems conductors, and cables. Students will read and interpret the National Electrical Code, drawings, specifications, and diagrams to determine the materials and procedures needed to complete a project. Students will calculate residential loads to recommend electrical hardware.

Standards in this course also introduce basic troubleshooting procedures and power systems and expand on principles of the construction industry, delving deeper into business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards: Identify **safety hazards on a job site** and demonstrate **practices for safe working.** Accurately read, interpret, and demonstrate **safety rules**, including but not limited to 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**. Recognize and employ **universal construction signs and symbols** such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate **construction company safety plans** from local industry. Explain the need for **job site security** to prevent liability.

1.2 Safety Records and Industry Practices: Maintain **safety records** and demonstrate **adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures** when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety Procedures: Follow procedures to work safely around materials. Adhere to responsibilities for employees in **material safety** as outlined by the **Hazard Communication Standard (HazCom)**, such as locating and interpreting **material safety data sheets (MSDS).** For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

1.4 Electricity Hazards: Describe **hazards involved when working with electricity** and determine **procedures to safeguard against them** in the workplace, including ensuring power load balance, adhering to the appropriate use of ground-fault circuit interrupters (GFCIs) when working with power tools, and performing lockout/tagout procedures.

2. Tools and Equipment

2.1 Tools: Identify and select the **proper tools** and accessories, critique the readiness of the tools, use the tools to **accomplish the desired tasks**, and then return the tools and accessories to their proper storage. Research a **new technology** recently developed for the electrical industry. For example, describe how a new power tool could improve efficiency for a technician.

2.2 Test Equipment: Distinguish among the **various types and uses of electrical test equipment**. Determine the **appropriate test equipment for a given situation and environment** and the **procedures necessary for safe use**. Utilize test equipment to inspect and test the **compliance of an electrical wiring system** according to drawings, specifications, and code requirements.

3. Construction Industry Principles

3.1 Electrical Work: Understand **how electrical work fits into the overall construction project**. Locate and assess **requirements for performing electrical work** including local, state, and national requirements. Interpret **electrical codes** and determine **inspection procedures** and other applicable portions of the law. Visit the **Tennessee Contractor's Licensing Board's website** and analyze its **policies and requirements**. Explain how such policies impact local construction businesses.

3.2 Alternative Project Delivery Methods: Explain a **project delivery method**. Consult a variety of sources to describe **alternatives to traditional project delivery methods**, such as the design-build and construction management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario. Examine the project delivery method of an actual company.

4. National Electrical Code (NEC©)

5. National Electrical Code: Describe the **purpose and layout of the National Electrical Code (NEC©)**. Illustrate **what is and is not covered by the NEC©,** citing evidence from *NEC© Article 90*. Navigate, read, and interpret the NEC© to determine **requirements for a given electrical installation**. For example, interpret the NEC© to compare and contrast the box requirements for a device box to support a wall receptacle with those for a box to support a lighting fixture.

Device Boxes

5.1 Identify Device Boxes: Distinguish among the various **types of device boxes**, such as metallic and nonmetallic device boxes. For a variety of given residential and/or commercial applications, **select appropriate device boxes** according to drawings, specifications, and code requirements. Steps should include identifying the proper box type and size and determining the minimum size pull or junction box for conduit entering and exiting both for a straight pull and at an angle.

5.2 Install Device Boxes: Utilize the proper tools, equipment, and procedures to safely install **a variety of device boxes** according to drawings, specifications, and code requirements.

6. Hand Bending

6.1 Hand Bend Conduit: Describe the procedures, techniques, and tools for **hand bending and installing conduit**. Implement **geometric principles to plan and use a hand bender** to make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends. For example, use trigonometric ratios of right triangles to determine the offset angle of an offset bend and use the calculation to accurately create the bend.

6.2 Cut, Ream, and Thread Conduit: Apply the appropriate tools, equipment, and procedures to safely **cut, ream, and thread conduit**. For example, ream the inside edge of a piece of conduit using a hand reamer.

7. Raceway Systems

7.1 Raceway Systems: Explain the **function of raceway systems**, including acting as a grounding conductor. Distinguish among the **various types of raceways, fittings, and conduit bodies** available for raceway systems**.** Analyze a given environment and select the **appropriate materials and installation methods for a raceway system** citing evidence from textbooks and codes. For example, recommend the appropriate raceway materials and installation method for a wood frame building of given parameters drawing on evidence from codes such as the National Electrical Code (NEC©).

8. Install Raceway Systems: Outline the **methods and procedures used to install various raceway systems, including terminating conduit.** Accurately **connect conduit to a box** according to code requirements explaining the need for a proper connection based on grounding requirements and protection of the wires. Apply the **appropriate tools and procedures to install flexible raceway systems.** **Conductors and Cables**

8.1 Conductor Capacity: Building on the knowledge of **conductors** from the *Mechanical, Electrical, & Plumbing Systems* course, read and interpret the NEC© and other instructional texts to determine **the allowable ampacity of conductors** for a variety of given applications. Include the insulation and jacket material, conductor size and type, number of conductors, temperature rating, and voltage rating of each. Describe possible **consequences of improper conductor selection or installation** citing evidence from resources such as textbooks or trade journals.

8.2 Conductors in Raceways: Describe the **proper methods and procedures for installing conductors in a raceway system** noting potential hazards that exist when conductors are installed incorrectly. Employ **tools and procedures to safely install conductors in a raceway system** and **verify the installation** is performed according to code requirements.

9. Construction Drawings and Specifications

9.1 Read Drawings and Specifications: Building on the knowledge of construction drawings and specifications from the *Mechanical, Electrical, & Plumbing Systems* course, read and interpret **electrical drawings and specifications**, including detailed drawings and equipment schedules, to create a **list of materials needed** for a given electrical project. For example, analyze a lighting plan, light fixture schedule, and specifications for a residence to determine the materials needed to install the lighting system.

9.2 Use Drawings and Specifications: Explain the **relationship between construction drawings and specifications**. For example, describe **how both the construction drawings and specifications provide information about the raceway system** indicated for a given building. Examine construction drawings and specifications to determine **the requirements for a raceway system in a given building.**

9.3 Request for Information: Describe processes by which construction professionals obtain **clarification from architects regarding construction documents**, such as by the use of requests for information (RFI's). **Write a request for information (RFI)** as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product.

10. Residential Electrical Services

10.1 Hardware in Residential Construction: Evaluate and recommend **proper electrical hardware for a residential building**. For example, for a residential dwelling with a given floor plan and schedule of major appliances, determine the size of the electrical service by referring to the National Electrical Code and local code to select the service-entrance equipment, such as conductors, panelboards, and protective devices. Steps should include calculating the load for lighting, small appliances, and large appliances, and determining the number of branch circuits required.

10.2 Dedicated Circuits: Describe the **installation rules pertaining to dedicated circuits** as applied to various equipment such as ranges, dryers, and HVAC systems.

11. Basic Maintenance and Repair Process

11.1 Troubleshooting: Identify and demonstrate **basic troubleshooting strategies appropriate for evaluating electrical systems and devices**. For example, in electrical systems, develop and implement a troubleshooting strategy to test and remedy an electrical fault.

11.2 Maintenance Procedures: Identify **routine maintenance procedures that should be performed on electrical systems** for a given building. Create a **timeline of recommended maintenance procedures for a client** justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of tests to ensure emergency alarms are operating properly.

12. Introduction to Power Systems

12.1 Power Systems: Analyze **typical electric power systems in a region** by explaining how electricity is generated, transmitted, and distributed from a power plant to a given location**.** Describe **different types of traditional power generation** including fossil-fuel generation and nuclear energy. Explain the **basic layout of the power grid** and the function of its components, including substations and transformers.

12.2 Environmental Impacts of Electricity: Discuss the **environmental impacts of generating and distributing electricity.** Research alternate electric power systems, including but not limited to photovoltaic systems and wind power technologies. Describe the **functions of the systems and analyze their use in regions across the country** according to informational texts and technical specs. Compare and contrast at least three **types of power generation systems.**

12.3 Control Operation: Understand the **basics of control operation in an electrical system**. Explore the different types of **control circuits** and their use. Identify the different types of

devices used in a control circuit and if they would be classified as input or output devices. Identify the devices and their use in ladder logic drawings and wiring schematics. Identify the **components in a PLC system**, including input devices, output devices, and variable speed drives. Identify their use in a basic PLC system. Identify how to safely perform **maintenance procedures and field wiring installations on various control systems**.

13. Business and Project Management

13.1 Contract Documents: Describe the **components and purpose of a basic contract document** for a residential project determining the meaning of **key terms and other industry-specific words**. Recognize the **relationship and responsibilities of various parties to a contract**. Write a **basic contract for a construction job,** such as an electrical service agreement, for wiring work done for a residential client.

13.2 Project Management: Establish and implement **specific goals to manage project assignments** in a timely manner, including organizing teams to effectively manage assignments, monitoring, and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work providing constructive feedback for improvement. Similarly, respond to **constructive feedback from a team member** to improve project outcomes and meet project goals.

13.3 Materials, Tools, and Equipment Lists: Interpret construction drawings and applicable national and local codes to determine **the correct materials, tools, and equipment needed to complete a construction project.** Plan and implement the **steps needed to complete the project** adhering to inspection procedures and **employing safe practices** throughout. **Create a material list, cost estimation, project schedule, and inspection checklist** for a project applying the components of the documents to the given project.

13.4 Write an Order: Produce clear and coherent writing for communication in the electrical industry. Create a **service order for a given electrical project.** Explain the service order to a peer, as would a service technician to a client.

13.5 Write a Report: Utilize technology to write and share **periodical reports** (e.g., weekly, monthly, etc.) to provide others with **information about progress during electrical projects as would a project manager to a supervisor**. Summarize the activities in a narrative form including overall progress in relationship to a previously planned schedule.

