TN Department of Education | College, Career and Technical Education

May 2025

Computer Science Foundations

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H11
Prerequisite:	None
Credit:	1 credit for core and two focus areas. 2 credits for all 36 standards.
Grade Level:	9
Elective Focus- Graduation Requirement:	This course satisfies one or two of the three credits required for an elective focus when taken in conjunction with other *IT* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the first course in the *Networking Systems, Coding, Web Design*, and *Cybersecurity* programs 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 post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 742, 952, 953
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-1.2** | Invite an industry professional to discuss safety equipment and protocols.
- **Standards 2.1-2.4** | Have the students partner with a physics professor on a real-life project.
- **Standards 3.1-5.1** | Invite an industry professional to discuss the history and various occupations in the Information Technology field.
- **Standards 6.1-6.3** | Have students do a virtual exchange with an industry partner to explain job terminology and concepts.
- **Standards 7.1-8.6** | Have students work on-site with an industry cloud expert to complete a real-world project.
- **Standards 9.1-9.3** | Discuss logical thought processes with an Information Technology Specialist.
- **Standards 10.1-12.2** | Have students create an integrated project with interactions with professionals.
- **Standards 13.1-14.3** | Have students job shadow a cybersecurity specialist.
- **Standards 15.1-16.3** | Have students job shadow a computer programmer.

Course Description

Computer Science Foundations (CSF) is a course intended to provide students with exposure to various information technology occupations and pathways such as Networking Systems, Coding, Web Design, and Cybersecurity. As a result, students will complete all core standards, as well as standards in two of four focus areas. Upon completion of this course, proficient students will be able to describe various information technology (IT) occupations and professional organizations. Moreover, they will be able to demonstrate logical thought processes and discuss the social, legal, and ethical issues encountered in the IT profession. Depending on the focus area, proficient students will also demonstrate an understanding of electronics and basic digital theory; project management and teamwork; client relations; causes and prevention of Internet security breaches; and writing styles appropriate for web publication. Upon completion of the CSF course, students will be prepared to make an informed decision about which Information Technology program of study to pursue.

The following implementation options are encouraged:

- 1 credit for core and two focus areas (listed below)
- 2 credits for all standards

Core standards are required for both one and two-credit implementation options.

Core standards: 1.1, 1.2, 2.1 ,3.1, 3.2, 4.1, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 13.1

Focus Areas	**Standards**
Networking Systems:	2.2, 2.3, 2.4, 5.1, 6.2, 6.3, 9.2, 9.3
Coding:	9.3, 15.1, 16.1, 16.2, 16.3
Web Design:	5.1, 6.1, 7.1, 9.1, 10.1, 10.2, 11.1, 12.1, 12.2
Cybersecurity:	6.3, 14.1, 14.2, 14.3

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read, interpret, and demonstrate adherence to safety rules**, including (1) rules published by the National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) internet safety, (4) Occupational Safety and Health Administration (OSHA) guidelines, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply.

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

2. Electronics and Basic Digital Theory

2.1 Electrical Circuits and Devices: Demonstrate **understanding of electrical circuits and devices and relate to the physical laws** (such as Ohm's Law and power laws) **that govern behaviors of electrical circuits and devices**. Accurately apply these physical laws to solve problems. For example, calculate the resistance of a DC circuit with a given DC voltage and current.

2.2 Basic Electronic Circuit Behavior: Assemble the required connections of electronic test equipment to properly **test the operation of basic electronic circuit behavior and performance, using equipment such as a digital multimeter**. For example, demonstrate the proper use of a digital multimeter by measuring the resistance of a circuit in a typical computer system; compare this finding by calculating the resistance given the voltage and current.

2.3 Counting Systems: Distinguish between the **binary and hexadecimal counting systems**. Using **appropriate units**, provide examples of each system and identify specific instances when IT professionals rely on them.

2.4 Gates in Logic Circuits: Explain the **functions of gates in logic circuits** (e.g., AND, OR, NOT). For example, construct a truth table for the seatbelt warning light in an automobile.

3. Career Exploration

3.1 Occupations: **Research various occupations in information technology industries**, such as programmers, web designers, webmasters, networking administrators, computer systems administrators, telecommunications line installers, and informational security analysts. Compose an informative table or chart that includes the following: **work activities typically performed, tools and technology used, nature of work environment, and the knowledge and skills needed for success**.

3.2 Professional Societies: Explore **various professional societies related to information technology and identify the services and benefits provided by each member**. Create a table that lists their purposes, benefits to membership, and any certifications affiliated with the organization. For example, investigate the Institute for Electrical and Electronics Engineers (IEEE), the Computing Technology Industry Association (CompTIA), and the Association for Computing Machinery (ACM).

3.3 Career and Technical Student Organization Introduction: **Introduce** the program's **aligned Career and Technical Student Organization** (CTSO), Technology Student Association (TSA) and Skills USA, **through an interactive activity**, such as classroom competition.

4. Overview of the Internet

4.1 History of the Internet: Drawing on multiple sources (i.e., internet, textbooks, videos, and journals), **research the history of the Internet**. For example, create a timeline or infographic, illustrating the Internet's historical evolution from its inception to the present time. Discuss the needs that led to the creation of the Internet; discuss both the benefits

and disadvantages of the Internet to society, as well as potential implications for the future. Provide examples drawn from the research to support claims.

5. Overview of Operating Systems

5.1 Development of Operating Systems: Drawing on multiple sources (i.e., internet, textbooks, videos, and journals), **research the history and development of operating systems** (e.g., Microsoft Windows, Linux, UNIX). For example, create a presentation, **illustrating their historical evolution, from their inceptions to the present, citing information found in research**. Compare and contrast the general capabilities of a variety of operating systems and explain how their designs and functionalities have improved over time.

6. Terminology and Concepts

6.1 Web Terminology: Demonstrate **an understanding of basic web terminology and concepts**. Practice explaining these terminologies and concepts by creating methods to help students learn and remember the information. For example, students should be able to explain the purpose of terminology such as server, domain name system (DNS), internet service provider (ISP), hardware and software connective devices, cloud computing, remote access protocols, map protocols, content management systems (CMS), cascading style sheets (CSS), and social networking terms.

6.2 Computer Hardware Components: Demonstrate **a basic understanding of computer hardware components**. **Identify these components** using pictures or actual models and briefly **explain the function of each**. Components should include, but are not limited to the following:

a. hardware used for input and output,
b. hardware inside the computer case,
c. motherboard,
d. processor and the chipset,
e. storage devices (e.g., primary, secondary),
f. expansion cards, and
g. electrical system.

6.3 Computer Networks: Demonstrate a **basic understanding of computer networking**. For example, explain the types of networks and describe a client-server environment.

7. Keyboard Shortcuts

7.1 Keyboard Shortcuts: **Identify, explain, and demonstrate the use of common keyboard shortcuts**. Create a quick reference guide that would be user-friendly for a novice web designer. For example, students may create a multiple column table showing keyboard shortcuts for navigation, text editing, and text formatting. The table would identify which shortcuts are applicable to using Windows versus Mac OS.

8. Emerging Technologies

8.1 Evolution of Cloud Computing: Synthesize **research of historical and significant milestones that influenced the evolution of cloud computing**. Create an annotated timeline or visual graphic illustrating significant time periods and major impacts of technology trends that influenced the development of cloud computing. Use academic research and news media citing specific textual evidence from research.

8.2 Cloud Technologies Role: Identify, describe, and effectively **summarize cloud technology roles including cloud computing customer, cloud service provider, and cloud service partner**. Create a written report or visual depiction outlining the characteristics of each.

8.3 Models of Cloud Technology: Research the **features and requirements of the four main deployment models for cloud technology: public, private, community, and hybrid**. Create a graphic illustration showing the roles of each and describe their differences.

8.4 Cloud Technologies: Consult a variety of sources to **describe how virtualization, storage, networking, and databases in cloud technologies are used**. Sources may include textbooks, manuals, websites, video tutorials, and more. Create a visual display with accompanying text comparing these methods.

8.5 Internet of Things (IoT): Explore the **onset of the Internet of Things (IoT)** and **explain how it is enabled by sensors, actuators, communication devices, and computers that exchange and process data and can interface with users in a most instinctual way**. Using a specific example, summarize in a graphic illustration or narrative how the IoT combines information, automation, computation, software, sensing, and networking to make traditional processes more efficient.

8.6 Statistical Efficiency and Quality: Consult internet forums, textbooks, industry journals, and other instructional materials to **research the importance of developing and implementing databases, data collection systems, data analytics, and other strategies that optimize statistical efficiency and quality**. Write a brief paper that discusses the importance of these services in business today. Provide specific examples to support the claims.

9. Introduction to the Logical Thought Process

9.1 Web Design Process: There are different versions of the web design and development process. For example, most versions of the web design and development process involve project definition, site structure, visual design, site development, testing, refining, and launch. Using various resources, **research, identify, and explain the steps involved in the process. As a class, develop an agreed-upon framework for applying the logical thought process to web design projects** in the form of a flowchart or logic model, justifying the reasoning behind each step. Explain why it is an iterative process and always involves refinement.

9.2 Troubleshooting Process: Research, identify, and describe the **specific activities involved at each step of the troubleshooting process,** including by not limited to) gather

information from the user or operator and back up data, 2) verify the problem exists, 3) isolate the cause of the problem and generate alternative solutions, 4) plan a solution and resolve the problem, 5) verify that the problem was resolved and prevent a future occurrence, and 6) document findings, resolution, and preventative maintenance plan. Explain why it is important to document the process throughout.

9.3 Flowcharts: Demonstrate an **understanding of flowcharts and know what various symbols mean**. Identify a problem that a programmer would solve using the logical thinking process and create a flowchart that would guide the code development. For example, create a flowchart that incorporates at least three decisions, or paths, to solve a problem.

10. Teamwork and Project Management

10.1 Roles of Team Members: Explore how teams are formed to complete and manage web design and development projects. Using the information gained from research, **identify and explain various roles and responsibilities for members of a web design and development team**. Include why teams are more efficient than individuals in the web design and development process. Present the findings to classmates.

10.2 Importance of Management Skills: Synthesize **common principles and templates for successful project management**. Explain, using examples, **why strong management skills are important in the web design and development process**.

11. Client Relations

11.1 Client Relations: Research and **identify the skills that are required to communicate effectively with a client**. Develop a questionnaire that would be used to determine the needs of a client for a prospective web development project. Using the questionnaire, conduct mock client interviews with classmates and provide each other with constructive feedback to revise the questionnaire and process.

12. Writing and Editing for Web Publication

12.1 Web-Based Writing Assignments: As a team, list **primary rules to guide writing content that is appropriate for a website publication**. Apply these rules to a variety of web-based writing assignments throughout the course. For example, develop and maintain a blog throughout the course to practice appropriate writing techniques and style for web publication.

12.2 Website Creation: Given a specific client's vision, **create a simple website using a content management system (CMS) such as WordPress**. Follow the multistep process to download the software application of your choice and demonstrate how to upload and store files. Practice proofreading and critiquing other classmates' sites and provide constructive feedback on one another's writing and layout design.

13. Social, Legal, and Ethical Issues

13.1 Social, Legal, and Ethical Issues: Drawing on multiple sources (i.e., internet, textbooks, videos, and journals), **research the various social, legal, and ethical issues encountered by IT professionals**. Using these findings, identify the roles and responsibilities one must consider while developing a prospective project or addressing an IT problem. For example, web developers and programmers must apply copyright laws and understand the uses of open-source software.

13.2 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.

14. Cybersecurity

14.1 Data Security: Using various sources (i.e., internet, textbooks, videos, and journals), research and **identify reasons as to why data security should be a priority to technology professionals** through demonstrating an understanding of information security fundamentals on Confidentiality, Availability, and Integrity.

14.2 Security Breaches: Demonstrate an **understanding of the various security breaches that can occur with the Internet**. Prepare a text explaining enterprise-level security, the purpose of encryption, and the protocols that can be implemented to secure websites. Evaluate personal privacy issues versus employers' rights to regulate computing resources.

14.3 Security Practices: Identify various **security practices for computer and network systems**, such as how to control access to secured resources and computer resources. Give specific examples of methods that an administrator can use, like encryption techniques, basic input/output system (BIOS) features, and strategies for dealing with malware.

15. Organization of Materials

15.1 Digital File Management: Understand and **demonstrate the effective use of file and folder management techniques to maintain directory structure for a website**. Describe the most efficient methods for digital file management, including the use of site root and subfolders for assets (e.g., images, templates, CSS).

16. Programming

16.1 Programming Language: Explore and **identify various languages**, such as Python, HTML, PHP, C++, Visual Basic, Java, JavaScript, and C #. **Explain how programmers use these languages to solve a variety of IT problems**, furnishing examples of how they are applied.

16.2 Software Development Life Cycle: Using various resources, **research, identify, and explain the steps involved in the software development life cycle**, including but not limited to

planning, designing, coding, testing, deployment, and maintenance. Explain why it is an iterative process and always involves refinement.

16.3 Batch Files: Demonstrate an understanding **of how batch files function within a programming environment**. Identify common commands to create code for batch files (e.g., title, echo, echo off, pause, CLS, ipconfig, and ping). For example, list various scenarios for using batch files to complete specific programming tasks. Create and execute batch file code to perform one of the tasks identified.

17. Data Analysis

17.1 Data Analysis in Information Technology: **Research** the **use of data in Information Technology cluster career fields**. Include data that is **generated internally** by businesses, **and externally** by local communicates, state, and the nation. Explore examples of how the data is used, including the following:

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

Standards Alignment Notes

*References to other standards include:

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

Coding I

Primary Career Cluster:	Information Technology
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H14
Prerequisite(s):	*Algebra I* (G02X02, G02H00), *Computer Science Foundations* (C10H11)
Credit:	1
Grade Level:	10
Focus Elective Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the second course in the *Coding* 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.
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Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153,173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 596, 740, 742, 952, 953
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-information-technology.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.
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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 1.1-2.1 | Invite a computer programmer to give a job overview and discuss ethical issues faced in the industry.
- Standards 3.1-3.7 | Have students partner with a computer programmer on a real project.
- Standards 4.1-4.5 | Have students visit a local industry and discuss project planning and quality assurance.

Course Description

Coding I is a course intended to teach students the basics of computer programming. The course places emphasis on practicing standard programming techniques and learning the logic tools and methods typically used by programmers to create simple computer applications. Upon completion of this course, proficient students will be able to solve problems by planning multistep procedures; write, analyze, review, and revise programs, converting detailed information from workflow charts and diagrams into coded instructions in a computer language; and will be able to troubleshoot/debug programs and software applications to correct malfunctions and ensure their proper execution.

Course Standards

1. Computer Programming Overview

1.1 Development of Computers and Logical Devices: Using news articles and instructional materials**, investigate key milestones in the development of computers and logical devices**. Create and present a document and/or illustration depicting the timeline of development that led to modern-day operating systems, programmable controllers, and widespread digital communications via the Internet and wireless networks, citing specific textual evidence.

1.2 Programming Language: Compare and contrast the **benefits, features, and typical applications of common modern programming languages and environments**. Craft an argument to defend the choice of a certain language to solve a particular problem, developing claim(s) and counterclaim(s) with specific textual evidence and reasoning.

2. Ethics

2.1 Ethical Programming Practices: Using news articles and text of legislation, analyze **ethical programming practices,** including but not limited to the **issues of confidentiality, privacy, piracy, fraud and misuse, liability, copyright, open-source software, trade secrets, and sabotage.** For example, research and report on the effects of unethical programming practices on a business.

3. Programming Skills

3.1 System Level and Application Practices: Differentiate between **system-level and application solutions and identify an appropriate code-based strategy to solve a given problem**. For example, given a file management problem, determine when a command-line script will be more efficient than a high-level program solution.

3.2 System Management Tools: Apply the **system management tools present in a programming development environment** to do the following:

a. Select the most appropriate programming language for the task at hand.
b. Develop syntactically correct program code using current best practices and emerging classes of development techniques.
c. Use a compiler to interpret the source code and produce executable program code.

3.3 Developing and Implementing Strategies: In the process of developing and implementing programming solutions, **develop strategies that work within the constraints of major operating system fundamentals**, such as the following:

a. security protocols and procedures for accessing files and folders;
b. file management syntax requirements, including but not limited to creating, naming, organizing, copying, moving, and deleting files; and
c. file naming conventions, as they apply across multiple software applications and file types.

3.4 Flowchart: Write pseudocode and **construct a flowchart for a process before starting to develop the program code**. For example, code and flowchart a simple process that takes an integer and reports whether it is odd or even.

3.5 Data Values: Organize and develop a plan to **acquire and manage the data values for a process**, including the following:

a. data types, such as string, numeric, character, integer, and date;
b. program variable names;
c. variables and constants;
d. arrays (at least one- and two-dimensional) and subscripts;
e. input from files and user responses; and
f. output to files and reports.

3.6 Code Design: Using a programming language specified by the instructor, **convert the pseudocode for a selected process to program code**, incorporating at least three of the following structures, the need for which will be dictated by the assigned problem(s) and process(es). The resulting code design can be event-driven, object-oriented, or procedural.

a. Operations and functions (user-defined and/or library)
b. Repetition (loops)
c. Decision (if…else, case)
d. Recursion

3.7 Operation of Program Code: **Verify the correct operation of the resulting program code with several test cases**:

a. all valid values,
b. error trapping of invalid values,
c. error trapping of invalid program operation, and
d. troubleshooting/remedying program problems.

4. Project Planning and Quality Assurance

4.1 Computer Programming Problem and Client Specifications: Compile the necessary documentation to **understand the nature of a computer programming problem and the customer/client specifications** for the request and summarize in an informational text. This will include evidence of the scope of the problem, its attendant input and output information, the required system processing, and the software specifications involved.

4.2 Project Plan: Analyze a given problem and **develop a coherent strategy in the form of a project plan to meet the customer/client's needs**. The plan will include, but will not be limited to, defining the project scope as addressed by the problem documentation, identifying software development and implementation issues, timeline, and benchmarks for design, and addressing issues associated with software maintenance and life cycle.

4.3 Nature of the Program: In the software development process, **articulate the nature of the program designs by creating documentation that addresses topics,** including but not limited to the following:

a. the procedural, object-oriented, event-driven, or other nature of the various portions of the resulting application;

b. the data structures used for inputs, outputs, and internal manipulations;
c. the algorithms and guiding formulas used;
d. constraints on accurate operation and results;
e. modular designs that enable portability; and
f. interface details that permit ready maintenance and upkeep.

4.4 Quality Assurance: Apply **principles of quality assurance during application development to certify bug tracking, audit trails, testing results, and other quality considerations**. Annotate each quality assurance task with evidence from best practices endorsed by industry or research.

4.5 Security Risks: Document the **security risks associated with new applications and evaluate the severity of the risk involved in each**, including but not limited to the following:

a. identifying threats to information systems facilities, data communications systems, and other applications;
b. adhering to federal and state legislation pertaining to computer crime, fraud, and abuse;
c. providing means for preserving confidentiality and encryption of sensitive data; and
d. detailing steps to recover from routine errors or catastrophic failures, that might be caused by a malicious computer virus.

5. Team Project

5.1 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 CTSO event.

a. **Problem Identification**: Brainstorm specific problems and challenges within 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 evaluate, 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 Level II 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:

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

Coding II

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H15
Prerequisite:	*Coding I* (C10H14)
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Coding* 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.
Available Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 596, 740, 742, 952, 953
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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** | Have a guest software developer come and speak about their development process.
- **Standards 2.1-2.4** | Have students job shadow a software developer.
- **Standards 3.1-3.4** | Have students do a project on computer applications partnered with industry professionals.
- **Standards 4.1-4.5** | Have students observe and/or assist an industry partner with a real coding project.
- **Standards 5.1-5.3 |** Invite an industry professional to discuss quality insurance.
- Standards 6.1 | Have students job shadow a project manager.

Course Description

Coding II challenges students to develop advanced skills in problem analysis, construction of algorithms, and computer implementation of algorithms as they work on programming projects of increased complexity. In so doing, they develop key skills of discernment and judgment as they must choose from among many languages, development environments, and strategies for the program life cycle. Course content is reinforced through numerous short- and long-term programming projects, accomplished both individually and in small groups. These projects are meant to hone the discipline and logical thinking skills necessary to craft error-free syntax for the writing and testing of programs. Upon completion of this course, proficient students will demonstrate an understanding of object-oriented programming language using high-level languages such as FOCUS, Python, or SAS.

Course Standards

1. Software Development Environments

1.1 Software Development Environments: Evaluate at least two **software development environments (SDEs) that are tailored to different programming languages on the basis of their suitability for a range of programming tasks, ease of use, and how ubiquitous they are within the IT community.** Document the similarities and differences between the two, and the features that lend themselves to the chosen programming languages. For example, students assigned to code a basic database interface can compare the benefits and features of a freeware SDE such as *JDeveloper* and a commercial SDE like *Microsoft Visual Studio*.

1.2 Software Creation Process: Investigate the typical **process around creating new software within a software development environment**. Describe and furnish examples of the steps taken within the SDE to guarantee reliable output, from prototyping and authoring to deployment and debugging.

1.3 Software Creation Management: Administer **the process of creating new software within a software development environment to manage the prototyping, authoring, revising, compiling, testing, deploying, and debugging of student-developed software**. For example, for an object-oriented payroll program assignment (retrieving file data to produce a run of paychecks and paystubs for a small business), perform and document the steps taken within the SDE to ensure the reliable and accurate output of paychecks.

2. Software Development Life Cycle

2.1 Software Development Life Cycles: Synthesize information from a range of sources (including original tests and simulations) to **critique the features of different software development life cycles** (agile, iterative, and sequential types). **Using domain-specific terminology**, explain to a technical audience the distinguishing features of each that make one more appropriate for certain types of applications.

2.2 Development of Original Software: For a selected assignment or **project involving the development of original software**, choose and **defend a strategy to follow for the program's development life cycle**. At the completion of the assignment, offer

recommendations for other environments and alternative strategies that could improve the development process.

2.3 Best Practices Techniques: Research common and **best-practice techniques in programming analysis, design, and implementation**. Drawing on model practices used by businesses and industry, employ analysis, design, and implementation techniques to satisfy a programming need, using an appropriate software lifecycle model.

2.4 Management Tool: Employ a requirement **management tool during a program's development life cycle, documenting the evolving versions, storage attributes, system elements, status tracking, and access permissions afforded by the tool,** as well as the successful attainment of the project vision.

3. Designing Computer Applications

3.1 Programming Language Defense: For a given programming assignment, **choose and defend a programming language** with regard to the language's capabilities and suitability to task, availability, portability, maintainability, and cost.

3.2 Method of Data Processing: For the assignment outlined in standard 8, **identify the method of data processing most appropriate for the task** (e.g., batch, interactive, or event-driven). For example, a weekly payroll application would handle its data differently (i.e., batch processing) than a web-based search engine (i.e., interactive processing), and still differently than a microprocessor control program for a washing machine (i.e., event-driven).

3.3 Specifications of Data Management: Define the **specifications of the data management plan, including variables** (naming, scope, and types), **validation measures** (to protect the data from corruption), **and data handling** (storing, input/output, and back-up). For example, programs handling historical temperature data would be best suited to floating point values stored in multidimensional arrays, written to permanent storage, and displayed with limited precision.

3.4 Development Cycle Preparation: For a selected programming assignment involving an object-oriented language, **design and define the classes, objects, properties, methods, and inheritance structures prior to the start of the development cycle**. Revise the plan (modifications, additions, and subtractions) as needed throughout the development cycle.

4. Coding Computer Applications

4.1 Documentation: For selected programming assignments, **create, edit, and improve documentation for technical support intended for fellow programmers, including within the program code itself as well as within supplemental documents**. For example, for a lawn sprinkler system microcontroller, the technical documentation would define the variables, functions and subroutines, and the critical events.

4.2 End-User Documentation: For selected programming assignments, **create, edit, and improve end-user documentation.** End-user documentation would include how to interact

with the user interface, the capabilities and limitations of the system, and the required conditions for successful operation.

4.3 Programming Techniques: **Incorporate structured, object-oriented, and event-driven programming techniques** that employ sequence, selection, and/or repetition (loops) to solve programming projects.

4.4 Programming Approaches: For each programming task, **consider and defend the choice of various programming approaches (**such as data-driven or event-driven, top-down, or bottom-up), citing examples from the syntax illustrating the chosen approach.

4.5 App Development: Design and **develop an app for a mobile computing device, using an online programming interface**, such as AppMakr, BuzzTouch, Appsbar, PhoneGap, or AppYet.

5. Software Testing Procedures & Quality Assurance

5.1 Quality Assurance: During the development, testing, and deployment of a new program, **implement checks for data and procedure accuracy, correctness, currency, and relevance, making and documenting revisions,** where justified.

5.2 Code Optimization: **Analyze the code** written by another programmer to **create a flowchart, suggesting points of confusion or generality in the program that could become problematic in future revisions.** Cite specific examples in the code to support recommendations.

5.3 Quality Testing: **Conduct quality testing of program code**, striving for satisfactory results at four levels or perspectives:

a. unit (component/module level verifications);
b. integration (verifying the interfaces between components, adding one at a time);
c. system (verifying that the whole package meets the requirements and specifications without corrupting other systems); and
d. acceptance (customer satisfaction).

6. Project Management

6.1 Programming Project: **Design, manage, and develop a course-long programming** project pre-approved by the instructor. The project will embody a variety of strategies and resources taught in this course, and require periodic reviews, status reports, and final project presentation. Use a software development environment to manage, document, test, deploy, and maintain the resources and assets of the finished project.

Standards Alignment Notes

*References to other standards include:

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

TN Department of Education | College, Career and Technical Education

May 2025

Mobile App Development

Primary Career Cluster:	Information Technology
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H22
Prerequisite(s):	*Algebra I* (G02X02, G02H00), *Computer Science Foundations* (C10H11) Coding I (C10H14)
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is an option for the third course in the *Coding* 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 Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 742, 952, 953
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-2.2** | Invite an industry expert to discuss mobile applications careers.
- **Standards 3.1-3.7** | Job shadow an industry partner.
- **Standards 4.1-4.3** | Invite a mobile designer to discuss mobile application design.
- **Standards 5.1-7.1** | Complete an integrated project with an industry professional.

Course Description

Mobile App Development is a course intended to teach students the basic concepts and skills of mobile app design. The course places an emphasis on the history of mobile technologies, design and development methodologies, code for mobile applications, application lifecycles, APIs, mobile device controls, user interfaces, deployment, publishing for mobile devices, developer tools, and career development. Upon completion of this course, proficient students will demonstrate an understanding of mobile app development concepts.

Course Standards

1. Introduction to Mobile Technologies

1.1 Development of Mobile Technologies: Using news articles and instructional materials, investigate **key milestones in the development of how mobile technologies came to be.** Create and present a document and/or illustration depicting the timeline of development that led current major mobile platforms and describe the effects upcoming mobile platforms may have on mobile technologies. For example, students should include the following:

a. early applications (calculators, basic arcade games, calendars);
b. wireless application protocol (WAP) and wireless markup language;
c. proprietary mobile platforms (Palm OS, Java Micro Edition, iPhone iOS, Android);
d. commercialization of applications; and
e. 'mobile-first' approach.

1.2 Mobile App Capabilities: Investigate the different **physical capabilities of a mobile device** including identifying different **device sensors, built-in hardware, and the specifications of the camera**. Create a chart that outlines the physical capabilities of a particular mobile device.

1.3 Modern Mobile Devices: Compare and contrast **the benefits, features, Application Programming Interface** (API's), **number of touch points, networking, energy savings, and typical applications of common modern mobile devices**. Craft an argument to defend the choice of certain key features, developing claim(s) and counterclaim(s) with specific textual evidence and reasoning.

2. Career Exploration

2.1 Mobile Application Careers: Explore **career opportunities, trends, and requirements related to careers in mobile applications** such as developer, architect, UI designer, interaction designer, product manager, and more. Produce a career pathways chart or other graphic detailing the aptitudes and training required (including personal aptitudes, postsecondary credentials, and licensing) for careers of interest.

2.2 Educational Opportunities: Research **educational opportunities to determine programs, degrees, and training availability to improve job prospects in mobile application development**. Synthesize findings into a presentation, document, spreadsheet data/chart, or other format highlighting the type of opportunity, focus, time commitment, cost, and outcomes.

3. Mobile Applications Overview

3.1 Mobile Application Market: Investigate the **size and scope of the mobile application market including the rising popularity of mobile apps, and implications for various industries** (gaming, location based navigation services, factory automation, banking, online shopping). For instance, investigate the growth of mobile medical apps and discuss security and privacy concerns and reliance on the internet. Discuss the global market and availability and use of mobile applications in developing countries and emerging economies.

3.2 Types of Mobile Applications: Differentiate between **types of mobile applications**, including **native applications, web applications, and hybrid applications**. Identify pros and cons of each type and instances where each type would be the best suited for a particular task.

3.3 Mobile Applications Categories: Identify major **categories of mobile applications: social networking, books, business and finance, lifestyle, travel, navigation, productivity,** and as a class, create, review, and revise a presentation explaining the different categories by citing resources and identifying examples of mobile applications.

3.4 Security Considerations**:** Understand **privacy needs in the development of mobile applications and explore the role security considerations play in development**. Research examples of how security and privacy leaks in mobile applications have affected users and society. Students should evaluate a mobile application in terms of meeting privacy needs, legal and intellectual property requirements, and security considerations (such as preventing attacks from malicious hackers, building secure applications, preventing data leaks, secure mobile transactions for in-app purchases).

3.5 Device Application Programming**: Define Device Application Programming Interface** (DAP) and discuss the **advantages/disadvantages of utilizing API in mobile application development**. List types of common DAPs available to developers (mapping/geolocation, device orientation, vibration, forms, media, etc.) and provide an example of an application that utilizes each type.

3.6 Programming Languages: Explore **programming languages used in the development of mobile applications**, including Objective-C, Swift, C#, Java, Ruby, and JavaScript. Demonstrate an understanding of why apps use different languages for development and discuss cross-platform app design.

3.7 Developer tools and Platforms: Identify the **most commonly used developer tools and platforms**. Communicate this information and engage each other effectively using appropriate wikis and blogs to support individual learning and contribute to the learning of others.

4. Mobile Applications Design

4.1 Mobile Application Design: **Describe elements of mobile application design** which includes designing for multiple devices, screen sizes, browsers, and operating systems. Discuss **how developers design applications for the best user experience**.