14. Portfolio

14.1 Portfolio: **Update materials from coursework to add to the portfolio** started in *Fundamentals of Construction* and *Mechanical, Electrical, & Plumbing Systems*. Continually reflect on coursework experiences, and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Electrical Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
    - 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.

Plumbing Systems

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H18
Prerequisite:	*Mechanical, Electrical, & Plumbing Systems* (C17H23)
Credit:	1
Grade Level(s):	11-12
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 one of the third-year course options in the *Mechanical, Electrical, & Plumbing (MEP) Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	527, 567, 580, 592, 703
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

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Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Welding.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2 |** Ask an industry representative to discuss construction industry principles' impact on the job.
- **Standards 4.1-4.4** | Ask an industry representative to discuss how drawings and specifications are used on the job.
- **Standard 5.1** | Ask an industry representative to discuss the importance of math on the job.
- **Standards 6.1-11.3** | Complete a project that is used by local industry or evaluated by local industry managers.
- **Standard 12.1** | Invite a guest speaker.
- **Standards 13.1-13.2** | Ask an industry representative to discuss the importance of troubleshooting.
- **Standards 15.1-15.5 |** Ask an industry representative to discuss project management.

Course Description

Plumbing Systems prepares students for careers in plumbing across a variety of residential and commercial settings. Upon completion of this course, proficient students will be able to implement safety procedures and tools to perform operations with plumbing systems. Students will be able to explain how drain, waste, and vent (DWV) systems, water distribution systems, and plumbing fixtures work and apply proper tools and procedures to perform operations with plumbing piping,

including measuring, cutting, joining, supporting, and hanging various types of pipe. Students will read and interpret drawings, specifications, and diagrams to determine the materials needed to complete a plumbing project. Standards in this course also introduce basic maintenance and troubleshooting procedures and expand on principles of the construction industry, delving deeper into business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards and Rules: Identify **safety hazards on a job site** and demonstrate **practices for safe working.** Accurately read, interpret, and demonstrate **adherence to safety rules,** including but not limited to 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**. Recognize and employ **universal construction signs and symbols** such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate construction company safety plans from local industry. Explain the need for job site security to prevent liability.

1.2 Safety Practices: Continue to maintain **safety records** and demonstrate **adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures when operating tools and equipment**, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: Follow **procedures to work safely around materials**. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate **safe procedures to move materials** by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. Describe **hazards involved with plumbing work**, including working in confined spaces.

2. Tools & Equipment

2.1 Tools: Identify and select the **proper tools and accessories**, critique **the readiness of the tools**, use the **tools to accomplish the desired tasks,** and then return the tools and accessories to their proper storage. Research a new technology recently developed for the plumbing industry. Explain how the use of the technology could benefit a company citing

evidence from resources. For example, describe how a new power tool could improve efficiency for a plumber.

3. Construction Industry Principles

3.1 Plumbing in the Construction Industry: Locate and assess **requirements for performing plumbing work** including local, state, and national requirements. Interpret **plumbing codes,** and determine **inspection procedures** and other applicable portions of the law. Visit the **Tennessee Contractor's Licensing Board's website** and analyze its **policies and requirements**. Explain how such policies impact local construction businesses.

3.2 Project Delivery Methods: Consult a variety of sources to describe **alternatives to traditional project delivery methods**, such as the design-build and construction management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario. Examine the **project delivery method** of an actual company. Develop a **company profile** with supporting graphics the company could share with a client describing the **services provided** and explaining the **project delivery method** used by the company.

4. Construction Drawings & Specifications

4.1 Construction Drawings: Building on the knowledge of construction drawings and specifications from *Mechanical, Electrical, & Plumbing Systems*, examine **plumbing drawings** and identify **common plumbing symbols used** for the **components of pipe assemblies**. **Read and interpret construction drawings**, including detailed drawings and equipment schedules, to create a list of materials needed for a given plumbing project. For example, analyze **plumbing plans and isometric drawings** to determine the **materials needed to install a drain, waste, and vent system.**

4.2 Drawings and Specifications: Explain the **relationship between construction drawings and specifications**. **Describe how both the construction drawings and specifications provide information about the plumbing system for a building.** For example, examine construction drawings and specifications to determine the requirements of hangers and supports for a given plumbing piping system.

4.3 Request for Information: Describe **processes by which construction professionals obtain clarification from architects regarding construction documents**, such as by the use of requests for information (RFIs). Write a **request for information (RFI)** as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product.

4.4 Scale Drawings: Demonstrate the ability to use an **architect's scale** to measure a **component of a scale drawing**. Create drawings commonly used in the plumbing trade, including orthographic and isometric sketches.

5. Plumbing Math

5.1 Math: Apply **mathematics concepts to solve plumbing problems** distinguishing which principles apply to a given problem. Concepts should include, but are not limited to the following:

a. Using the basic rules of right triangles, such as the 3-4-5 ratio, to lay out and check square corners.
b. Calculating values associated with angles and triangles to determine the run, travel, and rise of an offset.

6. Plastic Pipe & Fittings

6.1 Plastic Pipe and Fittings: Building on the knowledge of plastic piping from *Mechanical, Electrical, and Plumbing Systems*, distinguish among **different types of plastic plumbing pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of plastic pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of plastic plumbing pipe, including ABS, PVC, CPVC, PE, PEX, and PB. Create a list of the appropriate piping materials, tools, and equipment needed for a given plastic piping application including supports and spacing.

6.2 Install Plastic Pipe: Read and interpret the manufacturer's instructions, construction drawings, specifications, and applicable codes to **properly install plastic pipe**, including measuring, cutting, joining, and supporting plastic pipe. Utilize the **appropriate tools, equipment, PPE, and procedures** to safely complete installations. Once installed, pressure test the plastic pipe according to the local plumbing code to verify installation was properly completed.

7. Copper Tube & Fittings

7.1 Copper Tube and Fittings: Distinguish among **different types of copper tubes, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the material properties of copper tubes and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of copper tubes. Create a **list of the appropriate piping materials, tools, and equipment** needed for a given copper tubing application including supports and spacing.

7.2 Install Copper Tube and Fittings: Read and interpret the **manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install copper tubing**, including measuring, cutting, bending, joining, grooving, and supporting plastic pipe. Utilize the **appropriate tools, equipment, PPE, and procedures** to safely complete installations. Once installed, **pressure test the copper tube** according to the local plumbing code to verify installation was properly completed.

8. Cast-Iron Pipe & Fittings

8.1 Cast-Iron Pipe and Fittings: Distinguish among **different types of cast-iron pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of cast-iron pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for **cutting and joining hub-and-spigot cast-iron pipe and no-hub cast-iron pipe**. Create a list of the appropriate piping materials, tools, equipment, and PPE needed for a given cast-iron piping application including selecting the correct supports and spacing.

8.2 Install Cast-Iron Pipe and Fittings: Demonstrate **proper procedures to correctly measure, cut, and join cast-iron pipe** utilizing the appropriate tools, equipment, and PPE. Describe testing procedures used to check cast-iron piping for leaking joints, as designated in the local plumbing code.

9. Carbon Steel Pipe & Fittings

9.1 Carbon Steel Pipe and Fittings: Distinguish among **different types of steel pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of steel pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and **procedures for cutting and joining steel pipe**. Create a list of the appropriate piping materials, tools, and equipment needed for a given steel piping application including supports and spacing.

9.2 Install Carbon Steel Pipe and Fittings: Read and interpret **the manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install steel pipe,** including measuring, cutting, joining, and supporting steel pipe. Utilize the appropriate tools, equipment, PPE, and procedures to safely complete installations.

10. Plumbing Fixtures

10.1 Plumbing Fixtures: Describe the **features and operating principles of various types of plumbing fixtures**, including sinks, lavatories, faucets, bathtubs, showers, and water closets. Analyze the **operational procedures of two different water closets**, such as a siphon-action water closet and a blow-out water closet. Compare and contrast the functions and benefits of each citing resources to make a recommendation for a client based on the specific needs of a project.

11. Drain, Waste, & Vent (DWV) Systems

11.1 Sewer System: Study a **schematic plan of a typical community sewer system**. Citing evidence from a technical description or actual observation of a system, explain **how waste and air move through a drain, waste system, and vent system from the fixture to the**

environment. For example, create a basic diagram of how the waste generated by a clean-up sink in the classroom travels to the local sewage treatment plant.

11.2 Drain, Waste, and Vent System: Demonstrate an understanding of the **specific roles of various plumbing components in a drain, waste system, and vent system**. Identify the components, and describe the **function of each**. Be able to describe the physical principles involved such as gravity and pressure.

11.3 Correct a Defective Trap: Analyze the **function of a trap by examining a drain, waste system, and vent system whose trap has lost its seal.** Diagnose and explain **the cause of the problem with the trap** and determine the **appropriate solution** citing evidence from textbooks or technical manuals to justify why the chosen solution is preferable or more effective than another.

12. Water Distribution Systems

12.1 Water Distribution System: Study a schematic **plan of a typical municipal water distribution system**. Explain **how water travels from a water treatment plant to a fixture in a residence**. Create a graphic illustration to represent the **movement of water from one component to the others in the system**. For example, sketch an isometric drawing of a simple water distribution system and label its components.

13. Basic Maintenance & Repair Process

13.1 Troubleshooting: Identify and demonstrate **basic troubleshooting strategies appropriate for evaluating plumbing systems and devices**. For example, in a drain system, develop and implement a troubleshooting strategy to test and remedy a clogged drain.

13.2 Plumbing Maintenance: Identify **routine maintenance procedures that should be performed on plumbing systems** for a given building. Create a timeline of **recommended maintenance procedures for a client** justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of items to inspect and clean to keep a water heater running efficiently.