4.2 Interface Design: Identify and be able to **apply the principles of user interface design**, including the following:

a. Why designing applications that are intuitive and user-friendly is important.
b. How design can make common tasks easy.
c. How to design applications for users with disabilities.
d. How to handle user errors and provide feedback.

4.3 Interface Design Criteria: Apply **user interface design criteria**, such as navigating the app, user input, gestures, orientation, communication (alerts, confirmations, and feedback), first

impression of the polish of the design, launch time, to critique common user interfaces in mobile applications. Discuss **how the design can motivate or demotivate a user**. Compare and contrast various applications based on usability.

5. Mobile Application Development

5.1 Mobile Application Lifestyle: Demonstrate an **understanding of the mobile application life cycle and the iterative nature of a lifecycle**. Understand and use steps for designing a good software product.

5.2 Project Plan: **Develop an idea into a project plan** then write pseudocode and construct a flowchart for a process before starting to develop the program code.

5.3 Object-Oriented Programming: Develop a mobile application and **write original program code using basic Object-oriented programming (OOP) concepts** including the following:

a. variables,
b. methods,
c. control structures,
d. data structures, and
e. user input.

5.4 Code Evaluation: When **writing program code, demonstrate an ability to evaluate code, identify errors, and troubleshoot bugs**.

5.5 Phone/Custom Controls: Create **a mobile application that incorporates the use of phone controls and a custom control**. The application should display content, incorporate notifications, and use tasks to enhance functionality. For example, create a basic time management app.

5.6 User Interface Design Standards: Utilizing the application developed in the previous standard (or another), **enhance the application by incorporating user interface design standards and guidelines**, including optimizing the layout, designing screen orientation options, colors, and transparency.

5.7 Application Animations: **Integrate images and media in the application developed in the previous standards**. Students may create appropriate art, develop audio, and create applications animations or utilize pre-existing media.

6. Deployment

6.1 App Deployment: Demonstrate **an understanding of how to deploy a mobile application to the marketplace**, including marketplace submission rules and creating the deployment package. Advanced students might deploy an application.

7. Project Management

7.1 Project management: As a team during an extended project, **develop a platform-specific mobile application that conforms to acceptable coding standards**, including

organization and comments, and contains appropriate graphics, text, audio, and animations. The team should **utilize project management techniques to develop a plan with considerations for cost and time**. Additionally, the team should create a design document that details the application, the problem it solves, and its core features.

Standards Alignment Notes

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- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
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Coding Practicum

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H08
Prerequisite(s):	*Algebra I* (G02X02, G02H00) and *Coding II* (C10H15)
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study Sequence:	This is the capstone course in the *Coding* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
Available Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475,476, 477, 582, 595, 596, 740, 742, 952, 953
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	If students are assigned in work-based learning settings, teachers must attend WBL training and earn the WBL Certificate provided by the Tennessee Department of Education.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.html Best For All Central: https://bestforall.tnedu.gov/

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- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-2.3** | Receive on-the-job training.
- **Standards 3.1-.2** | Interview a local attorney on the ethical and legal responsibilities of the coding profession.
- **Standards 4.1-4.3** | Participate in an integrated project with an industry professional.
- **Standards 5.1-5.3** | Have students observe and/or assist with a troubleshooting issue with an industry partner.
- **Standards 6.1-7.2 |** Have an industry professional evaluate the students' portfolios.

Course Description

Coding Practicum is a capstone course intended to provide students with the opportunity to apply the skills and knowledge learned in previous *Coding* courses toward the completion of an in-depth project with fellow team members. Students who have progressed to this level in the program of study take on more responsibilities for producing independent work and managing processes involved in the planning, designing, refinement, and production of original software applications. The course is designed to allow students to choose their specific application of interest, such as the development of a mobile application (app), an animation package, a game, or other educational

tools, or any other approved program that requires coding and development skills. Upon completion of the practicum, proficient students will be prepared for postsecondary study and career advancement in programming and software development and will be equipped to market their finished product should they choose.

Work-Based Learning Framework

Practicum activities may take the form of work-based learning (WBL) opportunities, such as internships, cooperative education, service learning, job shadowing, or industry-driven project-based learning. These experiences must comply with the WBL 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 WBL Policy Guide available online at https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html. The Tennessee Department of Education provides a *Personalized Learning Plan* template to ensure compliance with the Work-Based Learning Framework, state and federal Child Labor Law, and Tennessee Department of Education policies, which must be used for students participating in WBL opportunities.

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 have 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. Programming & Software Development Career Planning

2.1 Career Planning: Research a **company or organization that employs computer programmers or specializes in software design and development solutions**. Companies could range from large software developers, to niche organizations that retain programmers on staff to serve their particular clients' needs. For the chosen company, cite specific textual evidence from the company's literature, as well as available press coverage (if available) 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.

2.2 Job Requirements & Qualifications: Analyze the **requirements and qualifications for various programming and development job postings identified from specific company websites or online metasearch engines.** Gather information from multiple sources, such as sample resumes, interviews with professionals, and job boards, to determine effective strategies for realizing career goals. Create a personal resume modeled after elements based on the findings above, then complete an authentic job application as part of a career search or work-based learning experience.

2.3 Mock 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**. Upon completion of the interview, write a thank you letter to the interviewer in a written or email format.

3. Professional Ethics and Legal Responsibilities

3.1 Privacy Rights: Investigate **current issues surrounding the use of software applications to collect and track user data**. Explore a range of arguments concerning **privacy rights as they relate to the mining of personal data; determine when it is ethical and legal to collect data for profit versus for security purposes**. Advance an original argument that debates the pros and cons and summarizes the potential ramifications for clients, users, the public, and one's own personal reputation, drawing on evidence gathered from news media, company policies, and state and federal laws.

3.2 Intellectual Property Rights: Research a case study involving an **ethical issue related to intellectual property rights**. Examine a variety of perspectives surrounding the issue, then develop an original analysis explaining the impact of the issue on those involved, using persuasive language and citing evidence from the research. Potential issues include copyright infringement, piracy, plagiarism, art licensing, creative commons, and the state/federal laws that govern them.

4. Course Project

4.1 Written Proposal: In teams or individually, **develop a written proposal for an original program or software application that involves advanced refinement and transfer of skills and knowledge acquired in previous *Programming & Software Development* courses**. The proposal should be narrative in nature but supplemented by relevant data and graphic illustrations as needed, such as flowcharts of development processes and diagrams or sketches of what the end product would resemble. Sample projects include developing a mobile app, designing an animation package or plug-in, writing an original game program, or any other programming-based project. Present the proposal to the class, and continually revise based on feedback from peers.

4.2 Design and Development Process: Throughout the design and development process, **develop supplementary documents, presentations, and strategies to support the production and promotion of the program, app, or product**. Identify the target market for the product, and **devise a tentative plan to inform, promote, and convince prospective users of the product's functions and value**. Research marketing plan templates, sample presentations, and synthesize information to produce an original plan outlining how the team intends to market the product once it is finished.

4.3 Coding Skills: Apply **coding skills learned in previous courses to novel contexts and development environments**. For example, develop skills in an emerging technology that would support the completion of the course project, or learn a new programming language not previously studied, in order to enhance the functionality of the product.

5. Advanced Troubleshooting, Critiquing, and Problem Solving

5.1 Troubleshooting: In the course of developing the project, regularly **test for functionality, compatibility, and other design aspects related to user-friendliness**. Conduct and document the proper code validation to resolve errors encountered in the design process.

5.2 Critiquing: Analyze the code written by another team member or peer and **create a flowchart for suggesting changes to improve functionality**. Cite specific examples in the code to support recommendations.

5.3 Problem Solving: Research and **test for potential security threats related to the intended uses of the app, program, or product**. For example, if a mobile app is developed, determine the most common security threats and identify areas of vulnerability in the product that could be remedied by adjusting for the proper code, patching, or system update. If possible, develop and incorporate security measures into the final product to ensure user safety.

6. Portfolio

6.1 Portfolio: Create a portfolio, or similar **collection of work, that illustrates 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 steps of the design process, as outlined by the instructor. The following documents will reside in the student's portfolio:

a. personal code of ethics;
b. career and professional development plan;
c. resume;
d. project proposal with supporting documents;
e. list of responsibilities undertaken through the course;
f. examples of visual materials developed and used during the course (such as drawings, models, presentation slides, videos, and demonstrations);
g. marketing plan;
h. description of the technology used, with examples if appropriate;
i. periodic journal entries reflecting on tasks and activities; and
j. feedback from the instructor and/or supervisor based on observations.

7. Communication of Project Results

7.1 Technical Reports: Produce **technical reports highlighting the purpose, content, and use of the app, program, and product developed for this course**. Cite evidence from multiple authoritative sources in order to justify design and development decisions and maximize the user experience. Incorporate supporting graphics, sketches, and data as needed to summarize the technical specifications of the product.

7.2 Technology Enhanced Presentation: Upon completion of the practicum, **develop a technology-enhanced presentation showcasing highlights, challenges, and lessons learned from the experience**. The presentation should be delivered orally, but supported by relevant graphic illustrations, such as diagrams, flowcharts, and/or market data on the target users. Prepare the presentation in a format that could be presented to both a technical and a non-technical audience, as well as for a career and technical student organization (CTSO) competitive event.

Standards Alignment Notes

*References to other standards include:

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

Cybersecurity I

Primary Career Cluster:	Information Technology
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H19
Prerequisite(s):	*Algebra I* (G02X02, G02H00); *Computer Science Foundations* (C10H11)
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 *Information Technology* courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study
Programs of Study and Sequence:	This is the second course in the *Cybersecurity* 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 Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 742, 952, 953
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Teacher Required Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities related 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** | Invite a guest speaker from a professional organization to discuss Cybersecurity.
- **Standards 2.1-2.2** | Discuss risk management with an employee responsible for risk management.
- **Standards 3.1-3.3** | Conduct technical monitoring through online interactions with partners.
- **Standards 4.1-4.6** | Complete a project that is used by a local industry or evaluated by a local industry.
- **Standards 5.1-5.6** | Visit a local company and discuss open systems and internet protocol.
- **Standards 6.1-7.2** | Invite an industry to discuss networking components, infrastructure, and security.
- **Standards 8.1-8.2** | Work on-site using command prompts with the assistance of an industry expert.
- **Standards 9.1-9.5** | Have students complete a project that is supervised or evaluated by a manager of a local company.
- **Standards 10.1-10.5** | Invite a security administrator to discuss their daily work routine to include required protocols.
- **Standards 11.1-11.2** | Invite a cryptologist to discuss the career field and job responsibilities.

Course Description

Cybersecurity I is a course intended to teach students the basic concepts of cybersecurity. The course places an emphasis on security integration, application of cybersecurity practices and devices, ethics, and best practices management. The fundamental skills in this course cover both in-house and external threats to network security and design, how to enforce network-level security policies, and how to safeguard an organization's information. Upon completion of this course, proficient students will demonstrate an understanding of cybersecurity concepts, identify fundamental principles of networking systems, understand network infrastructure and network security, and be able to demonstrate how to implement various aspects of security within a networking system.

Course Standards

1. Cybersecurity Fundamental Concepts

1.1 Ethical Security Practices: Using websites and journals from professional organizations related to information technology, analyze ethical security practices, including but not limited to the **issues of data security, confidentiality, integrity, availability, authentication, nonrepudiation, physical security, HIPPA Laws, Payment Card Industry (PCI) Compliance, and the importance of ISO27000 standards**.

1.2 Breaches: Using news articles, research current events on breaches; focus on particular Information Assurance (IA) areas that were compromised. For example, research and report on **the effects of unethical security breaches on a business citing specific textual evidence**.

1.3 Threats: Consult a variety of sources to analyze security threats, vulnerabilities, and exploits. Research common **ways that threats, vulnerabilities, and exploits impact an organization**. For example, research and report on the threats, vulnerabilities, and exploit(s) used in a recent high-profile breach.

2. Risk Management Techniques

2.1 Risk Management: Read and interpret technical information to **define risk management and how it applies to information security**. Examine a case study of a company using a systematic approach for the identification, assessment, and management of information security risks and compile a brief narrative summarizing conclusions.

2.2 Risk Assessment: Perform a simulated risk assessment by using the common industry framework from ISO. Analyze and **describe the risk mitigation techniques of acceptance, mitigation, avoidance, and transfer**.

3. Access Controls

3.1 Access Control: Gather relevant information from textbooks and online resources to explain the core **concepts of access control as they relate to authentication and authorization**. Create an infographic that a security analyst could use as a guide.

3.2 Principles of Access Controls: Interpret instructional materials to analyze and describe the core principles of access controls. Instructional material may include textbooks, manuals, websites, video tutorials, and more. For example, analyze **the use of administrative, logical (technical), and physical controls applied to systems and organizations**.

3.3 Use of Access Controls: Demonstrate the use of access controls that apply to user account management, including basic and advanced techniques. Drawing on evidence from textbooks and other resources, **evaluate the effectiveness of the controls and incorporate feedback when refining techniques**.

4. Fundamental Principles of Networking

4.1 Local Area Network (LAN): Prepare informational artifacts (e.g., brochure, poster, fact sheet, narrative, or presentation) for the following **LAN topics**:

a. Identify and describe common **LAN methodologies**.
b. Analyze the various **LAN topologies** including perimeter networks which may include the use of a DMZ.
c. Indicate and explain the **standards of Ethernet**.
d. Describe the **characteristics of LAN cabling**.

4.2 Wireless Networks: Explain the **industry standards used in wireless networks including security protocols used to protect the wireless network**. Read and interpret trade journals, assessing the usefulness of each source, to describe the impact the protocol has had on a particular network. For example, cite evidence from trade journals to explain the Secure Socket Layer (SSL) and Transport Layer Security (TLS) Protocols and their impact on the security of wireless networks.

4.3 Routing Protocols: Consult a variety of sources to **describe how routing protocols are used and the differences between static and dynamic methods of routing**. Sources may include textbooks, manuals, websites, video tutorials, and more. Create a visual display with accompanying text comparing and contrasting these two methods.

4.4 Installation: Create an illustrative guide that explains **how to install and configure Routing and Remote Access Service (RRAS) to function as a network route**r and **how to install and configure Routing Information Protocols**.

4.5 WAN Networks: **Choose between technologies and topologies utilized for WAN networks and justify the choices.** Make a written case for selecting one technology and topology over another, highlighting the features of each, and citing resources to validate claims.

4.6 Internet Connectivity: **Explain how the different types of personal and small business internet connectivity have changed throughout history** and **identify current internet systems most commonly used**. Consult internet forums, textbooks, industry journals, and other instructional materials, assessing the usefulness of each source, to describe the impact these changes have made. Create and present a document and/or illustration depicting the timeline of development that led to modern-day internet systems, citing specific textual evidence.

5. Fundamental Principles of Open Systems and Internet Protocol

5.1 OSI: Identify, describe, and effectively **summarize the common OSI model and the functions used by each layer**. Create a written report or visual depiction outlining the characteristics and properties of each.

5.2 Networking Models: **Research and create** an informational artifact (e.g., brochure, poster, fact sheet, narrative, or presentation) analyzing and describing the **differences between the TCP/IP and OSI models for networking**.

5.3 Data Transmission: Define and describe the **various services used by networks for the transmission of data** such as DNS, NAT, and DHCP. Create a graphic illustration showing the roles of each service and describe their differences.

5.4 Addressing Technologies: Analyze **the differences among the addressing techniques used by networks, including IPv4 and basic IPv6.** Write a brief paper that discusses the differences. Provide specific examples to support the claims.