14. Green Practices in Plumbing

14.1 Plumbing Efficiency: Define the term ***efficiency*** **in the context of the plumbing profession and plumbing systems**. Research and identify **strategies used in the design of plumbing systems and plumbing work practices to increase the efficiency of plumbing systems.** Drawing on resources such as those from the U.S. Green Building Council and EPA Energy Star, create a recommendation for a client outlining green plumbing strategies for a given building.

15. Business & Project Management

15.1 Contract: Describe the **components and purpose of a basic contract document** for a residential project determining the meaning of key terms and other industry-specific words. Recognize the **relationship and responsibilities of various parties to a contract**. Write a **basic contract for a job**, such as a **plumbing service agreement** for work done for a residential client.

15.2 Project Management: Establish and implement **specific goals to manage project assignments** in a timely manner, including organizing teams to effectively manage assignments, monitoring and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing constructive feedback for improvement. Similarly, respond to **constructive feedback from a team member** to improve project outcomes and meet project goals.

15.3 Determine Materials for a Project: Interpret **construction drawings and applicable local plumbing codes** to determine the **correct materials, tools, and equipment needed to complete a plumbing project.** Plan and implement the **steps needed to complete the project** adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a material list, cost estimation, project schedule, and inspection checklist for a project applying the components of the documents to the given project.

15.4 Communication: Produce **clear and coherent writing for communication** in the plumbing industry. Create a **service order** for a given plumbing project. Explain the service order to a peer, as would a service technician to a client.

15.5 Reports: Utilize technology to write and share **periodical reports** (weekly, monthly, etc.) to provide others with **information about progress during plumbing projects** as would a project manager to a supervisor. Summarize activities in a narrative form including overall progress in relationship to a previously planned schedule.

16. Portfolio

16.1 Portfolio: Update materials from coursework to add to the portfolio started in *Fundamentals of Construction* and *Mechanical, Electrical, & Plumbing Systems*. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Plumbing Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
    - 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.

Construction Practicum

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H22
Prerequisite(s):	Minimum of 2 credits in an Architecture & Construction program of study.
Credit:	1
Grade Level:	12
Elective Focus - Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 fourth course in the *Residential & Commercial Construction*, *Structural Systems,* and *Mechanical, Electrical, and Plumbing Systems* programs of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html .

Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	501, 502, 522, 523, 524, 527, 532, 553, 554, 555, 556, 567, 575, 580, 584, 585, 592, 598, 701, 702, 703, 705, 706, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	Teachers must hold and maintain an active WBL certificate by completing WBL Coordinator Training every two years to oversee this course for credit.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Work-Based Learning: Career Practicum is a capstone course intended to provide students with opportunities to apply the skills and knowledge learned in previous CTE and general education courses within a professional work environment. The course allows students to earn high school credit for select models of work-based learning, which allow students to interact with industry professionals in order to extend and deepen classroom work and support the development of postsecondary and career readiness knowledge and skills.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) in Your Classroom

Practicum activities may take the form of work-based learning (WBL) opportunities (such as internships, cooperative education, service learning, and job shadowing), or industry-driven project-based learning. These experiences must comply with the Work-Based Learning Framework guidelines established in SBE High School Policy 2.103. As such, this course must be taught by a teacher with an active WBL Certificate issued by the Tennessee Department of Education and follow policies outlined in the Work-Based Learning Policy Guide available online at https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html

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 2.1-2.4** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.4 |** Visit a local company and discuss career options with employees and managers.
- **Standard 3.5** | Ask an industry representative to participate in the mock interview.
- **Standards 4.1-5.1** | Complete a project that is used by local industry or evaluated by local industry managers.
- **Standards 6.1-6.3** | Ask an industry representative to help evaluate the portfolio and project.

Course Description

Construction Practicum is a capstone course intended to provide students with the opportunity to apply the skills and knowledge learned in previous Architecture & Construction courses within a professional, working environment. In addition to developing an understanding of the professional and ethical issues encountered by tradesmen and contractors in the workplace, students learn to refine their skills in problem-solving, communication, teamwork, and project management in the completion of a course-long project. Due to the importance of on-the-job training in the construction industry, a principle aim of the practicum is to assist students with placements where on-the-job training occurs, if available, so they can begin to log hours on a worksite and gain experience prior to entering the job market, such as in pre-apprenticeships. Additionally, students are exposed to the great range of postsecondary opportunities in today's construction fields as well, in order to prepare them to make an informed decision regarding their post-high school plans.

The course is highly customizable to meet local system needs. Instruction may be delivered through work-based learning arrangements such as internships, cooperative education, service learning, mentoring, and job shadowing, or school laboratory training with industry-driven project-based learning. For all projects undertaken in this course, students are expected to continue building skills related to their chosen program of study (*Residential & Commercial Construction, Structural Systems, or Mechanical, Electrical, & Plumbing Systems*), while also refining skills previously acquired to achieve deeper levels of mastery. In the course, students may pursue additional training and certification in a specialized area such as masonry, concrete, electricity, plumbing, HVAC, or carpentry. Upon completion of the practicum, proficient students will be prepared to pursue further study in architecture or construction or seek additional training and employment with the aid of a portfolio documenting student work completed throughout high school.

Course Requirements

This capstone course aligns with the requirements of the Work-Based Learning Framework (established in Tennessee State Board High School Policy), with the Tennessee Department of

Education's Work-Based Learning Policy Guide, and with state and federal Child Labor Law. As such, the following components are course requirements:

Course Standards

2 Personalized Learning Plan

1.1 Personalized Learning Plan: A student will complete a Personalized Learning Plan that identifies their **long-term goals**, demonstrates how the Work-Based Learning (WBL) experience aligns with their elective focus and/or high school plan of study, addresses how the student plans to **meet and demonstrate the course standards**, and addresses **employability skill attainment** in the following areas:

a. application of academic and technical knowledge and skills (embedded in course standards),
b. career knowledge and navigation skills,
c. 21st-century learning and innovation skills, and
d. personal and social skills.

3 Safety

2.1 Safety Hazards: Identify safety hazards on a job site and demonstrate **practices for safe working**. Accurately read, interpret, and demonstrate **adherence to safety rules**, including but not limited to 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. Recognize and employ **universal construction signs and symbols** such as colors, flags, stakes, and hand signals that apply to construction workplace situations.

2.2 Safety Records: Maintain safety records and demonstrate adherence to **industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures** when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

2.3 Safety Procedures with Materials: Follow procedures to work safely around materials. Adhere to responsibilities for employees in **material safety** as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). Demonstrate safe procedures to **move materials** by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

2.4 Procedures for Accidents and Injuries: Research state and national laws governing **workplace injuries**, particularly those common to the construction industry. Outline the necessary procedures to follow if an **injury is sustained on the job**; in particular, explain the responsibilities of managers, supervisors, and the injured parties in the event of an emergency, including incident reporting after the event. Practice explaining the process of **securing workers' compensation benefits** as if assisting a co-worker or subordinate.

4 Postsecondary and Career Preparation

3.1. Postsecondary Options: Research the **range of credentials** one can earn with advanced study of construction at the postsecondary level (i.e., apprenticeship, technical certification, B.A., B.S., M.B.A, etc.). Investigate both **in-state and out-of-state postsecondary programs** in a variety of construction fields, including but not limited to construction management, construction science, architecture, landscape design, civil engineering, and more.

3.2. Construction Companies: Research and select a **company or organization** for a **project in a construction field**. Cite specific textual evidence from the organization's literature, as well as independent news articles, to summarize:

a. the mission and history of the organization,
b. headquarters and organizational structure,
c. products or services provided,
d. credentials required for employment and how they are obtained and maintained,
e. policies and procedures,
f. reports, newsletters, and other documents published by the organization, and
g. website and contact information.

3.3 Resume: Search for the **resumes of construction professionals** retrieved from the websites of companies, organizations, or professional networks. Discuss **what is typically included in the resumes** of these professionals, compare and contrast several examples, and **create a personal resume** modeled after elements identified in the search.

3.4 Job Search: Simulate the experience of conducting a **job search** by researching local employment options. In preparation for a future career in construction, complete an **authentic job application form** and compose a **cover letter** following the **guidelines specified in the vacancy announcement.**

3.5 Interview: Participate in a **mock interview**. Prior to the interview, research tips on dress and grooming, most commonly asked interview questions, appropriate conduct during an interview, and recommended follow-up procedures. Highlight **sample work** compiled in the portfolio that illustrates **mastery of specific skills** attained in the program of study. Upon completion of the interview, write a **thank you letter** to the interviewer in a written or email format.

4 Transferring Course Concepts to Practicum

4.1 Work-Based Learning: Apply skills and knowledge from previous courses and participate in an **authentic work-based learning internship, job shadow, or classroom-based project.** Where appropriate, **develop, practice, and demonstrate skills** outlined in previous courses.

4.2 Project Plan: As part of a course project, **develop a comprehensive project plan**, appropriate to the project type, to guide all work. The plan should include at minimum the following:

a. material list,
b. cost estimation/mock bid package,
c. criteria and constraints,
d. project schedule,
e. inspection checklist,
f. applicable contracts,
g. minutes from project meetings and other documentation,
h. contingency plan in case of delay or emergency, and
i. justification for major design and budgeting decisions made.

Collaboratively update the plan to reflect unexpected changes in conditions or capacity. For example, demonstrate the ability to **reschedule an activity** if there is a delay in the arrival of materials.

4.3 Personal Journal: Create and continually update a **personal journal** to document skills learned during the practicum and draw **connections between the experience and previous course content** by reflecting on:

a. tasks accomplished and activities implemented,
b. positive and negative aspects of the experience,
c. how challenges were addressed,
d. team participation in a learning environment,
e. comparisons and contrasts between classroom and work environments,
f. interactions with colleagues and supervisors,
g. personal career development, and
h. personal satisfaction.

5 Business Skills and Project Management

5.1 Use Project Management Tools: Develop and successfully implement a **suite of project management tools and processes to aid in the completion of the course project**. If participating in a work-based learning experience, apply tools and processes to satisfy placement requirements. Demonstrate the ability to **divide roles and responsibilities** among team members, **track progress** toward goals, and **satisfy client specifications** as would a construction manager or contractor. For example, assign tasks and monitor deliverables using a Gantt chart or other tracker.

6 Portfolio

6.1 Portfolio: Update **materials from coursework to add to the portfolio** started in *Fundamentals of Construction* to illustrate mastery of skills and knowledge outlined in the previous courses and applied in the practicum. The portfolio should reflect a thoughtful assessment and evaluation of the **progression of work involving the application of project management skills specific to the construction industry**. The following documents will reside in the career portfolio:

a. career plan developed and revised in prior courses,
b. resume,
c. list of responsibilities undertaken through the course,
d. examples of visual materials used during the course (such as diagrams, schematics, and site plans) and artifacts of project outcomes (such as photographs of various stages of a construction project),
e. periodic journal entries reflecting on tasks and activities,
f. feedback from the instructor and/or supervisor based on observations,
g. transcripts or other evidence of certifications obtained throughout the program of study, and
h. communication of project results.

6.2 Technical Report: Apply all steps of the **construction process** to successfully build a structure and/or install a system(s) as outlined in the course project plan. Demonstrate the **ability to communicate results** over the course of the project's duration. Produce a **technical report** documenting the progress of the project and evaluating the final product.

6.3 Presentation: Upon completion of the practicum, **analyze highlights, challenges, and lessons learned** from the experience. The presentation should be delivered orally with supporting diagrams, drawings, videos, photographs, and/or finished structures or products. Justify construction decisions and assess the quality of the work.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - 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.

Residential & Commercial Construction I

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H24
Prerequisite(s):	*Fundamentals of Construction* (C17H15)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 second course in the *Residential & Commercial Construction* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	580 OR a minimum of three of the following endorsements: 522, 523, 524, 527, 598, OR a minimum of three of the following endorsements: 701, 702, 703, 706, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2** | Visit a local company and discuss career options with those employees.
- **Standards 4.1-4.2** | Ask an industry representative to discuss how construction industry principles impact on the job.
- **Standards 5.1-10.2** | Complete a project that is used by a local industry or evaluated by local industry managers.
- **Standard 11.1** | Ask an industry representative to discuss how drawings and specifications are used on the job.
- **Standards 12.1-12.4** | Ask an industry representative to discuss the importance of project management.

Course Description

Residential & Commercial Construction I is the second course in the *Residential & Commercial Construction* program of study intended to prepare students for careers in construction by developing an understanding of the different phases of a construction project from start to finish. Upon completion of this course, proficient students will be able to demonstrate knowledge and skill in the earlier phases of building construction, including site layout, foundation systems, concrete, framing systems, and electrical systems. Students will be able to perform concrete work; frame walls, ceilings, and floors of a structure; and install proper wiring while safely employing tools and interpreting construction drawings to complete projects. Emphasis is placed on demonstrating proper measurement and application of mathematical concepts. Standards in this course also include principles of the construction industry and business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards and Rules: Identify **safety hazards** on a job site and demonstrate **practices for safe working conditions.** Accurately read, interpret, and demonstrate **adherence to safety rules**, including but not limited to 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. Perform a **hazard assessment for a given task** such as changing the light bulbs in a classroom. Explain the steps necessary to safely perform the task, outlining procedures to follow in the case of an emergency.

1.2 Safety Practices: Maintain safety records and demonstrate **adherence to industry-standard practices** regarding **general machine safety, tool safety, equipment safety, electrical safety, and fire safety** to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures** when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete safety test with 100 percent accuracy.

1.3 Materials Safety: Follow **procedures to work safely around materials.** Adhere to **responsibilities for employees in material safety** as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting **material safety data sheets (MSDS)**. Demonstrate **safe procedures to move materials** by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

2. Tools and Equipment

2.1 Tools: For each of the systems covered in this course, identify, and select the **proper tools and accessories,** critique the **readiness of the tools, use the tools to accomplish the desired tasks**, and then return the tools and accessories to their proper storage locations. For example, demonstrate the ability to safely use a darby or bullfloat to level a concrete surface and effectively clean and store the tool.

3. Career Exploration

3.1 Apprenticeship: Referencing data from the U.S. Department of Labor and other sources, research and explain an **apprenticeship**. Describe the **benefits of the apprenticeship** approach of on-the-job training paired with related training for **individuals seeking construction careers.** Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable.

3.2 Postsecondary Programs: Research and explain **postsecondary programs** and their institutions (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer construction-related programs. Identify **entry requirements for a specific postsecondary program of study and the secondary courses** that will prepare students to be successful in the program.

4. Construction Industry Principles

4.1 Zoning Regulations: Investigate and report on the **process for determining the zoning regulations for a particular building site**. Describe how **zone designation and regulations** such as setbacks, ground coverage, and maximum height impact the **design and placement of a building on a given site** citing findings from the investigation.

4.2 Building Codes: Explain **inspection procedures** used to enforce building codes during the construction of a residential or commercial building outlining the **roles and responsibilities of the building inspector and the contractor** and the intervals at which inspections are performed.

5. Site Layout

5.1 Site Drawings: Describe the **basic procedures by which surveyors create site drawings**. Read and interpret a site drawing to determine the **steps, personnel, equipment, and materials needed to prepare a site for construction.** Relate the **site features** labeled on the plan to the layout and topography on the actual site. Develop a timeline and action steps needed to complete a site layout.

5.2 Site Layout: Apply the appropriate **mathematical principles, tools, equipment, and procedures to accurately lay out a site**, including the following:

a. Estimate distances by employing pacing techniques.
b. Complete precise measurements with manual or electronic equipment, using mathematical concepts as necessary, such as converting decimal feet to feet and inches, or applying right triangle rules such as the 3-4-5 rule. For example, in the process of staking the corners of a building using taping procedures, calculate the diagonal of the building by plugging the length and width of the building into the Pythagorean Theorem. Then, use the diagonal value to locate the third corner and check the completed layout for accuracy.
c. Describe the tools, equipment, and procedures involved in establishing elevations on a site. For example, use a builder's level to determine site and building elevations.
d. Annotate site layout data using proper field note techniques.

6. Foundation Systems and Properties of Concrete

6.1 Foundation Systems: Compare and contrast **types of foundation systems and footings**. Create a written report or visual description outlining the **structure and properties** of each type. Describe the **conditions, costs, and other factors that influence the decision to use each type of system.**

6.2 Concrete Composition: Describe the **composition of concrete** by listing the **materials used to make concrete.** Analyze the **factors that impact the compression strength of concrete,** such as the water-cement ratio. Identify **additional materials used in concrete construction**, such as **reinforcement materials and forms**. For example, create a comparison chart outlining the materials, forms, and reinforcement used in concrete for a sidewalk versus a bridge.

6.3 Concrete Volume: Calculate the total **volume of concrete and the specific materials necessary for a given project based on construction drawings and specifications**. Use the information to estimate the amount of each **material needed to mix concrete for the project**.

6.4 Concrete Curing: Analyze **factors influencing the curing of concrete**, such as the weather, moisture, and the use of control joints. Explain the curing of concrete outlining the **procedures necessary to ensure concrete cures properly** for a given date and location, including **procedures to prevent cracking and recommendations for the spacing of control joints.**

6.5 Place Concrete: Apply the **appropriate tools, equipment, and procedures to safely place concrete and clean up after a concrete project**. Work in teams to safely and properly employ **tools and personal protective equipment (PPE**). Follow **procedures to construct a simple concrete form, place concrete into the form, and strike-off (screed), level, smooth, edge, and joint concrete to finish the project**.

7. Framing Systems Overview

7.1 Framing Systems: Distinguish among the **basic types of wood framing systems**, such as platform frames, balloon frames, and post-and-beam frames. Define and compare the **pros and cons of each citing examples of when each is used.**

8. Floor Framing Systems

8.1 Floor Frame Components: Identify the **components that make up a floor frame** analyzing the **purpose of and interrelationships among each component** and explaining the **sequence in which each is constructed**.

8.2 Floor System Requirements: Read and interpret construction drawings to determine **floor system requirements,** such as the proper girder and joist size for a given span and floor load, and estimate the **amount of material needed to frame a floor assembly**.

8.3 Build a Floor Assembly: Describe the procedures necessary to fasten sills to the foundation and construct a floor assembly. Apply the **appropriate tools, equipment, and procedures to build a floor assembly.** Work in teams to install girders, layout and install floor joists, install bridging and blocking, and apply subflooring.

9. Wall and Ceiling Framing Systems

9.1 Wall Frame Components: Explain the **procedure to lay out a wood frame wall,** defining and describing **the components** such as plates, studs, partitions, door and window openings, bracing, and other components.

9.2 Wall and Ceiling Frame Requirements: Read and interpret drawings to determine **wall and ceiling frame requirements for a given residential or commercial structure.** For example, calculate the **length of a stud** and estimate **the amount of material needed** to frame a wall and ceiling assembly.

9.3 Build a Wall and Ceiling Frame: Work in teams to construct a **wall frame and ceiling assembly** by implementing **required safety techniques, tools, and equipment.** Accurately **measure and lay out the frame**; accurately **level and plumb the walls**.

9.4 Steel Framing: Compare and contrast the **different tools, procedures, and fastening methods used in steel wall framing versus wood wall framing in building construction.** Outline the major **similarities and differences in each** and provide a **recommendation** to a client for a specific project.

10. Electrical Systems

10.1 Electrical Safety: Describe how OSHA's different **levels of electrical shock** affect the human body. Research **current standards and other regulations specific to electrical systems to identify methods and equipment** to reduce the risk of injury due to electrical shock. Drawing on evidence from textbooks and OSHA standards, **apply lockout/tagout procedures to ensure safe working conditions.** For example, perform a lockout/tagout to prepare to work on an electrical device.