5.5 Subnets: Using instructional materials, analyze and then **demonstrate the use of subnets in an organization's network environment**. For example, create a simple network using subnets for different organizational locations. Instructional materials may include textbooks, instructional manuals, websites, video tutorials, and more.

5.6 Client Server Network: Research the features and **requirements of a working model of a client-server network and how services function in a networked Windows environment**. Drawing on multiple resources, demonstrate the installation of the various network services in the client-server network.

6. Network Infrastructures and Network Security

6.1 Types of Networks: Compare and contrast the **differences and uses of the Internet, Intranets, and Extranets**. Citing specific examples, create an illustrative guide that outlines the benefits of each and the major similarities and differences.

6.2 Secure Networks: Research and describe **the most common various methods and technology used to secure networks**. Investigate and distinguish among the following common methods to secure a network.

a. VPNs for remote access
b. Firewalls

c. Perimeter network designs
d. Preventative technologies

7. Fundamental Network Components of Cybersecurity

7.1 Network Security Devices: Research the **different applications of network security devices**. Create a table or other graphic organizer that lists examples of each device and details their purpose, characteristics, and proper maintenance. Demonstrate proper installation and configuration of each device while using the appropriate media.

a. Optical drives
b. Combo drives and burners
c. Connection types
d. Hard drives
e. Solid state/flash drives
f. RAID types
g. Floppy drive
h. Tape drive
i. Media capacity

7.2 Simple Secure Networks: Demonstrate **secure networking techniques by designing a simple secure network**. For example, show how the various security protocols, technology, and designs protect an organization's network.

8. Basic and Advanced Command Prompts

8.1 Networking Commands: Synthesize information from a range of sources to **analyze the various networking commands used to test and examine networks**. Using domain-specific terminology, explain to a technical audience the distinguishing features of each command that make one more appropriate for certain types of applications.

8.2 Command Line Utilities: Analyze and research the **features and uses of command line utilities to configure and examine networking services** and construct a flow chart that a security analyst could reference.

9. Application Security and Host Systems

9.1 Operating and File Systems: Explore and **identify various operating and file systems used in networks.** Create a chart to define the pros and cons of how these systems are designed to provide the security necessary in a multiuser environment, citing examples of when each is used.

9.2 Security Threats: Research and describe the **most common security threats to computer systems, such as social engineering, malware, phishing, viruses**, etc. Investigate and distinguish among the following common prevention methods to secure a computer system. For a given scenario, identify the most applicable best practice to secure a workstation as well as describe methods for data destruction and disposal. Implement these practices and write a justification for each scenario solution. Provide supporting

evidence for each solution, drawing on technical texts and industry standards. Prevention methods include the following:

a. physical security (e.g., lock doors, tailgating, biometrics, badges, key fobs, retinal, etc.);
b. digital security (e.g., antivirus, firewalls, antispyware, user authentication, etc.);
c. user education; and
d. principles of least privilege.

9.3 Recent Threats: Using news articles and instructional materials, **research and report on recent threats and vulnerabilities to systems in networking environments, making reference to the top application vulnerabilities** and how they are used to exploit systems and networking resources.

9.4 Network Attacks: Differentiate between threats and vulnerabilities and **what constitutes a network attack and identify how to differentiate between the different types of application attacks**. Citing specific examples, create an illustrative guide that outlines major similarities and differences.

9.5 Anti-virus Software Installation: Identify and *explain ways to install and configure anti-virus software*. Demonstrate the **installation of security software design to protect systems on the network**. Upon completion of the work, write an explanation and justify the actions by citing supporting evidence from technical manuals and industry standards.

10. Security Administration

10.1 Security Procedures: Research the **features and requirements of common security procedures used to protect system resources on a network**. Drawing on multiple resources, explain why it is important to know this information when developing a security procedure.

10.2 Baseline Security Measures: Identify and describe **the differences among various methods to create baseline security measures**. Utilizing existing tools on a system, such as the Microsoft Baseline Security Analyzer, outline the steps taken to create a security measure.

10.3 Storage Devices and Backup Media: **Research the following storage devices and backup media**. Create a table or other graphic organizer that lists examples of each device and details their purpose, characteristics, proper maintenance, and methods used to back up and protect data from unauthorized use and access of data.

a. Optical drives
b. Combo drives and burners
c. Connection types
d. Hard drives
e. Solid state/flash drives
f. RAID types
g. Floppy drive
h. Tape drive
i. Media capacity

10.4 File and Folder Permissions: Demonstrate the **methods used to protect against unauthorized use of files**. Configure file and folder permissions using both Windows and Linux environments.

10.5 Security Protocols: Analyze various **protocols and services used by systems for securing them in a network environment.** Create a table that lists the purpose and distinguishing features of each protocol and service.

11. Cryptology

11.1 History of Cryptology: Drawing on multiple sources (i.e., internet, textbooks, videos, and journals), **research the history of cryptology**. Create a timeline or infographic, illustrating cryptology's historical evolution from its inception to the present time, including but not limited to public key infrastructures and asymmetric and symmetric encryptions. Provide examples drawn from the research to support claims.

11.2 Use of Cryptology: Analyze common methods and **use of cryptology to protect data**. Compare and contrast general methods used and explain how their designs and functionalities support the security of data.

12. Team Project

12.1 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 CTSO event.

a. **Problem Identification**: Brainstorm specific problems and challenges within 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 evaluate, 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 Level II 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:

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

Cybersecurity II

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H20
Prerequisite:	*Cybersecurity I*
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Cybersecurity* 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 Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 742, 952, 953
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-information-technology.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 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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-3.2** | Invite a local attorney to explain the legal and ethical concepts and threats involved with cybersecurity.
- **Standards 4.1-4.3** | Have an industry rep discuss the importance of cryptology.
- **Standards 5.1-6.3** | Job shadow a cybersecurity policy director.
- **Standards 7.1-9.1** | Create a project interacting with industry professionals.

Course Description

Cybersecurity II challenges students to develop advanced skills in the concepts and terminology of cybersecurity. This course builds on previous concepts introduced in Cybersecurity I while expanding the content to include malware threats, cryptography, wireless technologies, and organizational security. Upon completion of this course, proficient students will be able to demonstrate an understanding of cybersecurity ethical decisions, malware threats, how to detect vulnerabilities, principles of cryptology, security techniques, contingency plan techniques, security analysis, risk management techniques, and advanced methods of cybersecurity.

Course Standards

1. Legal and Ethical Concepts in Cybersecurity

1.1 Legislation: Drawing from various resources, analyze **current legislation that governs computer-related crimes**. For example, create a presentation discussing common computer crimes, terms of use, and legal issues such as copyright laws, fair use laws, and trademark ethics pertaining to images, videos, and recorded sounds.

1.2 Acts of Computer Crime: Using news articles, research and report on **current legal cases involving acts of computer crime**. For example, research and report on a recent case of computer fraud, piracy, and abuse.

1.3 Evidence Collection: Consult a variety of sources to analyze **methods used to discover methods of evidence collection to support legal cases involving computer-related crime**. Create a presentation highlighting the methods used.

2. Malware Threats

2.1 Forms of Malware: Conduct research to **determine various forms of malware**. Give specific examples and create an infographic highlighting the different types.

2.2 Methods to Handle Malware: Analyze **methods to handle malware**, such as how to control access to secured resources and computer resources. Give specific examples of methods that a security analyst can use, like encryption techniques, basic input/output system (BIOS) features, and strategies for dealing with malware.

3. Threats and Vulnerabilities

3.1 Types of Attacks: Analyze and differentiate among various **types of attacks on systems and networks**. Create a table or other graphic organizer that lists the following types of attacks and details their purposes and characteristics. Different types of attacks can include but are not limited to:

a. virus,
b. worms,
c. trojans,
d. unpatched software,
e. password cracking,
f. advanced persistent threat,
g. reconnaissance/footprinting,
h. infiltration,
i. network breach,
j. network exploitation,
k. attack for effects (e.g., deceive, disrupt, degrade, and destroy),
l. DoS/DDoS, session hijacking,
m. HTTP spoofing,
n. DNS attacks,
o. switch attacks,

p. man-in-the-middle (MITM) attacks,
q. cross-site scripting, and
r. drive-by-attacks.

3.2 Attack Methods: Consult a variety of sources to **research attack methods** and create a **report on at least two events**. For example, show how social engineering (e.g., baiting, phishing/spear phishing, pretexting/blagging, tailgating, quid pro quo, etc.) led to the breach of an organization.

4. Principles of Cryptology

4.1 Cryptology Tools: Research and create an information artifact (e.g., brochure, fact sheet, or narrative) **analyzing cryptographic tools, procedures for use, and products** including but not limited to PKI, Certificates, PGP, and Certificate authorities.

4.2 Public Key Infrastructures: In teams, examine trade journals and research literature from product vendors to **develop a simple public key infrastructure to be used by a small business**. For example, show how an organization can use digital certificates, encrypted file transfers, and email utilizing encryption.

4.3 Self-Signed Certificate: Investigate and demonstrate **the creation of a self-signed certificate for use on a web server by using command line or online tools**. For example, create, install, secure, backup, and restore a certificate.

5. Wireless Security Techniques

5.1 Wireless Attack Methods: Analyze **attack methods on wireless networks**. Read and interpret trade journals, assessing the usefulness of each source, to **describe the different methods used**. For example, cite evidence from trade journals to explain man in the middle, sniffing, and wireless SSID spoofing to explain their unique attack methods.

5.2 Wireless Security Protocols: Demonstrate **the use of wireless security protocols**. Drawing on evidence from textbooks and other resources, **evaluate the capabilities of WPA, WPA-2, and WEP, and the effectiveness of the security protocols** and demonstrate how to use them appropriately.

6. Organizational Security Techniques

6.1 Environmental Controls: Consult a variety of sources to analyze, define, and demonstrate **the use of environmental controls**. Instructional material may include textbooks, manuals, websites, video tutorials, and more. For example, show how BIOS sets controls on a system.

6.2 Security Operations: As a class, work collaboratively to develop simple **policies that support the operations of security in an organization**. For example, create an email security policy that outlines rules regarding responsible technology use.

6.3 Security Awareness: Research and analyze **security awareness in an organization**. Create a table or other graphic organizer that lists the following examples of **how to manage user habits and expectations**:

a. security policy training and procedures;
b. personally identifiable information;
c. information classifications;
d. data labeling, handling, and disposal;
e. compliance with laws, best practices, and standards;
f. user habits;
g. threat awareness; and
h. use of social networking.

7. Contingency Planning Techniques

7.1 Impact of Security Incidents: Synthesize information from a range of sources to analyze and **define the impact of security incidents on an organization**. For example, describe the various types of incidents including but not limited to malware, intrusion, and other forms of compromise.

7.2 Disaster Recovery Plan: Research and define **what is disaster recovery (DR) plan is and how to develop one**. For example, develop a step-by-step guide on how an organization would recover from an incident. The disaster recovery plan should highlight three key aspects: preventive measures, detective measures, and corrective measures. Write a justification that explains to a client why a disaster recovery plan is important.

8. Security Analysis Evaluation

8.1 Assessment Methods: Explore and identify various **assessment methods including but not limited to network penetration and vulnerability testing**. Create a chart to define how these systems are designed to help identify weak links in a company's cybersecurity chain, and how they provide feedback and recommendations needed in order to address them.

8.2 Security Testing Tools: Identify and explain **the uses of security testing tools**. Demonstrate and compare the effectiveness of Nessus and Nmap. Write an explanation and justify conclusions by citing supporting evidence from technical manual vendor resources.

8.3 Security Analysis: Demonstrate each of the following concepts:

a. Evaluate the **patch status of a machine**.
b. Demonstrate knowledge of **packet-level analysis** in order to install and view packets.
c. Perform **secure data destruction** (e.g., Secure Erase, BCWipe).

9. Advanced Methods of Cybersecurity

9.1 Network Configuration: Utilizing prior fundamentals, demonstrate **proper secure network configuration and administration**. For example, use common tools and design a network utilizing secure protocols, and evaluate the network upon completion. The plan should address, but is not limited, to the following:

a. Applying and implementing secure network administration principles.
b. Demonstrating knowledge of how network services and protocols interact to provide network communications in order to securely implement and use common protocols.
c. Identifying commonly used default network ports.
d. Setting up a Network Address Translation (NAT) device.
e. Configuring a Virtual Private Network (VPN).
f. Configuring a remote access policy Layer 2 Tunneling Protocol (L2TP) and Point-to-Point Tunneling Protocol (PPTP).
g. Demonstrating knowledge of network protocols (e.g., Transmission Control Protocol and Internet Protocol (TCP/IP)), Dynamic Host Configuration Protocol (DHCP) and directory services (e.g., Domain Name System (DNS) by setting up common protocols, e.g., Secure Shell (SSH), netstat, Simple Mail Transfer Protocol (SMTP), nslookup, Telnet, DNS/Bind, FTP, IIS/Web Pages, DHCP/DNS server).
h. Locating open ports by completing a port scan.
i. Demonstrating the knowledge and use of network statistics (netstat).

Standards Alignment Notes

*References to other standards include:

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

Cybersecurity Practicum

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H21
Prerequisite(s):	*Algebra I* (G02X02, G02H00) and *Cybersecurity II*
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the capstone course in the *Cybersecurity* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
Promoted Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 152, 153, 173, 203, 204, 311, 413, 434, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 742
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	If students are assigned in work-based learning settings, teachers must attend WBL training and earn the WBL Certificate provided by the Tennessee Department of Education.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-3.2** | Receive technical mentoring through online interactions with industry partners.
- **Standards 4.1-6.1** | Have students complete a project that is used and evaluated by a local industry partner.

Course Description

Cybersecurity Practicum is a capstone course intended to provide students with the opportunity to apply the skills and knowledge learned in previous *Cybersecurity* courses toward the completion of an in-depth project with fellow team members. Students who have progressed to this level in the program of study take on more responsibilities for producing independent work and managing processes involved in the planning, designing, refinement, and production of cybersecurity applications. Upon completion of the practicum, proficient students will be prepared for post-secondary study and career advancement in cybersecurity and will be equipped to market their finished product should they choose.

Work-Based Learning Framework

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 WBL 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 WBL Policy Guide available online at https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html. The Tennessee Department of Education provides a Personalized Learning Plan template to ensure compliance with the WBL Framework, state and federal Child Labor Law, and Tennessee Department of Education policies, which must be used for students participating in WBL opportunities.

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 have 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. Cybersecurity Career Planning

2.1 Career Planning: Research a **company or organization that utilizes cybersecurity applications or specializes in cybersecurity solutions**. Companies could range from large software developers to niche organizations that retain specialists on staff to serve their particular clients' needs. For the chosen company, cite specific textual evidence from the company's literature, as well as available press coverage, if available 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.

2.2 Career Qualifications: Analyze the **requirements and qualifications for various cybersecurity job postings identified from specific company websites or online metasearch engines**. Gather information from multiple sources, such as sample resumes, interviews with professionals, and job boards, to determine effective strategies for realizing career goals. Create a personal resume modeled after elements based on the findings above, then complete an authentic job application as part of a career search or work-based learning experience.

2.3 Mock 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**. Upon completion of the interview, write a thank you letter to the interviewer in a written or email format.

3. Professional Ethics and Legal Responsibilities

3.1 Current Issues in Cybersecurity: Investigate **current issues surrounding cybersecurity and its applications**. Explore a range of arguments concerning privacy rights as they relate to the mining of personal data; determine when it is ethical and legal to collect data for profit versus for security purposes. Advance an original argument that debates the pros and cons and summarizes the potential ramifications for clients, users, the public, and one's own personal reputation, drawing on evidence gathered from news media, company policies, and state and federal laws.

3.2 Ethical Issues: Research a case study involving an **ethical issue related to intellectual property rights**. Examine a variety of perspectives surrounding the issue, then develop an original analysis explaining the impact of the issue on those involved, using persuasive language and citing evidence from the research. Potential issues include copyright infringement, piracy, plagiarism, art licensing, creative commons, and the state/federal laws that govern them.

4. Course Project

In teams, students will complete the capstone security assessment to help identify gaps and provide mitigating solutions for a fictitious small and medium-sized business (SMB) that is concerned over the security posture of their business. This assessment should span the various types of tests and attack vectors that students learned about in previous courses in the program of study. The project must provide opportunities for members to experience a high level of interactivity related to the challenges of learning and applying advanced skills in cybersecurity. The project must provide a safe, legal, and ethically sound environment with up-to-date facilities and equipment.

4.1 Policies and Procedures: Research and investigate **how policies and procedures are used to define the practices within the business and how they are used to define the**

practices within the business as they relate to information security. Create three policies that will help establish a solution to potential security concerns:

a. Create an administrative policy, based on this research that employees would need to follow to have access to system resources, or password usage.
b. Create a technical policy that defines how a technical control helps to protect an organization. For example, define how the IT department must configure a firewall.
c. Create a control policy for the physical controls of the organization. For example, a policy to define the physical access to the IT equipment to help contain unauthorized access to the firewall and or routers.

4.2 Technical Security Solution: Analyze a technical security solution scenario and **determine what solution could be deployed to help mitigate an issue and protect the organization against malware infections**.

4.3 Vulnerabilities: Test and run a **vulnerability assessment on the SMB to determine what vulnerabilities exist on a resource** (server, network device, computer, etc.) using Nessus. Students will run a scan on a computer, find the vulnerabilities, and perform the mitigating steps to remove the identified vulnerabilities.

5. Communication of Project Results

5.1 Technology Enhanced Presentation**:** Upon completion of the practicum, **develop a technology-enhanced presentation showcasing their findings and solutions, highlights, challenges, and lessons learned from the experience to a small volunteer panel of professionals who could serve as fictitious business owners**. The presentation should be delivered orally, but supported by relevant graphic illustrations, such as diagrams, flowcharts, and/or market data on the target users. Prepare the presentation in a format that could be presented to both a technical and a non-technical audience, as well as for a career and technical student organization (CTSO) or CyberPatriot competitive events.

6. Portfolio

6.1 Portfolio Artifacts: Create a portfolio, or similar **collection of work, that illustrates the 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 steps of the design process, as outlined by the instructor. The following documents will reside in the student's portfolio:

a. personal code of ethics;
b. career and professional development plan;
c. resume;
d. project proposal with supporting documents;
e. list of responsibilities undertaken through the course;
f. examples of visual materials developed and used during the course (such as drawings, models, presentation slides, videos, and demonstrations);
g. marketing plan;
h. description of technology used, with examples if appropriate;
i. periodic journal entries reflecting on tasks and activities; and
j. feedback from instructor and/or supervisor based on observations.

Standards Alignment Notes

*References to other standards include:

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

Computer Systems

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H10
Prerequisite(s):	*Computer Science Foundations* (C10H11); *Algebra I* (G02X02, G02H00)
Credit:	1
Grade Level(s):	10-11
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the second course in the *Networking Systems* 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 post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	152, 153, 173, 311, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 953
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-information-technology.html Best For All Central: https://bestforall.tnedu.gov/

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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 1.1-2.2** | Invite an industry expert to speak on safety protocols and career opportunities.
- **Standards 3.1-3.5** | Visit a local industry and have the students see the equipment in operation.
- **Standards 4.1-4.6** | Have students job shadow an information technologist.
- **Standards 5.1-7.1** | Have students do an informational interview with a cybersecurity expert.
- **Standards 8.1-9.1** | Have students develop a networking plan with their local IT person**.**
- **Standards 10.1-12.2** | Have students run their school's computer lab.
- **Standards 13.1-14.1** | Have students troubleshoot for a local company and be evaluated.

Course Description

Computer Systems is an intermediate course designed to prepare students with work-related skills and aligned certification in the information technology industry. Content provides students the opportunity to acquire knowledge in both theory and practical applications pertaining to hardware, operating systems, safe mode, command prompt, security, networking, printers, peripheral devices, laptops, mobile devices, troubleshooting, and customer service management. Upon completion of the course, proficient students will have acquired skills and knowledge to install, configure, and maintain computer systems. Students who are proficient in this course will be eligible to pursue the IT industry-standard credential, CompTIA's A+ certification.

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read, interpret, and demonstrate adherence to safety rules**, including rules published by the (1) National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) Internet safety, (4) Occupational Safety and Health Administration (OSHA) guidelines, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply.

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

2. Career Exploration

2.1 Technical Certifications: Explore the **types of technical certifications recognized in the information technology (IT) industry**. Write a brief paper that distinguishes between vendor-neutral and vendor-specific certifications, providing examples of each. Explain why earning technical certification is advantageous to IT professionals. Cite evidence from technical literature and industry standards to support claims.

2.2 Computer Technology Industry Association: Locate and **access the Computer Technology Industry Association (CompTIA) website and analyze its structure, policies, and requirements for CompTIA A+ certification**. Identify what steps are required to obtain the certification and explain how to prepare for the examination.

3. Hardware

3.1 Storage Devices and Backup Media: **Research** the following **storage devices and backup media**. Create a table or other graphic organizer that **lists examples of each device and details their purpose, characteristics, and proper maintenance**. Demonstrate proper installation and configuration of each device while using the appropriate media.

a. Optical drives
b. Combo drives and burners
c. Connection types
d. Hard drives
e. Solid state/flash drives
f. RAID types
g. Floppy drive
h. Tape drive
i. Media capacity

3.2 Motherboard Components: Identify and **explain** the following **motherboard components**. Citing specific examples, write a brief paper **differentiating between the components and describing the purpose, properties, and characteristics of each**.

a. Expansion slots
b. RAM slots

c. CPU sockets
d. Chipsets
e. Jumpers
f. Power connections and types
g. Fan connectors
h. Front panel connectors
i. Bus speeds

3.3 Power Supply: Given an assignment with defined hardware specifications, **identify the appropriate power supply**. Noting the following technical components, write a text explaining the various types of power supply that were considered. Citing specific evidence, explain the characteristics of each and how the final selection was determined. Install the appropriate power supply.
a. Connector types and their voltages
b. Specifications (e.g., wattage, size, number of connectors, etc.)
c. Dual voltage options

3.4 Central Processing Units (CPU): Explore various types of central processing units (CPU). Describe the following **characteristics of the CPU types**. Identify appropriate cooling methods (e.g., heat sink, fans, thermal paste, liquid-based) for each type discussed and justify the selection with supporting evidence.
a. Speeds
b. Cores
c. Cache size/type
d. Hyperthreading
e. Virtualization support
f. Architecture (32-bit vs 64-bit)
g. Integrated GPU

3.5 Memory Types: **Investigate** the following **memory types**. Create a table or other graphic organizer that **describes, compares, and contrasts each type**. Explain the memory compatibility and speed, as well as the appropriate application of each memory type. Cite evidence supporting each application prescribed.
a. DDR
b. DDR2
c. DDR3
d. SDRAM
e. SODIMM
f. RAMBUS
g. DIMM
h. Parity vs. non-parity
i. ECC vs. non ECC
j. RAM configurations
k. Single-sided vs. double-sided

4. Operating Systems

4.1 Microsoft Operating System: Research the **features and requirements of Microsoft operating systems**. Write a brief paper that compares and contrasts the operating systems. Drawing on multiple resources, explain why it is important to know this information when installing and configuring an operating system.

4.2 Operating System Installation: Identify and explain **various alternatives to install and configure an operating system**. For a given assignment, install and configure an operating system by selecting the most appropriate method. Upon completion of the work, write an explanation and justify the actions by citing supporting evidence from technical manuals and industry standards. The explanation should include, but is not limited to, information on the following:

a. boot methods (e.g., USB, CD-ROM, DVD, PXE);
b. type of installations (e.g., creating an image, unattended installation, upgrade, multiboot, etc.);
c. partitioning (e.g., dynamic, basic, primary, extended, logical);
d. file system types/formatting (e.g., FAT, FAT32, NTFS, CDFS, quick format vs. full format);
e. loading alternate third-party drivers;
f. workgroup vs. domain group;
g. driver installation; and
h. factory recovery partition.

4.3 Command Line Tools: Demonstrate an understanding of **how to apply the following command line tools to identify problems with networking and operating systems**. For a given assignment, follow the multistep process to execute an appropriate command and justify why it was selected to perform a specific action.

a. Networking (e.g., PING, TRACERT, NETSTAT, IPCONFIG, NET, NSLOOKUP, NBTSTAT)
b. Operating system (e.g., TASKKILL, BOOTREC, SHUTDOWN, TASKLIST, MD, RD, CD, DEL, FORMAT, COPY, XCOPY, ROBOCOPY, DISKPART, SFC, CHKDSK)

4.4 Operating System Features: Demonstrate the **proper selection and use of the following operating system features and tools**. For a given assignment, explain the selection of the tools and the results.
a. Administrative (e.g., local security policy, Windows firewall, performance monitor, etc.)
b. MSCONFIG (e.g., general, boot, services, startup, and tools)
c. Task Manager (e.g., applications, processes, performance, networking, users)
d. Disk management (e.g., drive status, mounting, extending partitions, splitting, adding drives, adding arrays, etc.)
e. Command line utilities (e.g., MSCONFIG, REGEDIT, CMD, SERVICES.MSC, MMC, MSTSC, NOTEPAD, EXPLORER, MSINFO32, DXDIAG)

4.5 Control Panel Utilities: Demonstrate **the proper application of the following control panel utilities that are common to all Microsoft operating systems, as well as those specific to unique Windows operating systems**. Write a text describing the utilities and explain the results of the various applications.
a. Internet options (e.g., connections, security, general, privacy, programs, advanced)
b. Display/Display settings
c. User accounts
d. Folder options (e.g., view hidden files, hide extensions, general options, view options)
e. System (e.g., performance, remote settings, system protection)
f. Windows firewall
g. Power options (e.g., hibernate, power plans, sleep/suspend, standby)

4.6 Operating System Security Settings: Identify and describe **the differences among the following basic operating system security settings**. Write a brief paper that discusses when each setting is most applicable. Provide specific examples to support the claims.
a. User and groups (e.g., administrator, power user, guest, standard user)
b. NTFS vs. share permissions (e.g., allow vs. deny, moving vs. copying file folders and files, file attributes)
c. Shared files and folders (e.g., administrative vs. local folders, permission propagation, inheritance)
d. System files and folders
e. User authentication (e.g., single sign-on)

5. Safe Mode and Command Prompt

5.1 Safe Mode and Command Prompt: Demonstrate an **understanding and application of safe mode versus the command prompt**. Describe specific scenarios when the safe mode should be used to solve a problem, as well as provide specific examples of the types of tasks that can be completed using the command prompt. Also, describe when the safe

mode should be used with the command prompt. For example, safe mode can be used to solve problems with corrupted and/or malicious applications.

6. Preventative Maintenance Procedures

6.1 Preventive Maintenance: Create and execute a **plan for preventative maintenance of a computer system**. The plan should include a schedule and description of the following procedures. Write a justification that explains to a client why preventative maintenance is important.

a. Backup
b. Check disk
c. Defragmentation
d. Windows updates
e. Patch management
f. Driver/firmware updates
g. Antivirus updates

7. Security

7.1 Security Threats: Research and describe the **most common security threats to computer systems, such as social engineering, malware, phishing, viruses,** etc. Investigate and distinguish among the following common prevention methods to secure a computer system. For a given scenario, identify the most applicable best practice to secure a workstation as well as describe methods for data destruction and disposal. Implement these practices and write a justification for each scenario solution. Provide supporting evidence for each solution, drawing on technical texts and industry standards. Prevention methods include the following:

a. physical security (e.g., lock doors, tailgating, biometrics, badges, key fobs, retinal, etc.);
b. digital security (e.g., antivirus, firewalls, antispyware, user authentication, etc.);
c. user education; and
d. principles of least privilege.

8. Networking

8.1 SOHO Network: Identify and describe the following **fundamental principles of a small office/home office (SOHO) network** (wireless and wired router).

a. MAC filtering
b. Channels (1 -11)
c. Port forwarding, port triggering
d. SSID broadcase (on/off)
e. Wireless encryption
f. Firewall
g. DHCP (on/off)
h. DMZ

Create and execute a plan to configure, install, and upgrade a SOHO network. Upon completion of the work, write an explanation and justify the actions by citing supporting evidence from technical manuals and industry standards.

8.2 Wired and Wireless Network Security: Given scenarios **for both wired and wireless small office home office** (SOHO) networks, **develop and execute an appropriate plan to secure the network.** The plan should address, but is not limited to, the following:

a. Wireless network
    i. Change default usernames and passwords
    ii. Changing SSID
    iii. Setting encryption
    iv. Disabling SSID broadcast
    v. Enable MAC filtering
    vi. Antenna access point placement
    vii. Radio power levels
    viii. Assign static IP addresses
b. Wired network
    i. Change default usernames and passwords
    ii. Enable MAC filtering
    iii. Assign static IP addresses
    iv. Disabling ports
    v. Physical security

Justify the plan with evidence supported by technical literature and industry standards.

9. Servers

9.1 Servers: Create a document that explains **the purpose and components of a server. Include descriptions of the various types of servers** (e.g., file, email, web, etc.) **and the hardware specifications required to support each type**. Using multiple resources, cite evidence to support the information identified and discussed. For example, a file server used in a home office will not require as much RAM (random access memory) as one that supports a large office building.

10. Printers and Peripheral Devices

10.1 Printer Types: Explore and **distinguish among the following printer types**. Briefly describe their similarities and differences, as well as **the imaging process required for applicable printer types**. Explain why it is important to know this information when installing and configuring printers.

a. Laser
b. Inkjet
c. Thermal
d. Impact

10.2 Printer Installation, Configuration, and Maintenance: For a given assignment, **write and execute a plan to install, configure, and maintain a printer that is most appropriate for each of the following example situations**. Explain and justify the selection with supporting evidence from technical manuals and computer systems texts.

a. Installing and configuring onto a specific operating system
b. Print device sharing (e.g., wired, wireless, printer hardware print server)
c. Printer sharing (e.g., via operating system settings)

10.3 Peripheral Devices: Distinguish among and **describe the following peripheral devices commonly found in computer systems**. Install and configure these devices conforming to technical manuals and industry standards.
a. Input devices (e.g., mouse, keyboard, touch screen, scanner, barcode reader, etc.)
b. Multimedia devices (e.g., digital cameras, microphone, webcam, camcorder, MIDI-enabled devices)
c. Output devices (e.g., printers, speakers, display devices)

11. Laptops

11.1 Laptop Components: Identify and explain the following **laptop components**. Citing specific examples, write a brief paper **differentiating between the components and describing the purpose, properties, characteristics, and proper maintenance of each**. Demonstrate proper installation and configuration of each component. For example, replace an optical drive in a laptop.
a. Expansion options (e.g., express card, PCMIA, SODIMM, flash)
b. Keyboard
c. Hard drive
d. Memory
e. Optical drive
f. Wireless card
g. Mini-PCIe
h. Screen
i. DC jack
j. Battery
k. Touchpad
l. Plastics
m. Speaker
n. System board
o. CPU

11.2. Laptop Display Features: Compare and contrast the following **components within the display of a laptop and the laptop features**. Citing specific examples, write a brief paper differentiating between the components and describing the purpose and characteristics of each. Demonstrate the execution of the features. For example, turn on the keyboard backlight.