10.2 Electrical Circuits: Citing technical data, explain the **interrelationships among sources of current, voltage, resistance, and power in electric circuits** and the **units to quantify each (amperes, volts, ohms, and watts).** Demonstrate understanding of **the operation of electrical circuits** (series, parallel, and series-parallel circuits) and relate it to the **physical laws**, such as Ohm's law and Kirchhoff's law, that govern the behavior of electrical circuits and devices such as the **function of resistors in electrical circuits**. Accurately apply these physical laws to solve problems. For example, use Ohm's law to calculate the current flow of a circuit for an electric dryer with a given voltage and resistance.

11. Construction Drawings and Specifications

11.1 Drawings and Specifications: Inspect and interpret a full set of **construction drawings and specifications for a construction project** including civil, architectural, structural, mechanical, plumbing, electrical, and fire protection drawings and specifications. Read and interpret different **drawing types including plan view drawings, elevation view drawings, section drawings, detail drawings, and schedules.** Explain the **relationship between different types of drawings and the importance of cross-referencing** different types of drawings with one another and cross-referencing drawings with specifications. For example, explain how a **floor plan, elevation, and detail drawing** may all be used to inform the reader about the layout and material of a given building component, such as a cabinet layout or an exterior wall.

12. Business and Project Management

12.1 Management and Communication: Describe **strategies used to promote collaboration, trust, and clear communication** among internal and external parties on a job site. Practice **effective verbal, nonverbal, written, and electronic communication skills** for working with colleagues, employers, clients, and other personnel while demonstrating the ability to listen attentively, speak courteously and respectfully, resolve obstacles in construction, and respond to criticism. For example, assume the roles of a construction business owner and a potential client, listen to the needs of the potential client, and respond to the potential client by email; explain the services provided by the company and the next steps needed to begin the project. Other role-playing could include a construction business owner and a potential subcontractor.

12.2 Contracts: Describe the **components and purpose of a basic contract document for a residential project.** Recognize the **relationship and responsibilities of various parties to a contract.** Write a **basic contract for a construction job**, such as a carpenter's contract to complete a deck addition for a residential client.

12.3 Materials: Interpret **construction drawings to determine the correct materials, tools, and equipment needed to complete a construction project.** Plan and implement the **steps needed to complete the project,** adhering to **inspection procedures** and employing **safe practices** throughout. Draw from print and electronic examples to create and publish a **material list, cost estimation, construction schedule, and inspection checklist** for a project applying the components of the documents to the given project.

12.4 Reports: Log **daily activities completed during a construction project** over an extended period of time. Document important facts concisely in a daily report as would a project manager on a job site, including **daily progress, equipment and materials used, personnel involved, and other work-related activities.** Review and revise as appropriate.

13. Portfolio

13.1 Portfolio: **Update materials from coursework to add to the portfolio** started in *Fundamentals of Construction*. Continually reflect on coursework experiences, revise, and refine the career plan generated in the prior course using technology where appropriate. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

14. Team Project

14.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identify one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)

e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
  - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will complete modules working toward a certificate of completion for NCCER Construction Technology and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
  - 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.

Residential & Commercial Construction II

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code:	C17H25
Prerequisite:	*Residential & Commercial Construction I* (C17H24)
Credit:	1-2 credits (see Recommended Credit below)
Grade Level:	11
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 third course in the *Residential & Commercial Construction* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	580 OR a minimum of three of the following endorsements: 522, 523, 524, 527, 598, OR a minimum of three of the following endorsements: 701, 702, 703, 706, 707
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2** | Ask an industry representative to discuss how construction industry principles impact the job.
- **Standards 4.1-10.2** | Complete a project that is used by local industry or evaluated by local industry managers.
- **Standards 11.1-11.2** | Ask an industry representative to discuss how drawings and specifications are used on the job.
- **Standards 12.1-12.3** | Ask an industry representative to discuss the impact of project management on the job.

Course Description

Residential & Commercial Construction II is the third course in the *Residential & Commercial Construction* program of study intended to prepare students for careers in construction by developing an understanding of the different phases of a construction project from start to finish. Upon completion of this course, proficient students will be able to demonstrate knowledge and skill in the later phases of building construction including roofing systems, exterior finishing, stair framing systems, masonry systems, and plumbing systems. Students will be able to perform masonry work; frame roofs; install shingles on roofs; apply exterior finishes; and install proper piping for plumbing systems while safely employing tools and interpreting construction drawings to

complete projects. Emphasis is placed on demonstrating proper measurement and application of mathematical concepts. Standards in this course also include an introduction to heating, ventilation, and air conditioning systems, principles of the construction industry, and business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Recommended Credit

If all standards in the course are covered, the course is recommended for two credits. If only one credit is to be offered, the following two options are recommended:

1 Credit Option A: Exterior

Content	Standards
Safety	1.1-1.3
Tools & Equipment	2.1
Construction Industry Principles	3.1-3.2
Roofing Systems	4.1-4.6
Exterior Finishing	5.1-5.4
Basic Stair Framing Systems	6.1-6.2
Introduction to Masonry Systems	7.1-7.2
Construction Drawings & Specifications	11.1-11.2
Business & Project Management	12.1-12.3
Portfolio	13.1

1 Credit Option B: Interior

Content	Standards
Safety	1.1-1.3
Tools & Equipment	2.1
Construction Industry Principles	3.1-3.2
Plumbing Systems	8.1-8.6
Principles of Electrical Systems	9.1-9.3
Introduction to HVAC	10.1-10.2
Construction Drawings & Specifications	11.1-11.2
Business & Project Management	12.1-12.3
Portfolio	13.1

Course Standards

1. Safety

1.1 Safety Hazards and Rules: Identify **safety hazards on a job site** and demonstrate **practices for safe working conditions.** Accurately read, interpret, and demonstrate **adherence to safety rules,** including but not limited to 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. Recognize and employ **universal construction signs and symbols** such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate **construction company safety plans** from local industry. Explain **the need for job site security to prevent liability**. Drawing from examples, create and implement a **job site safety program** in the class to ensure safe practices and procedures including job site security procedures.

1.2 Safety Practices: Maintain **safety records** and demonstrate adherence to **industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment**. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate **safety procedures when operating tools and equipment,** such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: Follow procedures to work safely around materials. Adhere to responsibilities for employees in **material safety** as outlined by **the Hazard Communication Standard (HazCom)**, such as locating and interpreting **material safety data sheets (MSDS)**. For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate safe **procedures to move materials** by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

2. Tools & Equipment

2.1 Tools: For each of the systems covered in this course, identify, and select the **proper tools and accessories,** critique the **readiness of the tools,** use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage. Research a **new technology** recently developed for the construction industry. Convince an employer how the use of the technology could benefit the company, citing evidence from resources. For example, describe how a new power tool could improve efficiency and reduce muscle fatigue for a construction team.

3. Construction Industry Principles

3.1 Policies: Locate and assess the **Tennessee Contractor's Licensing Board's website** and analyze the **policies and requirements for construction work in Tennessee**. Explain how such policies impact local construction businesses.

3.2 Project Delivery Methods: Consult a variety of sources to describe **alternatives to traditional project delivery methods**, such as the design-build and construction management-related methods distinguishing among the **roles and relationships of various construction personnel** in each scenario. Examine the **project delivery method** of an actual company. Develop a **company profile** with supporting graphics the company could share with a client **describing the services provided and explaining the building delivery method used by the company.**

4. Roofing Systems

4.1 Roof Components: Define and describe the **framing components of gable and hip roofs** such as the ridge board, plates, and types of rafters. Explain and/or illustrate the **roles of each component** and **how they work together in a roof framing system**.

4.2 Roof Framing Requirements: Read and interpret drawings to determine **roof framing requirements**, such as calculating the length of a rafter based on the **desired pitch** and estimating the **materials needed to frame and sheath a roof**. For example, use a speed square to lay out a common rafter on a piece of lumber.

4.3 Construct Roof Frame: Work in teams to construct a **roof frame assembly** by implementing required **safety techniques, tools, and equipment** to accurately measure, lay out, construct, and sheath a roof frame. For example, frame a gable roof with an opening.

4.4 Roof Framing Procedures: Compare and contrast different **procedures to frame a roof**. For example, describe the benefits of using prefabricated trusses in place of framing with rafters on site. Outline the major similarities and differences in each and describe **why using either prefabricated trusses or framing with rafters is more beneficial for a specific project**.

4.5 Roofing Materials: Compare and contrast the **materials, methods, and procedures for roofing** with fiberglass shingles with other roofing materials such as wood shingles, metal roofing, and membrane-type roofing systems. Perform a **cost analysis** for a client to help the client choose between two roofing materials for a specific project given the **site** location, project budget, environmental considerations, and other factors.

4.6 Install Shingles: Apply the appropriate tools, equipment, and procedures to safely install **shingles on a roof,** including strategies for **watertight installation**, using quantitative reasoning and geometric formulas where applicable. For example, interpret **construction documents to estimate the roofing materials needed to install fiberglass shingles on a gable roof**. Install fiberglass shingles after preparing the roof with **underlayment, flashing, and other preparation materials.**

5. Exterior Finishing

5.1 Wall Section: Examine a **wall section drawing** for a specific building. Identify, define, and explain the **function of each component** including wall insulation, flashing, and the structure of the cornice.

5.2 Construct Cornice: Interpret **wall section drawings** for the **safe construction of a cornice**. For example, accurately measure materials, employ tools, and follow procedures to build a box cornice, checking for accuracy in each step.

5.3 Finish Systems: Analyze various **finish systems used to sheath a building**, including but not limited to wood siding, fiber-cement siding, vinyl siding, metal siding, stucco, and masonry veneer finishes. Explain **why the different materials and methods are used for specific projects.**

5.4 Siding Materials: Estimate the **siding materials needed to cover a building** utilizing mathematical principles such as area formulas and quantitative reasoning. Utilize the appropriate **procedures, tools, and materials to install various types of siding**. For example, identify three siding methods that are commonly used in the area and demonstrate the ability to plan the installation of and install each.