11.3. Components:
a. Types (e.g., LCD, LED, OLED, plasma)
b. Wi-Fi antenna connector/placement
c. Inverter
d. Backlight

11.4. Features:
    a. Special key functions
    b. Docking station vs. port replicator
    c. Physical laptop lock and cable lock

12. Mobile Devices

12.1 Mobile Operating Systems: Explore the following basic **features of mobile operating systems**. Write a brief paper that compares and contrasts these systems on the following features. Drawing on multiple resources, explain why it is important to know this information when installing and configuring an operating system.
    a. Open source vs. closed source/vendor-specific
    b. App source (app store and market)
    c. Screen orientation (accelerometer/gyroscope)
    d. Screen calibration
    e. GPS and geo-tracking

12.2 Security Threats: Research and describe **the most common security threats related to mobile devices**. Investigate and distinguish among the following common prevention methods to secure a mobile device.
    a. Passcode locks
    b. Remote wipes
    c. Locator applications
    d. Remote backup applications
    e. Failed login attempt restrictions
    f. Antivirus
    g. Patching/OS updates

13. Troubleshooting

13.1 Troubleshooting Theory: Investigate a simple problem and create a flowchart or other graphic illustration that **explains the following steps representing a general troubleshooting** theory.
    a. Gather information from the user or operator and back up data.
    b. Verify the problem exists.
    c. Isolate the cause of the problem and generate alternative solutions.
    d. Plan a solution and resolve the problem.
    e. Verify that the problem was resolved and prevent a future occurrence.
    f. Document findings, resolution, and preventative maintenance plan.

    Compare and contrast the findings, resolution, and maintenance plan with those of other classmates. Provide supporting evidence for any selections that differ from classmates, and work together to come to a consensus on a resolution.

13.2 Troubleshooting Theory Application: Given a problem related to the following components, **follow the troubleshooting theory using appropriate tools**. Identify the problem and document the findings and resolution. Include an explanation of the common symptoms, diagnostic procedures, and specific tools used that led to the problem resolution.

a. Motherboards, RAM, CPU, and power
b. Hard drives and RAID arrays
c. Video and display
d. Wired and wireless networks
e. Client-side network connectivity
f. Operating systems
g. Security issues
h. Laptops
i. Printers

14. Customer Service and Client Relations

14.1 Customer Service: Compare and contrast the **processes of servicing customers on the phone, online, on-site, or in a shop**. Based on the findings, write a brief description of how to service a customer in each of these situations. Include the following in the description:

a. identify questions that a customer should be asked to identify his/her problem,
b. approaches to dealing with difficult customers,
c. when it is appropriate to escalate a problem to a senior support team member, and
d. how to document the services provided.

15. Team Project

15.1 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 CTSO event.

a. **Problem Identification**: Brainstorm specific problems and challenges within 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, evaluate, 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 Level II 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.

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Networking

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H13
Prerequisite(s):	*Computer Systems* (C10H10), *Algebra I* (G02X02, G02H00)
Credit:	1
Grade Level(s):	11-12
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *IT* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Networking Systems* 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 Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	152, 153, 173, 311, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 953
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities related 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 1.1-2.2** | Invite an industry to discuss career options and safety protocols.
- **Standards 3.1-3.2** | Conduct an informational interview with an industry partner.
- **Standards 4.1-6.2** | Have students complete a project that is useful to a local employer for evaluation.
- **Standards 7.1-7.2** | Invite an industry expert to discuss topologies.
- **Standards 8.1-11.1** | Visit an industry partner with this equipment and have the students see it in operation.
- **Standards 12.1-12.4** | Discuss security with the employee responsible for networking security for a local business.
- **Standards 13.1-13.2** | Discuss troubleshooting with an employee responsible for troubleshooting for a local business.

Course Description

Networking is an advanced course designed to emphasize the conceptual and practical skills necessary to design, manage, and diagnose network hardware and software. Upon completion of this course, proficient students will identify types of networks, understand the layers of the open systems interconnection (OSI) model, prevent security risks, and apply troubleshooting theory to the successful execution of networking tasks. Course content covers transmission control protocol, internet protocol, wired and wireless topologies, switching and routing, network hardware, wireless networking, and network operating systems (NOS). Upon completion of this course, proficient students will be prepared to sit for the CompTIA Network+ exam.

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 National Science Teachers Association (NSTA), rules pertaining to electrical safety, Internet safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. Complete the safety test with 100 percent accuracy.

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

2. Career Exploration

2.1 Computer Technology Industry Association: **Locate and access the Computer Technology Industry Association** (CompTIA) website and **analyze its structure, policies, and requirements for CompTIA Network+ certification**. Explain what steps are required to obtain the certification, methods to prepare for the examination, and how it can be a stepping stone to more advanced certifications.

2.2 Networking Standards Organizations: **Research the** following **networking standards organizations** and write an informative paper **explaining the industry standards that are managed by each**. Describe why these standards are important and how they influence the work of a network administrator or other IT professional.

a. American National Standards Institute
b. Electronic Industries Alliance and Telecommunications Industry Association
c. Institute of Electrical and Electronics Engineers
d. International Organization for Standardization
e. International Telecommunication Union
f. Internet Society
g. Internet Assigned Numbers Authority
h. Internet Corporation for Assigned Names and Numbers

3. Types of Networks

3.1 Network Features and Components: **Define the term "network." Define and describe the necessary features and components of a network and differentiate between different network types**. Using graphic illustrations, or other diagrams, identify and describe the following types of networks, outlining the features that distinguish each network from the others and effectively diagraming the flow of information in each.

a. Peer-to-peer networks
b. Client/server networks
c. Local area networks (LAN)
d. Metropolitan area networks (MAN)
e. Wide area networks (WAN)

3.2 Network Functions: Describe the following **functions provided by a network**. Distinguish between these network services in a large office versus an office with few users, providing specific examples.

a. File and print services
b. Access services
c. Communication services
d. Internet services
e. Management services

4. Open Systems Interconnection Model (OSI) Model

4.1 Open System Interconnection (OSI) Model: Create and use diagrams to **explain the Open Systems Interconnection (OSI) Model and the flow of data through it**. Define the functions and identify the associated hardware components of the OSI Model's following seven layers. For example, explain how each layer interacts to ensure that data arrives in the correct place without errors.

a. Application
b. Presentation
c. Session
d. Transport
e. Network
f. Data Link
g. Physical

5. Data Transmission

5.1 Standard Cable Types: **Identify and describe a range of standard cable types** (e.g., coaxial cable, shielded twisted pair, unshielded twisted pair, single-mode fiber, multimode fiber, serial, plenum, and non-plenum), comparing and contrasting their characteristics and properties, and differentiating between them accurately. Explain why it is necessary to consider the following properties when selecting and installing the appropriate cables for a networking task and why these decisions must conform to industry standards. For a given task and environment, make a recommendation about an appropriate cable type and defend the recommendation with specific evidence and reasoning.

a. Transmission speeds
b. Distance
c. Duplex
d. Noise immunity (e.g., security, electromagnetic interference (EMI))
e. Frequency

6. Transmission Control Protocol (TCP)/Internet Protocol (IP)

6.1 Subprotocols: Research and **identify the common subprotocols associated with transmission control protocol (TCP) and internet protocol**. Using a combination of text and graphic illustrations, explain their functions and how they correlate to the layers of the open systems connection (OSI) model. Examples of subprotocols include but are not limited to hypertext transfer protocol (HTTP), user diagram protocol (UDP), internet control message protocol (ICMP), internet group management protocol (IGMP), address resolution protocol (ARP), domain name system (DNS), network time protocol (NTP), file transfer protocol (FTP), and trivial file transfer protocol (TFTP).

6.2 Address Formats: **Describe** the following **address formats**: IPv6, IPv4, and MAC. **Using the advantages and disadvantages as supporting evidence, identify and explain the application of each format**.

7. Topologies

7.1 Physical Network Topologies: **Define each** of the following **physical network topologies and draw diagrams to distinguish among the layouts**. Include examples of the most effective applications, as well as identify the advantages and disadvantages of each topology.
a. Star
b. Mesh
c. Bus
d. Ring
e. Point-to-point
f. Point to multipoint
g. Hybrid

7.2 Types of Topologies: **Compare and contrast logical network topologies to physical network topologies**. Explain how these two types of topologies differ. Identify the common logical network topologies and describe their characteristics. Provide examples demonstrating how logical network topologies are useful in troubleshooting.

8. Switching and Routing

8.1 Switching: Define **switching and** detail **the role that it occupies in a logical network topology**. Describe the three types of switching (circuit, message, and packet) and identify the specific details that distinguish how each method establishes paths between nodes.

8.2 Routing: Define routing and **explain why a router is protocol-dependent**. Identify and list the properties of a router and describe its basic functions, citing examples found in informational texts.

8.3 Data Flow: Write descriptive **text that outlines the process used to determine the most efficient path** (e.g., route) **for data to flow across a network**. Identify and describe that variables influence the best path, including the following most common routing protocols.
   a. Link-state: open shortest path first (OSPF), intermediate system to intermediate system (IS-IS)
   b. Distance-vector: routing information protocol (RIP), routing information protocol version 2 (RIPv2), border gateway protocol (BGP)
   c. Hybrid: enhanced interior gateway routing protocol (EIGRP)

9. Network Hardware

9.1 Network Interface Cards (NICS): Research the **following types of network interface cards (NICs)**. Create a table or other graphic organizer that lists **examples and characteristics of NICs, as well as steps to selecting the appropriate NIC**. Demonstrate proper installation and configuration of each device, attending to appropriate measurements and units. Summarize the multistep procedure to install and configure the various NICs.
   a. Internally attached (internal bus standards)
   b. Externally attached (peripheral bus standards)
   c. On-board
   d. Wireless

9.2 Repeaters: **Define a repeater and explain its limitations**. Describe the characteristics of a hub; explain how it is a type of repeater, yet it still differs from the repeater. Install and configure the following types of hubs and identify their distinguishing characteristics.
   a. Passive
   b. Intelligent
   c. Managed
   d. Stand-alone
   e. Workgroup

9.3 Bridges, Repeaters, Hubs: **Compare and contrast bridges with repeaters and hubs**, identifying examples of **advantages that bridges have over these devices**. Provide supporting evidence to justify each example.

9.4 Node Installation: Create and execute a plan to first **install multiple nodes to a small switch and then to connect the switch to another connectivity device**. Verbally describe the steps of the procedure as they are being demonstrated.

9.5 Gateway Devices: Identify **common gateway devices** and explain **how they are different from connectivity devices**. Further, explain why the gateways must operate on multiple layers of the open systems interconnection (OSI) model.

10. Wireless Networking

10.1 Wireless Transmission Technology: Demonstrate **understanding of wireless transmission technology**. Use a combination of graphic illustrations and text to describe how a wireless signal originates from an electrical current and travels along a conductor. Include definitions and functions of the following concepts.

a. Antenna
b. Signal propagation
c. Signal degradation
d. Frequency ranges
e. Narrowband, broadband, and spread spectrum signals
f. Fixed vs. mobile

10.2 Wireless Local Area Networks: **Compare and contrast wireless local area network (WLAN) infrastructure to that of wired network topologies**. Identify and explain the differences between the two layout types.

10.3 Wireless Fidelity Standards: Locate and **access the 802.11 standards** (wireless fidelity or Wi-Fi) developed by the Institute for Electrical and Electronics Engineers (IEEE). Explain the **purpose of these standards, as well as how IT professionals should apply them to networking systems**.

10.4 Bluetooth Technology: Explore **Bluetooth technology, differentiating between purposes of, and standards that govern, Bluetooth and other technologies** (such as those governed by IEEE 802.111).

10.5 Basic Wireless Network: Given specifications to **install and configure a basic wireless network in a home or small office**, write and execute a plan that includes, but is not limited to, the following:

a. install the client,
b. locate and place the access point,
c. install the access point, and
d. verify installation.

Provide details of the multistep procedure and justify the recommendations in the plan by providing supporting evidence that conforms to industry standards (e.g., Institute for Electrical and Electronics Engineers (IEEE) 802.11; Bluetooth).

10.6 Wireless Network Installation Large Office: Given specifications to **install and configure a wireless network in a large office**, conduct a site survey to **assess the requirements of the clients, facility characteristics, and coverage area**. Using the survey results, write and execute a plan that includes, but is not limited to, the following:

a. wireless access point placement,
b. antenna types,
c. interference,
d. frequencies,
e. channels,
f. wireless standards, and
g. service set identifier (SSID) (e.g., enable/disable).

Provide details of the multistep procedure and justify the plan by providing supporting evidence that conforms to the Institute for Electrical and Electronics Engineers (IEEE) 802.11 standards.

11. Network Operating Systems

11.1 Network Operating Systems: In teams, **research** various **types of network operating systems** (NOS) (e.g., Microsoft Windows server, Linux enterprise server, UNIX, etc.). Identify the basic functions of a NOS, and synthesize the findings to write an explanatory text that includes, but is not limited to, the following:

a. guiding questions to determine the optimal software requirements;
b. client support features;
c. organization of network elements;
d. sharing applications;
e. managing system resources (e.g., memory, multitasking, multiprocessing); and
f. why it is important to consider future needs.

Present the paper to other teams and revise it based on constructive feedback from peers.

12. Security

12.1 Scheduled Audit: Develop a **plan for a regularly scheduled audit to examine a network's security risks.** The plan should include, but is not limited to, the following:

a. how often and when the audit will be conducted,
b. security threats to be examined,
c. rating system to assess the security threats,
d. security policy goals and content, and
e. how security breaches will be addressed.

Implement the security plan for the duration of the course, revising it as necessary.

12.2 Security Risks: Research and describe the **most common security risks associated with people; data transmission and hardware; protocols and software; and internet access**. Investigate and distinguish among the following common prevention methods to secure a network system.

a. Physical security
b. Security in network design
c. Network operating system security
d. Encryption
e. Authentication protocols
f. Wireless network security

Given various scenarios, identify the most applicable best practices to secure a network. Implement these practices and write a justification for each scenario solution. Provide supporting evidence drawing on industry standards.

12.3 Firewalls: Explore the **application of firewalls to secure networks**. Describe their features and functions while distinguishing between the types (e.g., software and hardware). Install and configure a basic firewall. Verbally explain each step of the implementation process as it is executed. Cite any applicable industry standards.

12.4 Fault Tolerance: **Define fault tolerance**, **distinguishing between failures and faults in a network**. Write a paper describing the following aspects that should be monitored and managed to sustain fault tolerance.

a. Environment
b. Power
c. Topology and connectivity
d. Servers
e. Storage

Identify those aspects that are most influential on fault tolerance and justify the claim with supporting evidence. Demonstrate the application of these practices and compare the changes, if any, in the tolerance to results generated by other classmates.