6. Basic Stair Framing Systems

6.1 Plan Stair System: Analyze the **components of a stair system**. Read and interpret construction drawings to determine **stair system requirements** such as the total rise, number and size of risers, and number and size of treads. Based on stated requirements, estimate the **amount of material needed to frame a stair assembly**.

6.2 Build Stair System: Apply the **appropriate tools, equipment, and procedures for the safe building of a small stair unit** demonstrating proper procedures for **laying out and cutting stringers, risers, and treads.**

7. Introduction to Masonry Systems

7.1 Masonry: Describe the **materials and methods used in modern masonry**. Distinguish between masonry units made of **clay products** (i.e., brick) and masonry units made of **concrete** (i.e., block), analyzing the composition and structure of common units. Differentiate between the **types of masonry construction**, such as solid masonry walls, cavity walls, and veneer walls, citing examples of when each is used. Apply the knowledge to examine two different masonry constructions found in the school or community comparing the **composition and construction methods** of each.

7.2 Bricklaying: Describe and demonstrate the **procedures and techniques of basic bricklaying**, including preparing mortar, laying a mortar bed, and laying bricks. Apply the **appropriate tools, equipment, and procedures to safely mix mortar** and properly use a **trowel** to spread and furrow **bed joints** and buttered **joints**.

8. Plumbing Systems

8.1 Sewer System: Study a **schematic plan of a typical community sewer system**. Citing evidence from a technical description or actual observation of a system, explain the **path of waste and air through a drain, waste system, and vent system from the fixture to the environment**.

8.2 Plumbing Components: Demonstrate understanding of the **specific roles of various plumbing components** in a drain, waste, and vent system. Identify and describe the **components and their functions**, including the physical **principles involved such as gravity and pressure.**

8.3 Trap: Analyze the **function of a trap** by examining a **drain, waste, and vent system** whose trap has lost its seal. Diagnose and explain the cause and determine the **appropriate solution**; then justify why the chosen solution is preferable or more effective than another.

8.4 Plumbing Codes: Determine **common requirements found in plumbing codes** and explain why the codes are necessary; include **the importance of proper plumbing on human health**. Examine a case in which poor plumbing contributed to the outbreak of disease in a community and describe how it could have been prevented with proper plumbing applications.

8.5 Plumbing Materials: Compare and contrast the **material properties and uses of the various types of plastic and copper piping,** including storing and handling, safety issues, and types of fitting and hanging equipment. Describe the **factors influencing the decision to use plastic or copper piping in a residence**. Demonstrate the ability to select the **correct materials, tools, and PPE to complete both plastic and copper piping projects** by creating a list of the items needed for a specific installation. For example, for a residential bathroom sink drain, create a list of the materials, tools, and equipment needed to install the drain.

8.6 Use Plumbing Tools: Employ **tools and procedures to safely measure, cut, ream, and join plastic and copper piping and fittings**. For example, accurately measure PVC pipe, use a miter box and handsaw to cut pieces of pipe, ream and chamfer the ends, and join the pipe using solvent cement.

9. Principles of Electrical Systems

9.1 Electrical Hardware: Evaluate and recommend **proper electrical hardware for a residential building**. For example, for a residential dwelling with a given floor plan and schedule of major appliances, determine the **size of the electrical service** by referring to the **National Electrical Code** to select the service-entrance equipment, such as conductors, panelboards, and protective devices. Steps should include calculating the load for lighting, small appliances, and large appliances and determining the number of branch circuits required. Describe the **installation rules pertaining to dedicated circuits** as applied to various equipment such as ranges, dryers, and HVAC systems.

9.2 Install Box Device: Utilize the proper tools, equipment, and procedures to select and safely perform **basic installation of device boxes** according to drawings, specifications, and code requirements.

9.3 Testing Electrical System: Explain the **inspection and testing of an electrical wiring system** for compliance according to drawings, specifications, and code requirements using equipment such as a voltmeter.

10. Introduction to Heating, Ventilation, and Air Conditioning Systems (HVAC)

10.1 HVAC Principles: Demonstrate understanding of the **principles of heating, ventilation, and air conditioning systems.** Describe the **structure and function of each**.

10.2 HVAC Regulations: Examine the **regulations that impact the work of HVAC technicians**, such as the Clean Air Act and EPA guidelines. Explain **key considerations for beginning an HVAC business using these regulations**.

11. Construction Drawings & Specifications

11.1 Drawings and Specifications: Explain the **relationship between construction drawings and specifications**. For example, describe how both the construction drawings and specifications provide information about the exterior sheathing indicated for a building. Examine construction drawings and specifications to **determine the requirements of the sheathing for a given part of a building** and verify with measurements and other sources as needed.

11.2 Request for Information: Describe **processes by which construction professionals obtain clarification** from architects regarding construction documents, such as by the use of **requests for information (RFIs).** Examine a request for information (RFI) from a construction professional to an architect requesting clarification for a detail of the construction documents, such as the selection of a product.

12. Business & Project Management

12.1 Management: Establish and implement specific goals for **project assignment management** in a timely manner, including organizing teams to effectively manage assignments, monitoring, and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing **constructive feedback for improvement**. Similarly, respond to constructive feedback from a team member to improve project outcomes and meet project goals.

12.2 Estimating and Scheduling: Perform **estimating and scheduling techniques for a long-term project**, including calculating material quantities and cost (including tax) and labor cost to complete a bid sheet; scheduling construction activities using a flow chart; and determining amounts to be charged to the client at various intervals throughout the project.

12.3 Reports: Examine **periodic reports,** such as those from a project manager to a supervisor, that provide **information about progress during construction activities.** Identify the **key components of these reports.**

13. Portfolio

13.1 Portfolio: Update materials from coursework to add to the portfolio started in *Fundamentals of Construction* and *Residential & Commercial Construction I*. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses, using technology where appropriate. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will complete modules working toward a certificate of completion for NCCER Construction Technology and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
    - 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.

Structural Systems I

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H26
Prerequisite(s):	*Fundamentals of Construction* (C17H15)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 second course in the *Structural Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	522, 575, 580, 592, 706
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
  - **Standards 2.1-2.2** | Visit a local company and discuss career options with those employees.
  - **Standards 3.1-3.2** | Ask an industry representative to discuss how construction industry principles affect the job site.
  - **Standards 4.1-5.2** | Invite a guest speaker.
  - **Standard 7.1** | Ask an industry representative to discuss the use of drawings and specifications on the job.
  - **Standards 8.1-12.2** | Create a project that is used by local industry or evaluated by local industry managers.
  - **Standards 13.1-13.4** | Ask an industry representative to discuss the importance of project management.

Course Description

Structural Systems I prepares students for careers in residential and commercial carpentry. Upon completion of this course, proficient students will be able to demonstrate knowledge and skill in framing buildings. Students will be able to frame floors, walls, ceilings, roofs, and stairs while safely employing tools and interpreting construction drawings to complete projects. Emphasis is placed on demonstrating proper measurement and application of mathematical concepts. Standards in this course also include principles of the construction industry and business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards and Rules: **Identify safety hazards on a job site** and demonstrate practices for safe working. Accurately read, interpret, and **demonstrate adherence to safety rules**, including but not limited to 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. Perform a hazard assessment for a given task such as working on a ladder to install roof framing components. Explain the steps necessary to safely perform the task, outlining steps to take in case of an emergency.

1.2 Safety Records and Practices: **Maintain safety records and demonstrate adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety and Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: **Follow procedures to work safely around materials**. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

2. Career Exploration

2.1 Apprenticeship: Referencing data from the U.S. Department of Labor and other sources, **explain an apprenticeship**. Write persuasively to describe the benefits of the apprenticeship approach of on-the-job training paired with related training for individuals seeking construction careers. Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable.

2.2 Postsecondary Programs: Research apprenticeships and **postsecondary institutions** (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer **construction-related programs**. Write an informative paper or develop an infographic identifying entry requirements for a specific apprenticeship or postsecondary program of study and the secondary courses that will prepare students to be successful in the program.

3. Construction Industry Principles

3.1 Zoning Regulations: Investigate and report on the process for determining the zoning regulations of a building site. Describe how zone designation and regulations such as setbacks, ground coverage, and maximum height impact the design, placement, and use of a building on a given site, citing findings from the investigation. **Read and interpret zoning ordinances and other regulations impacting a given site** (city, county, historic district, subdivision regulations, etc.).

3.2 Building Codes: Explain inspection procedures used to **enforce building codes** during the construction of a residential or commercial building, outlining the roles and responsibilities of the building inspector and the contractor and the intervals at which inspections are performed.

4. Types of Structural Systems

4.1 Structural Framing Systems: **Compare and contrast types of structural framing systems**, including wood light-frame, structural steel, and reinforced concrete, analyzing the factors influencing the selection of a structural system for given building functions. Using textbooks, online resources, or examples in the community, select three buildings with different framing types and explain why each type was used for the building's function.

5. Materials and Methods of Light-Frame Wood Construction

5.1 Wood Framing Systems: **Distinguish among the basic types of wood framing systems**, such as platform frames, balloon frames, and post-and-beam frames. Create a chart to define and compare the pros and cons of each type citing examples of when each is used.

5.2 Wood Products: Analyze the **characteristics and uses of various types of wood products** used in light-frame construction.

a. Categorize types of wood as hardwood or softwood.
b. Identify differences in woods used in interior and exterior applications.
c. Identify grades of lumber, common lumber defects, and differences in treated and untreated lumber.
d. Explain the difference between actual and nominal lumber sizes.

e. Distinguish among the properties and uses of engineered wood products, such as plywood, hardboard, particleboard, oriented strand board, mineral fiberboard, glulam lumber, and wood I-beams.