13. Troubleshooting

13.1 Troubleshooting Theory: **For each network system problem** given, **apply the** following **general troubleshooting theory**.

a. Gather information from users or the system, back up data, and document findings.
b. Verify the problem exists and how many users are affected.
c. Isolate the cause of the problem and generate alternative solutions.
d. Determine whether escalation is necessary.
e. Plan a solution and resolve the problem.
f. Verify that the problem was resolved and prevent a future occurrence.
g. Document findings, resolution, and preventative maintenance plan.

Following the steps of the general troubleshooting theory, select a problem to present to classmates as a case study.

13.2 Applying Troubleshooting Theory: For a given assignment related to the following common problems, **follow the troubleshooting theory using appropriate hardware and software tools** (e.g., cable tester, butt set, multimeter, protocol analyzer, throughput testers, connectivity software, etc.).

a. Wireless problems (e.g., interference, signal strength, configurations, latency)
b. Router and switch problems (e.g., switching loop, bad cables, port configuration)
c. Physical connectivity problems (e.g., connectors, wiring, split cables, cable placement)

Identify the problem(s) and document the findings and resolution. Include an explanation of the common symptoms, diagnostic procedures, and specific tools used that led to the problem resolution.

Standards Alignment Notes

*References to other standards include:

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

Cabling & Internetworking

Primary Career Cluster:	Information Technology
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H09
Prerequisite(s):	*Algebra I* (G02X02, G02H00) and *Networking* (C10H13)
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the fourth and final course in the *Networking Systems* 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 post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	173, 523, 532, 533, 537, 582, 595, 701, 740
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-information-technology.html https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-3.1** | Have an industry partner explain safety protocols and job overview.
- **Standards 4.1-4.2** | Visit a local industry with this equipment and have the students see it in operation and being maintained.
- **Standards 5.1-5.2** | Invite industry experts to a panel discussion.
- **Standards 6.1-6.2** | Have students do a project with an industry mentor that is evaluated by a real company.
- **Standards 7.1-8.1** | Observe and/or assist a telecommunication specialist.

Course Description

Cabling & Internetworking is an advanced course intended to equip students with the conceptual and practical skills necessary to install voice and data network cabling. This course emphasizes industry standards, types of media and cabling, physical and logical networks, and signal transmission. Upon completion of this course, proficient students will have skills in cable termination, reading network design documentation, pulling and mounting cable, setting up telecommunications rooms, basic cable testing, and troubleshooting.

Course Standards

1. Cabling Overview

1.1 History and Development of Communications: Research the **history and development of communications cabling** to acquire knowledge of **present-day network cabling concepts and uses**, including but not limited to:

a. the history of telephone and wireless communications in the United States;
b. the differences between analog and digital communication systems;
c. the three main types and typical applications of twisted-pair cabling; and
d. proper uses of plenum- and riser-rated cabling.

Create and deliver a brief presentation on at least one of the above topics, citing specific textual evidence.

2. Safety

2.1 Safety Standard: Assess a variety of situations requiring the use of network cabling and demonstrate the ability to follow procedures safely. Explain the **applicability of various safety standards and procedures**, including but not limited to:

a. safety codes and standards for the cabling materials and installation methods,
b. safe practices working around electricity,
c. workplace safety practices, and
d. personal safety equipment.

3. Computers and Electronics

3.1 Communications Signals: Compare and contrast **aspects of communication signals carried by various types of cabling**, identifying which types are best suited for different applications. Complete a graphic organizer to differentiate the characteristics of:

a. analog signals versus digital signals,
b. voltage signals versus optical signals, and
c. multiplexed signals.

Craft an argument on which type of signal is best suited for a specific application, developing both claim(s) and counterclaim(s) with fair evidence and reasoning.

4. Transmission Media

4.1 Data Cables Application: Compare and contrast the typical **applications for various types of data cables** (such as twisted pair, coaxial cable, fiber optic), and **the conditions under which a technician may use them**. Defend the choice of cable for an example application, coherently and respectfully expressing the rationale behind the choice to a mock customer.

4.2 Data Cables: Compare and contrast **conducting data cables with fiber-optic data cables**, including but not limited to:

a. transmission modes (electrical conduction versus optical transmission),
b. connectors,

c. installation issues, and
d. advantages and disadvantages.

5. Specifications and Standards

5.1 Wiring Standards: Research **wiring standards and the organizations responsible for drafting and overseeing them**. During a practice installation, explain **how the communication of the standards impacts a user's ability to specify, install, and test the appropriate cabling.** The subject organizations should include:
   a. American National Standards Institute (ANSI),
   b. Telecommunications Industry Association (TIA), and
   c. Electronics Industries Alliance (EIA).

5.2 National Electric Code and Underwriters Laboratories: During a practice installation of data cabling, describe **the applicability of the National Electrical Code (NEC) and Underwriters Laboratories (UL) requirements,** citing specific textual evidence.

6. Cabling System Design

6.1 Telecommunications Closet: Design a **telecommunications closet (TC) for a Local Area Network (LAN) installation**. Craft a full explanatory text that cites specific textual evidence in descriptions of:
   a. differences between TC and equipment rooms;
   b. recommended number of TCs in a large building;
   c. TC construction standards (including required and prohibited features and dimensions);
   d. typical equipment and features in TC; and
   e. required environmental conditions inside the TC.

6.2 Star Network Installation: Explain and demonstrate, in writing or a presentation, **the role played by each component in a typical star network installation**, including the Network Interface card (NIC), media converter, repeater, hub, bridge, switch, server, and router. For each component, detail the likely consequences in the event of failure, and prescribe strategies for prevention and maintenance.

7. Cabling Installations

7.1 Small-Scale LAN Installation: Plan and **implement a small-scale LAN installation**, properly using the tools, techniques, and materials accepted in the cabling industry, including but not limited to building schematics, wire cutters, and wire strippers, cable crimpers, punch-down tool, "fish tape" and pull/pushrods, diagnostic test tools, lubricants, and cable identification tags. Before completing installation, design a summary document that includes a narrative of activities and a graphic illustration of sites to share with potential customers.

7.2 Horizontal and Vertical Installations: As part of a real or practice installation, explain and **demonstrate the rough-in phase for both horizontal and vertical installations of data cabling in a small office**, including but not limited to horizontal and vertical installations, fire stops, and telecommunications closet construction or upgrades.

7.3 Trim-Out Phase: As part of a real or practice installation, explain and **demonstrate the trim-out phase of an installation**, including but not limited to cable management, connectors and splices for copper media and fiber-optic media, and patch panels.

7.4 Completion stage for Installation: As part of a real or practice installation, explain and **demonstrate the completion stage of an installation**, including but not limited to cable testing and certification, performance testing, final dressing of the installation, and documentation and drawings representing the finished installation and test results.

8. Special Cabling Situations

8.1 Special Coding Situations: Demonstrate an **understanding of the special cabling situations required for high bandwidth scenarios,** providing power over Ethernet (PoE), standards of SCADA systems, industrial-grade data cabling requirements, and preventive maintenance programs for cable systems. Create and deliver a brief presentation on at least one of the above topics, citing specific textual evidence.

Standards Alignment Notes

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IT Clinical Internship

Primary Career Cluster:	Information Technology
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H12
Prerequisite(s):	Two credits in the *Networking Systems* program of study
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 *Information Technology* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the final course in the *Networking Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/ Technology Student Association (TSA): http://www.tntsa.org
Promoted Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	153, 173, 311, 435, 436, 470, 474, 475, 476, 477, 582, 595, 740, 953
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	If students are assigned in work-based learning (WBL) settings, teachers must attend WBL training and earn the WBL Certificate provided by the Tennessee Department of Education.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.html Best for All Central: https://bestforall.tnedu.gov/

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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 1.1-1.18 | Internship with a local business or school.

Course Description

IT Clinical Internship is a capstone course and work-based learning experience designed to provide students with real-world application of skills and knowledge obtained in previous *Networking Systems* courses. Students are eligible to take the *IT Clinical Internship* if they have successfully completed all the prerequisites in the *Networking Systems* program of study. Prospective students must apply for admission to the class (acceptance at the discretion of the instructor). The internships are designed to be completed in an IT Support environment, such as the student's school, a community-based shop that provides IT Support, or the IT Support department of a local business. This course puts to practical use all of the skills attained in previous courses and provides the student with valuable hands-on experience. It meets the recommended 500 hours of work experience to prepare each student to sit for the CompTIA A+ exams, which certifies industry-recognized IT Support technicians. Upon completion of this course, proficient students will be prepared to pursue further training at a Tennessee College of Applied Technology (TCAT) or other postsecondary institution.

Work-Based Learning Framework

Clinical experiences must comply with the Work-Based Learning (WBL) Framework guidelines established in SBE High School Policy 2.103. The TDOE provides a *Personalized Learning Plan* template to ensure compliance with the WBL Framework, state and federal Child Labor Law, and Tennessee Department of Education policies, which must be used for students participating in WBL

opportunities. Additionally, 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.

Course Standards

1. Clinical Internship

1.1 Personalized Learning Plan: A student will have 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.

1.2 Safety Guidelines: Accurately **read, interpret, and demonstrate adherence to safety guidelines appropriate for the roles and responsibilities of an employee in an IT setting**. Listen to safety instructions and be able to explain why certain rules apply. Demonstrate safety techniques and follow all applicable guidelines related to the clinical placement. Based on placement, document completion of training topics on the appropriate work-based learning (WBL) and work site forms.

1.3 Student Learning Plan: **Develop a personalized student-learning plan, in accordance with approved policies, to address the methods for practicing and demonstrating each of the skills identified in the pre-requisite IT course standards**. Relate how each skill applies to a placement in an IT setting, and document day-to-day applications. Participate in ongoing review and communications around the progress of the plan with the WBL Coordinator.

1.4 Organizational Culture/ Practices: Observe and **analyze organizational culture and practices,** e.g., how to interact with supervisors, clients, and co-workers, and how to recognize and address health, safety, and sustainability issues. Seek information from supervisors and other employees about appropriate methods of pursuing employment in the industry, and determine what knowledge, skills, and educational credentials are required.

1.5 Career Pathway Plan: **Apply learning experiences from internship placement to review and update an education and career pathways plan based on the knowledge and feedback acquired**. Proactively identify areas of strength and opportunities for professional growth, encourage and act on feedback from peers, supervisors, and customers, and seek and use resources and support to improve skills.

1.6 Workplace Solutions: Identify and **ask significant questions to solve problems in the workplace**. Use inductive and deductive reasoning methods to recognize faulty reasoning, and to understand problems and alternative solutions.

1.7 System Thinking: A**nalyze quality assurance methods used by IT professionals** in a variety of industries. **Solve problems using systems thinking**, e.g., by understanding problems in terms of complex processes and environments. Identify key components and relationships that enable, influence, and produce outcomes.

1.8 Ethical Behavior: **Demonstrate integrity and ethical behavior when engaging in all worksite activities**, including the secure use of client data, responsible Internet use, use of tools and materials, documentation of services provided, sharing of information, client relations, and completion of all personnel-related forms.

1.9 Written/Verbal Communication: **Articulate ideas effectively in written personal communications with supervisors, coworkers, and customers using appropriate IT terminology**, reviewing and revising as needed, and developing claims with appropriate evidence and reasoning. Verbally articulate ideas effectively in interpersonal communications with supervisors, coworkers, and customers. Develop and deliver messages effectively in oral presentations. Demonstrate effective listening skills, attending to the meaning and intention of communication, and accurately paraphrasing what has been heard. Communicate effectively with individuals of diverse backgrounds who may also speak languages other than English, using foreign language skills as appropriate.

1.10 Team Member Expectations: **Work effectively as a member of a team and address conflict with sensitivity and respect for diverse points of view**. Demonstrate an understanding of one's impact and build on different perspectives to strengthen joint efforts. Demonstrate leadership where appropriate to collaborate on workplace tasks. Effectively employ meeting management strategies, such as agenda setting, timekeeping, and meeting facilitation strategies, and list action items to identify and schedule the next steps.

1.11 Accessing Information: **Access information efficiently, using sources appropriate to task, purpose, and audience**. Distinguish between credible and non-credible sources, including the difference between advertising and legitimate research. Evaluate information for usefulness, bias, and accuracy, and question information that may not originate from credible sources. Demonstrate the ability to organize and manage information effectively and efficiently. Demonstrate ethical and legal use of information, including adherence to all rules and regulations related to the sharing of protected information. For example, when a user reports a network system problem, investigate and verify that the problem exists, determine how many users are affected, and diagnose the problem using the information at hand.

1.12 Technology Usage: **Use appropriate technology for information search and retrieval**, synchronous and asynchronous communications, multimedia presentations, document production, quantitative and qualitative analysis, and information management. Use social networking and online collaboration tools such as shared documents and web conferencing to create, integrate, and manage information in group projects.

1.13 Online Communication: Access and **manage online communication and information, such as a customer relationship management system, using multiple digital devices**. Demonstrate adherence to all rules and regulations related to the use of electronic tools and the Internet, including appropriate protection of passcodes and adherence to all security protocols.

1.14 Self-Efficacy: **Complete tasks as directed without direct supervision, knowing when questions or guidance should be requested**. Exhibit resourcefulness and initiative in taking on new tasks and solving problems on one's own as appropriate to the workplace setting. Demonstrate how to learn and exhibit personal agency in identifying and achieving instrumental and ultimate learning objectives. Demonstrate curiosity to learn more about the tasks, workplace, and/or industry. Explore deeper content on one's own and request opportunities for professional development. Demonstrate self-efficacy and confidence in one's ability to succeed in specific situations.

1.15 Workplace Culture: **Present oneself professionally and respectfully when interacting with coworkers, supervisors, and customers**. Demonstrate reliability and responsibility in attendance in following through on agreed-upon tasks and communicating with the supervisor when circumstances change. Understand and adhere to appropriate workplace non-discrimination standards. Respect cultural differences and work effectively with people from diverse social and cultural backgrounds.

1.16 Flexibility: Exhibit **flexibility by adapting to varied roles, jobs responsibilities**, **schedules, and contexts**; working effectively in a climate of ambiguity and changing priorities; and dealing positively with praise, setbacks, and constructive criticism.

1.17 Time Management: **Manage time and projects effectively by setting goals; developing and using a system for prioritizing, planning, and managing daily work; persisting in the face of challenges; and seeking assistance and adjusting plans to adapt to changing circumstances**. Demonstrate attention to detail and accuracy appropriate to the task. Demonstrate accountability to supervisors, coworkers, and customers by delivering work to agreed-upon standards; accepting constructive criticism; completing agreed-upon projects on time; and exhibiting pride in workmanship.

1.18 Portfolio: Create a portfolio, or similar **collection of work, that illustrates mastery of skills and knowledge outlined in the previous Networking Systems courses and applied in the internship experience**. The portfolio should reflect a thoughtful assessment and evaluation of the progression of work involving the application of steps of the troubleshooting process, as outlined by the instructor. The following documents will reside in the career portfolio:

a. career and professional development plan;
b. resume;
c. documentation of work hours at each site;
d. list of responsibilities undertaken throughout the placement;
e. examples of materials developed and used throughout the placement;
f. Periodic journal entries reflecting on tasks and activities;
g. supervisor evaluations and observations;

h. approved WBL forms; and
i. WBL coordinator evaluations and observations.