6. Tools and Equipment

6.1 Tools: Accurately **identify hand and power tools used in carpentry** describing the safe use and maintenance of each. Hand tools include levels, squares, planes, clamps, and hand saws. Power tools include power saws, drill presses, routers, laminate trimmers, portable power planes, power metal shears, and pneumatic and cordless nailers and staplers. For each of the systems covered in this course, identify and select the proper tools and accessories, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage.

7. Construction Drawings and Specifications

7.1 Drawings and Specifications: **Inspect and interpret a full set of construction drawings and specifications for a construction project** including civil, architectural, structural, mechanical, plumbing, electrical, and fire protection drawings and specifications. Read and interpret different drawing types, including plan view drawings, elevation view drawings, section drawings, detail drawings, and schedules. Explain the relationship between different types of drawings and the importance of cross-referencing different types of drawings with one another and cross-referencing drawings with specifications. For example, explain how a floor plan, elevation, and detail drawing may all be used to inform the reader about the layout and material of a given building component, such as a cabinet layout or an exterior wall.

8. Floor Framing Systems

8.1 Building Layout: Implement geometric principles to **square a building layout**. For example, in the process of staking the corners of a building, check the layout for squareness by using the 3-4-5 rule based on right triangles and the Pythagorean Theorem.

8.2 Floor Frame Components: **Identify the components that make up a floor frame** analyzing the purpose of and interrelationships among each component and explaining the sequence in which each is constructed.

8.3 Floor System Requirements: Read and interpret construction drawings to **determine floor system requirements**, such as the proper girder and joist size for a given span and floor load, and estimate the amount of material needed to frame a floor assembly.

8.4 Build a Floor Assembly: Describe the procedures necessary to fasten sills to the foundation and **construct a floor assembly**. Apply the appropriate tools, equipment, and procedures

to build a floor assembly. Work in teams to install girders, lay out and install floor joists, install bridging and blocking, and apply subflooring.

9. Wall and Ceiling Framing Systems

9.1 Layout Wall Frame: Explain the procedure to **lay out a wood frame wall**, defining and describing the components such as plates, studs, partitions, door and window openings, bracing, and other components.

9.2 Frame Requirements: Read and interpret drawings to **determine wall and ceiling frame requirements** for a given residential or commercial structure. For example, calculate the length of a stud and estimate the amount of material needed to frame a wall and ceiling assembly.

9.3 Construct Wall Frame and Ceiling Assembly: Work in teams to **construct a wall frame and ceiling assembly** by implementing the required safety techniques, tools, and equipment. Accurately measure and lay out the frame; accurately level and plumb the walls.

10. Roof Framing Systems

10.1 Roof Framing Components: Define and describe the **framing components of gable and hip roofs** such as the ridge board, plates, and types of rafters. Demonstrate understanding of the roles of each component and how they work together in a roof framing system.

10.2 Roof Framing Requirements: Read and interpret drawings to **determine roof framing requirements**, such as calculating the length of a rafter based on the desired pitch and estimating the materials needed to frame and sheath a roof. For example, use a speed square to lay out a common rafter on a piece of lumber.

10.3 Construct Roof Frame Assembly: Work in teams to **construct a roof frame assembly** by implementing required safety techniques, tools, and equipment to accurately measure, lay out, construct, and sheath a roof frame. For example, frame a gable roof with an opening.

10.4 Framing Procedures: **Compare and contrast different procedures to frame a roof.** For example, describe the benefits of using prefabricated trusses in place of framing with rafters on site. Outline the major similarities and differences in each and explain why using either prefabricated trusses or framing with rafters is more beneficial for a specific project.

11. Introduction to Building Envelope Systems

11.1 Components of Building Envelope System: Analyze the **components of a building envelope system**, including building wrap, insulation, and various types of windows and exterior doors. Describe how the selection and installation of various components affect the

energy efficiency of the building, such as the impact of air sealing on energy efficiency. Identify materials and installation strategies used to minimize or prevent air infiltration. For example, explain how the glass type and the proper installation of a window impact the energy efficiency of the building.

11.2 Window and Door Installation: Describe the procedures necessary to prepare a rough opening and install windows and doors. **Apply the appropriate tools, equipment, and procedures to prepare rough openings for proper window and door installation**. Properly install a lockset in an exterior door.

12. Basic Stair Framing Systems

12.1 Components of Stair System: **Analyze the components of a stair system**. Read and interpret construction drawings to determine stair system requirements such as the total rise, number and size of risers, and number and size of treads. Based on stated requirements, estimate the amount of material needed to frame a stair assembly.

12.2 Build Stair Unit: Apply the appropriate tools, equipment, and procedures to safely **build a small stair unit**, demonstrating proper procedures for laying out and cutting stringers, risers, and treads.

13. Foundation and Concrete

13.1 Foundation: Explain the importance of the foundation to a structure. Describe the **procedures used to lay a foundation for a building**. Identify **various types of footings, foundation walls, and slabs, and explain their uses.**

13.2 Concrete Forms: Identify the various types of concrete forms and their components. **Erect, plumb, level, and brace a simple concrete form** with reinforcement.

13.3 Concrete: Identify the properties of cement. Describe the composition of normal concrete. **Place and finish concrete**. Perform a slump test.

14. Business and Project Management

14.1 Management and Communication: Describe strategies used to promote collaboration, trust, and clear communication among internal and external parties on a job site. **Practice effective verbal, nonverbal, written, and electronic communication skills** for working with colleagues, employers, clients, and other personnel while demonstrating the ability to listen attentively, speak courteously and respectfully, resolve obstacles in construction, and respond to criticism. **Describe the roles of a construction business owner** and a potential client. For example, role-playing could include a construction business owner and a potential subcontractor.

14.2 Contract: **Describe the components and purpose of a basic contract document** for a residential project. Recognize the relationship and responsibilities of various parties to a contract. Write a basic contract for a construction job, such as a carpenter's contract to complete a deck addition for a residential client.

14.3 Project Planning: Interpret construction drawings to determine the correct materials, tools, and equipment needed to complete a construction project. **Plan and implement the steps needed to complete the project,** adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a materials list, cost estimation, construction schedule, and inspection checklist for a project, applying the components of the documents to the given project.

14.4 Reports: Log daily activities completed during a construction project over an extended period of time. **Document important facts concisely in a daily report** as would a project manager on a job site, including daily progress, equipment and materials used, personnel involved, and other work-related activities.

15. Portfolio

15.1 Portfolio: **Update materials from coursework to add to the portfolio** started in *Fundamentals of Construction.* Continually reflect on coursework experiences and revise and refine the career plan generated in the prior course using technology where appropriate. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

16. Team Project

16.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)

e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
  - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Carpentry Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills
  - 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.

Structural Systems II

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H27
Prerequisite(s):	*Structural Systems I* (C17H26)
Credit:	1-2 credits (see Recommended Credit below)
Grade Level:	11-12
Elective Focus - Graduation Requirements:	This course satisfies one or two of the three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
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 third course in the *Structural Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.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/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary 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/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	522, 575, 580, 592, 706
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.

Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Course At A Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

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

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the 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 demonstrations. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Masonry.

Using Work-Based Learning (WBL) 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 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2 |** Ask an industry representative to discuss construction industry principles.
- **Standards 4.1-4.2** | Invite a guest speaker.
- **Standards 5.1-13.1** | Do a project that is used by local industry or evaluated by local industry managers.
- **Standards 15.1-15.2** | Ask an industry representative to discuss the impact of construction drawings and specifications on the job.
- **Standards 16.1-16.3** | Ask an industry representative to discuss the importance of project management.

Course Description

Structural Systems II is an advanced-level course that builds on the introductory skills learned in the *Fundamentals of Construction* and *Structural Systems I* course. This course will explore advanced framing, the physics of structural loads, and the coverings and finishes of structural systems. Upon completion of this course, proficient students will be able to install interior and exterior finishing, including roofing, siding, thermal and moisture protection components, drywall, doors, and trim. Throughout the course, students will interpret construction drawings to complete projects, implementing material estimating procedures and safe working practices. Standards in this course also expand on principles of the construction industry and delve deeper into business and project management strategies. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Recommended Credit

If all standards in this course are covered, the course is recommended for two credits. If only one credit is to be offered, it is recommended that the following standards be covered:

1 Credit Option

Content	Standards
Safety	1.1-1.3
Tools & Equipment	2.1
Construction Industry Principles	3.1-3.2
Structural Systems Loads	4.1-4.2
Cold-Formed Steel Framing	5.1-5.2
Exterior Finishing	6.1-6.4
Thermal & Moisture Protection	7.1-7.4
Roofing Applications	8.1-8.2
Green Building	14.1
Construction Drawings & Specifications	15.1-15.2
Business & Project Management	16.1-16.3
Portfolio	17.1

Course Standards

1. Safety

1.1 Safety Hazards and Rules: **Identify safety hazards on a job site** and demonstrate practices for safe working. Accurately read, interpret, and **demonstrate adherence to safety rules**, including but not limited to 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. Recognize and employ universal construction signs and symbols such as colors, flags, stakes, and hand signals that apply to construction workplace situations.

1.2 Safety Records and Practices: **Maintain safety records and demonstrate adherence to industry-standard practices** regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete the safety test with 100 percent accuracy.

1.3 Materials Safety: **Follow procedures to work safely around materials**. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment.

2. Tools & Equipment

2.1 Tools: For each of the systems covered in this course, **identify and select the proper tools and accessories**, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage. Research a new technology recently developed for the construction industry. Explain how the use of new technology could benefit the company. For example, describe how a new power tool could improve efficiency and reduce muscle fatigue for a construction team.

3. Construction Industry Principles

3.1 Policies and Requirements: Locate and assess the Tennessee Contractor's Licensing Board's website and **analyze the policies and requirements for construction work in Tennessee**. Explain how such policies impact local construction businesses.

3.2 Project Delivery Methods: Consult a variety of sources to **describe alternatives to traditional project delivery methods**, such as the design-build and construction

management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario. Examine the project delivery method of an actual company. Develop a company profile with supporting graphics the company could share with a client describing the services provided and explaining the project delivery method used by the company.

4. Structural System Loads

4.1 Structural Loads: **Categorize and describe the structural loads that act on a building**, including vertical loads (such as dead loads, live loads, and rain loads) and lateral loads (such as wind and earthquakes). Drawing on textbooks and other resources, create a visual display with supporting text to explain how the various loads act on a building's structural system.

4.2 Structural Failures: **Distinguish among the types of structural failures that can occur in a structural system**, including compressive failures, tensile failures, and buckling failures. Explain how specific components of a structural system prevent structural failures based on descriptions in texts and through classroom experiments synthesizing information gathered from both to illustrate concepts. For example, explain how blocking between studs in a wood frame wall prevents the buckling of studs.

5. Cold-Formed Steel Framing

5.1 Cold-Formed Steel Framing: Examine the **components, fasteners, tools, and procedures used in cold-formed steel framing**; compare and contrast cold-formed steel framing with wood framing in building construction. Outline the major similarities and differences in each and write persuasively to provide a recommendation to a client for a specific project.

5.2 Build Steel Framing: Demonstrate the ability to build steel frame components including back-to-back, box, and L-headers. Work in teams to **lay out and install steel stud walls** (both structural and non-structural) with openings to include bracing and blocking by implementing required safety techniques, tools, and equipment.

6. Exterior Finishing

6.1 Wall Section Components: Examine a wall section drawing for a specific building. **Identify, define, and explain the function of each component,** including wall insulation, flashing, and the structure of the cornice. Draw from textbooks and other resources to annotate the wall section drawing with notes explaining the purpose of each component.

6.2 Construct Cornice: Interpret wall section drawings to safely **construct a cornice**. For example, accurately measure materials, employ tools, and follow procedures to build a box cornice, checking for accuracy in each step.

6.3 Finish Systems: Analyze various **finish systems used to sheath a building**, including but not limited to wood siding, fiber-cement siding, vinyl siding, metal siding, stucco, and masonry veneer finishes. Examine different buildings in the community that are sheathed in different ways, hypothesizing why the different materials and methods were selected for each.

6.4 Install Siding: Estimate the siding materials needed to cover a building utilizing mathematical principles such as area formulas and quantitative reasoning. Utilize the appropriate procedures, tools, and materials to **install various types of siding**. For example, identify three siding methods that are commonly used in the area and demonstrate the ability to plan the installation of and install each.

7. Thermal & Moisture Protection

7.1 Heat Transfer: Explain the **impact of heat transfer in a building**, including heat loss during cold temperatures and heat gain during warm temperatures. Describe how building components such as insulation work to resist the transfer of heat in a structure. Interpret charts and graphs in building codes to determine the recommended R-values of insulation in a given location.

7.2 Insulation: **Categorize the various types of insulation** based on their characteristics and installation methods. Summarize the key properties and installation procedures of each insulation type.

7.3 Moisture Control, Waterproofing, and Ventilation: Describe the **materials and methods used in a structure for moisture control, waterproofing, and ventilation**. Explain how a vapor barrier protects an interior from moisture and describe the permeability rating necessary for a material to be considered a vapor retarder. Analyze guidelines for a builder or architect to use as reference when selecting appropriate vapor barriers for a specific location based on the climate and other factors.

7.4 Install Moisture Protection Materials: Interpret construction drawings and building codes to select and estimate the thermal and moisture protection materials needed to complete a project utilizing mathematical principles such as area formulas and quantitative reasoning. Utilize the appropriate procedures, tools, and materials to **install blanket insulation in a wall, a vapor barrier on a wall, and building wraps.**

8. Roofing Applications

8.1 Roofing Options: **Compare and contrast the materials, methods, and procedures for roofing with fiberglass shingles with other roofing materials** such as wood shingles, metal roofing, and membrane-type roofing systems. Perform a cost analysis for a client to help the client choose between two roofing materials for a specific project given the site location, project budget, environmental considerations, and other factors.

8.2 Install Shingles: Apply the appropriate tools, equipment, and procedures to safely **install shingles on a roof** including strategies for watertight installation, using quantitative reasoning and geometric formulas where applicable. For example, interpret construction documents to estimate the roofing materials needed to install fiberglass shingles on a gable roof. After preparing the roof with underlayment, flashing, and other preparation materials, install fiberglass shingles, install a cricket or saddle, and install ridge caps.

9. Windows, Doors, and Door Hardware

9.1 Windows: Describe the common **styles and components of windows**. Read and interpret construction drawings, window schedules, specifications, and manufacturers' information to determine the types of windows and installation procedures required for a project. **Apply the appropriate tools, equipment, and procedures to safely install windows.**

9.2 Doors: Analyze the parts of a door frame, including sills, jambs, and casings, and describe different interior door types. Read and interpret door schedules and other construction documents to **determine the type of door and door hardware required for a project**.

9.3 Install Doors: Apply the appropriate tools, equipment, and procedures to safely **install a door**, including checking the plumb and square of a door frame and installing a prehung door unit. Demonstrate proper procedures to work with door hardware, including laying out and cutting hinges in a wooden door and installing door closers and locksets.

10. Drywall Installation & Finishing

10.1 Components Drywall Installation: Describe the various components involved in drywall installation, including the types of drywall, drywall fasteners and adhesives, and drywall accessories. Explain the procedure to install drywall, noting the proper tools involved. Describe the role drywall plays in sound isolation and fireproofing, outlining how fire-rated walls are constructed.

10.2 Drywall Materials: Read and interpret drawings to **select the type and thickness of drywall required** for a specific installation. Utilize quantitative reasoning to estimate the amount of drywall, fasteners, and finishing materials needed for a project.

10.3 Install Drywall: **Install gypsum drywall panels** on stud walls and ceilings using different types of fastening systems, including nails, screws, and adhesives. Perform single-layer and multi-layer installations by implementing required safety techniques, tools, and equipment. Describe the differences in procedures for installing gypsum panels on steel wall frames.

11. Drywall Finishing

11.1 Drywall Finishing: **Describe the procedures, tools, and materials used in drywall finishing**, indicating the purpose of each material. Read and interpret industry standards

regarding drywall finish, such as the *Recommended Levels of Gypsum Board Finish.* Observe finished drywall and determine the level of finish citing evidence from industry standards documents.

11.2 Finish Drywall: **Implement the proper procedures, tools, and materials to finish drywall**. Procedures include preparing compounds, taping joints, applying joint compounds, sanding, spotting fastener heads, and finishing corners.

11.3 Correct Drywall Problems: Diagnose the cause and **determine the appropriate solution for problems** that occur in drywall finishing citing evidence from textbooks or technical manuals to justify why the chosen solution is appropriate. Implement the proper tools and procedures to **patch damaged drywall**.

12. Window, Door, Floor, and Ceiling Trim

12.1 Trim: **Distinguish among the different types of standard trim, including base, wall, ceiling, window, and door trim.** Utilize the proper tools, equipment, and procedures to make square cuts, miter cuts, and coped joint cuts in trim.

12.2 Install Trim: Apply the appropriate tools, fasteners, and procedures to **install window, door, floor, and ceiling trim.** Estimate the quantities of different trim materials needed for a given room.

13. Cabinet Installation

13.1 Install Cabinets: Identify the **components that make up a basic set of cabinets** analyzing the purpose of and interrelationships among each component and explaining the sequence in which each is constructed. Components include wall cabinets, base cabinets, countertops, and cabinet hardware. Read and interpret drawings and technical manuals to determine the steps, equipment, and materials needed to **lay out and install a basic set of cabinets**. Develop a timeline and action steps needed to complete a cabinet installation.

14. Green Building

14.1 Green Strategies: Research and **identify green strategies used in the design and construction of buildings** specifically impacting carpenters. Drawing on resources such as those from the U.S. Green Building Council, discuss green work practices of carpenters, such as reducing waste in the construction process, citing resources to support claims.

15. Construction Drawings & Specifications

15.1 Drawings and Specifications: Explain the relationship between **construction drawings and specifications**. For example, describe how both the construction drawings and specifications provide information about the exterior sheathing indicated for a building.

Examine construction drawings and specifications to determine the requirements of the sheathing for a given part of a building.

15.2 Request for Information: Describe processes by which construction professionals obtain clarification from architects regarding construction documents, such as by the use of requests for information (RFIs). **Write a request for information** (RFI) as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product.

16. Business & Project Management

16.1 Management: Establish and implement specific goals to **manage project assignments** in a timely manner, including organizing teams to effectively manage assignments, monitoring and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing constructive feedback for improvement. Similarly, respond to constructive feedback from a team member to improve project outcomes and meet project goals.

16.2 Estimating and Scheduling: **Perform estimating and scheduling techniques for a long-term project**, including calculating material quantities and cost (including tax) and labor cost to complete a bid sheet; scheduling construction activities using a flow chart; and determining amounts to be charged to the client at various intervals throughout the project.

16.3 Reports: Utilize technology to **write and share periodical reports** (weekly, monthly, etc.) to provide others with information about progress during construction activities as would a project manager to a supervisor. Summarize activities in a narrative form including overall progress in relationship to a previously planned schedule.

17. Portfolio

17.1 Portfolio: **Update materials from coursework to add to the portfolio** started in *Fundamentals of Construction* and *Structural Systems I*. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses using technology where appropriate. Include photographs or illustrations and written descriptions of sequential progress in construction projects.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their

students will receive a certificate of completion for NCCER Carpentry Level Two and be placed in NCCER's National Registry Database.

- P21: Partnership for 21st Century Skills
    - 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.