Standards Alignment Notes

*References to other standards include:

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

Web Design Foundations

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C10H16
Pre-requisite(s):	*Computer Science Foundations* (6095)*, Algebra I* (G02X02, G02H00)*, Geometry* (G02H11, G02X03)
Credit:	1
Grade Level:	10
Elective Focus- Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *IT* courses. In addition, this course satisfies one fine arts credit required for graduation.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the second course in the *Web 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 Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 070, 153, 157, 173, 203, 204, 230, 231, 232, 233, (042 and 043), (042 and 044), (042 and 045), (042 and 046), (042 and 047), (042 and 077), (042 and 078), (042 and 079), (043 and 044), (043 and 045), (043 and 046), (043 and 047), (043 and 077), (043 and 078), (043 and 079), (044 and 045), (044 and 046), (044 and 047), (044 and 077), (044 and 078), (044 and 079), (045 and 046), (045 and 047), (045 and 077), (045 and 078), (045 and 079), (046 and 047), (046 and 077), (046 and 078), (046 and 079), (046 and 047), (046 and 077), (047 and 077), (047 and 078), (047 and 079), (077 and 078), (077 and 079), (078 and 079), 311, 434, 435, 436, 470, 475, 476, 477, 516, 519, 582, 583, 595, 543, 711, 740, 953, 982
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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** | Invite an industry partner to discuss occupational safety protocols.
- **Standards 2.1-2.4** | Conduct an informational interview with an industry partner as a mock client.
- **Standards 3.1-3.3** | Invite an industry partner to demonstrate site mapping.
- **Standards 4.1-4.3** | Invite a copyright attorney to present on copyright laws.
- **Standards 5.1-5.7** | Job shadow a web designer.
- **Standards 6.1-6.3** | Visit a local company with this equipment and have the students see the operation.
- **Standards 7.1-7.2** | Visit a local publishing company.
- **Standards 8.1-8.5** | Visit a local marketing firm.
- **Standards 9.1-9.5** | Work with an industry partner on an integrated project.
- **Standards 10.1-11.1** | Present a quality assurance plan to a local agency for evaluation.

Course Description

Web Design Foundations is a course that prepares students with work-related web design skills for advancement into postsecondary education and industry. The course is intended to develop

fundamental skills in both theory and practical application of the basic web design and development process, project management and teamwork, troubleshooting and problem-solving, and interpersonal skill development. Laboratory facilities and experiences simulate those found in the web design and development industry; where interaction with a "client" is indicated in the standards, it is expected that students' peers or the instructor may serve as mock clients in lieu of an actual relationship with an industry partner. Upon completion of this course, proficient students will be prepared for more advanced coursework in the Web Design program of study.

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read, interpret, and demonstrate adherence to safety rules**, including rules published by the (1) National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) Internet safety, (4) Occupational Safety and Health Administration (OSHA) guidelines, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply.

2. Client Relations

2.1 Artificial Intelligence (AI) Enhanced Client Interactions: Introduce the **use of AI tools** for **gathering and analyzing client requirements** and feedback more efficiently. Discuss how AI can help **predict client needs** based on data.

2.2 Client Interview: Create a questionnaire and **conduct an interview with a client to gather specific information to guide the web development project**. Develop interview questions that will determine the purpose; target audience; branding and perception goals; content sources; and any factors that will affect the project schedule.

2.3 Project Brief: Using the information gathered from the client interview, **write a project brief that identifies the goals, audience profile, audience perception, primary message of the website, and the competitive advantage of the client**. Allow the client to review the project brief and make corrections based on client feedback.

2.4 Website Specifications: Research the **specifications that will be required to produce a website that meets the needs of the project brief**. Using the findings, produce technical specifications for the website. For example, the specifications should consider the screen resolution, browser compatibility, download time for the website, and accessibility.

2.5 Maintenance Requirements: Demonstrate an **understanding of maintenance requirements for a website that is aligned with the project brief**. Develop a plan that thoroughly describes how the site will be consistently updated and reviewed. Write a text explaining the maintenance requirements and plan to a client. For example, a website maintenance plan should include, but is not limited to, any automated processes for changing content, required training for content contributors, and assignments for specific updates (e.g., keyword, search engine, Metadata, and graphics).

3. Site Mapping

3.1 Content Outline: Conduct a brainstorming session to solicit a client's feedback on website content. **Create an outline that organizes the content into categories**. **Ensure that the outline is aligned with the project brief and that there is space for future expansion**. Present the outline to the client for review and approval. For example, use a mind mapping process to capture all the ideas and topics for a website development project.

3.2 Site Map: Applying the content outline, **develop a diagram that visually represents the website structure**. The site map (or website wireframe) should show the interconnection of features such as the homepage, links, and content for each link. For example, use software like Google Drawings, Microsoft Visio, OmniGiraffe, Adobe Illustrator, or Microsoft Office to create a website wireframe.

3.3 Wireframe: **Convert the website wireframes to individual web page wireframes**. A wireframe should consider each element (e.g., navigation, images, content, functionality, and footer) and group the information of its corresponding page.

4. Copyright/Licensing

4.1 Stock Images: Explore the **use of stock images and demonstrate an understanding of the various types of stock images** like stock photography, microstock photography, and free (e.g., open source) images. Identify the advantages and disadvantages of using these images.

4.2 Licensing: Compare and contrast **royalty-free and rights-managed licensing and explain how each licensing affects the use of images**. Research and describe the process to obtain permission to use copyrighted photography.

4.3 Photo sharing: Investigate multiple **photo-sharing services and how they embed metadata within images to assist in keyword searches**. As a class, create a photo-sharing system (class use only) for student-created images that include embedded metadata.

5. Introduction to Design and Layout

5.1 Digital Images: Demonstrate an **understanding of how specific characteristics affect the quality and size of a digital image.** Define the following terminology and explain their effects on digital images:

a. pixels,
b. color depth,
c. resolution,
d. palettes, and
e. dithering.

5.2 Types of Graphics: **Compare and contrast raster and vector graphics and provide scenarios when it is best to use each format**. Further, explore their applications to

vector-based drawing and paint programs. Describe the advantages and disadvantages of using each program type.

5.3 AI-Enhanced Imagery in Web Design: **Utilize AI technologies to generate** and enhance **images for web design**, ensuring visually compelling and optimized content for diverse user interfaces. Apply AI tools for image creation, enhancement, and optimization, aligning with web standards for speed, accessibility, and aesthetic appeal.

5.4 File Format: Research and **identify the extensions of various image file formats** like Bitmap, Tagged Image File Format, Windows Metafile, Joint Photographic Experts Group, Portable Network Graphics, and Graphics Interchange Format. Describe which file formats are supported by all browsers and which formats require special software or a plug-in to view an image. Explain when it is most appropriate to apply specific image file formats.

5.5 Image Optimization: In teams, **investigate image optimization and its importance**. Describe how file formats influence image optimization and identify optimization guidelines and sources to apply to web graphics.

5.6 Composition: **Explain the graphic design concept of composition**. Include various applications like visual hierarchy, grouping, visual cues, and integration of elements.

5.7 Grid-Based Layout: Explore **the use of grid-based layout and why it is used to create coherent, organized web pages**. Give examples of when it is suitable to use one-, two-, and three-column layouts to display content. For example, research and discuss how the golden ratio (golden mean) is used to create a design grid.

5.8 Typography: Drawing on multiple resources, demonstrate an **understanding of typography, including related definitions like measure and lead**. Explain a designer's application of the following typography characteristics to create balance and relationship between elements on a web page.

a. Legibility
b. Typeface
c. Case
d. Emphasis
e. Type size and accessibility

6. Composition

6.1 Color Perceptions: Conduct research to **determine how various colors are perceived by specific audiences and cultures**. Citing evidence from research findings, explain the following concepts:

a. symbols, objects, and images that attract or repel audiences;
b. color combinations that complement each other; and
c. smooth color transitions and the effects on download time.

For example, create a class demonstration showing which colors are most complementary and how many colors define a color scheme.

6.2 Pixels and Display Color: Demonstrate an **understanding of the relationship between pixels and display color**. Explain how black and white are each created using color schemes CMYK (cyan, magenta, yellow, and black) and RGB (red, green, blue) respectively. Furthermore, describe the differences between subtractive and additive colors and how they are applied to print media versus a computer monitor display.

6.3 Standardized Numeric Formats: Consider the **two standardized numeric formats for color on the computer screen**—RGB values and Hexadecimal code. Compare and contrast the **format of values for each** and briefly explain **how they are applied to represent color**.

7. Writing, Critiquing, and Publishing Content for the Web

7.1 Writing Styles: In teams, **research writing styles on various websites** including sites of well-known organizations and companies. **Identify characteristics that are consistently used** and include examples of **what made the text memorable and easy to scan**. Use the research findings to create guidelines for the class to apply to upcoming web design and development projects. During the survey of writing styles on the web, take notice of the following:

a. location of important information on the page,
b. use of bulleted lists and tables,
c. length and simplicity of paragraphs,
d. headlines and introduction sentences,
e. tone and voice used, and
f. accuracy of information (current or outdated).

7.2 Writing Guidelines: Given a specific topic from a web development project, **write content for a web page and apply the class writing guidelines**. Proofread and rewrite the content to align with the class guidelines. Give the writing assignment to multiple classmates for review. Revise the content based on reviewer feedback. Follow this multistep process until the written product is appropriate for publication on a website.

8. Marketing, Branding, Identity, and eCommerce

8.1 Logos: Research various logos of well-known companies and organizations on the web. **Identify shapes and colors that are consistently used, and include examples of what made the logos unique, attractive, and memorable**.

8.2 Brand Management: Drawing from various resources, **identify several ways that a web designer can apply and strengthen brand management and identity**. Consider the concepts of consistent color and logo placement and explain the application of each.

8.3 eCommerce: Investigate how to set up and **implement a secure e-commerce site**. Citing evidence from reliable resources, describe 1) measures to prevent shopping cart vulnerabilities, 2) pre-built shopping software, and 3) hosting options for shopping cart software.

8.4 Marketing: In teams, **examine how demographics, psychographics, and audience data are used to market a product or service online**. Using this information, create a questionnaire to survey people about a product or service. For example, the questionnaire could survey alternative promotion methods, market growth drivers, and barriers.

8.5 Marketing Plan: As a team, use the survey results and **develop a marketing plan that identifies the following for a web development project**.

a. Promotions for both global (mass) and niche (micro) markets
b. Web marketing strategies and goals
c. Market growth drivers and barriers
d. Product distribution and availability
e. Product or service pricing
f. Advertising options to be used (e.g., links, banner ads, viral marketing, social media)

8.6 AI and XR in Branding and Marketing: Integrate **AI tools for market analysis**, customer behavior prediction, and personalization strategies. Explore the potential of extended reality (XR) in **creating immersive brand experiences**.

9. Introducing Coding Skills

9.1 Markup Language: Research the **history of markup languages**; briefly describe **the function of markup languages and why they are different from programming languages**.

9.2 HTML: Explore the **origin of the HTML standard and the creation of the World Wide Web Consortium (W3C)**. Discuss the six versions of the HTML standard and how each differs from the other. Explain the role of standardization and provide examples of how it promotes universality for all web users.

9.3 HTML Tags: **Define HTML tags distinguishing between empty tags and container tags**. Explain their application to web development, why Hypertext Markup Language (HTML) evolved, and provide examples of tags frequently used. Create a simple web page that consists of paragraph text, text hyperlinks, tables, and elements in frames.

9.4 Cascading Style Sheets: Demonstrate **understanding of Cascading Style Sheets (CSS)**. Investigate and report how CSS separates formatting elements from HTML and solves a number of design limitations, such as the following:

a. proprietary HTML extensions,
b. text-to-image conversion to retain fonts,
c. page layout using tables, and
d. images controlling white space.

9.5 Use of Cascading Style Sheets: Explore the **use of Cascading Style Sheets (CSS) for page layout and cite evidence as to why CSS provides more flexible and precise layout capabilities than tables and frames**. Explain and demonstrate coding for the following elements of CSS page layout.

a. CSS box model (e.g., inline, block)

b. Document flow and positioning (e.g., static, relative, absolute, fixed, float, z-index)
c. CSS positioning schemes (e.g., two-column layout, three-column layout)

10. Organization

10.1 Effective use of File/Folder Management: As a class, define the **guidelines for effective use of file and folder management techniques to maintain directory structure for forthcoming website class projects**. The guidelines should address efficient methods for maintaining site root and subfolders for assets (e.g., images, templates, CSS), as well as the correct way to use file paths for relative, site root relative, and absolute links.

11. Troubleshooting and Problem Solving

11.1 Troubleshooting and Problem Solving: **Troubleshooting and formal testing is a systematic quality assurance process and should be routinely completed throughout the life cycle of a website**. There are various multistep testing procedures for a website. The following recommendations provide a general approach to testing:

a. review the content for accuracy, spelling, and grammar;
b. review site for broken links;
c. test the functionality of the website as defined by the project specifications;
d. validate the HTML and CSS coding;
e. check the accessibility using automated tools;
f. test site on various browsers that the target audience uses;
g. analyze the connection speed and size of web pages;
h. conduct usability testing with the target audience;
i. work with the server administrator to conduct load testing; and
j. conduct authentication testing and review file authorizations.

As a class, develop a quality assurance plan that incorporates the above testing procedures, as well as outlines how the testing will be managed, how the issues will be prioritized, and how problems will be solved.

12. Team Project

12.1 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 CTSO event.

a. **Problem Identification**: Brainstorm specific problems and challenges within 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 evaluate, 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 Level II 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:

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

Web Site Development

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H17
Prerequisite:	*Web Design Foundations* (C10H16)
Credit:	1
Grade Level(s):	11-12
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other IT courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Web 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 Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 070, 153, 157, 173, 203, 204, 230, 231, 232, 233, (042 and 043), (042 and 044), (042 and 045), (042 and 046), (042 and 047), (042 and 077), (042 and 078), (042 and 079), (043 and 044), (043 and 045), (043 and 046), (043 and 047), (043 and 077), (043 and 078), (043 and 079), (044 and 045), (044 and 046), (044 and 047), (044 and 077), (044 and 078), (044 and 079), (045 and 046), (045 and 047), (045 and 077), (045 and 078), (045 and 079), (046 and 047), (046 and 077), (046 and 078), (046 and 079), (046 and 047), (046 and 077), (047 and 079), (047 and 077), (047 and 078), (077 and 078), (077 and 079), (078 and 079), 311, 434, 435, 436, 470, 475, 476, 477, 516, 519, 582, 583, 595, 543, 711, 740, 953, 982
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-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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 1.1-2.1** | Invite an A/V worker to give a safety demonstration.
- **Standards 3.1-3.2** | Conduct an Informational Interview with an industry partner.
- **Standards 4.1** | Complete an integrated project with multiple interactions with professionals in the Arts, A/V Technology and Communications field.
- **Standards 5.1-5.6** | Participate in a student-run enterprise with team involvement.
- **Standards 6.1-6.2** | Complete a virtual portfolio exchange with an industry partner.
- **Standards 7.1-7.3 and 8.1-9.1** | Present final presentation to a potential industry employer.

Course Description

Web Site Development builds on the skills and knowledge gained in *Web Design Foundations* to further prepare students for success in the web design and development fields. Emphasis is placed on applying the design process toward projects of increasing sophistication, culminating in the production of a functional, static website. As students work toward this goal, they acquire key skills in coding, project management, basic troubleshooting and validation, and content development and analysis. Artifacts of the work completed in this course will be logged in a student portfolio demonstrating mastery of skills and knowledge. Upon completion of this course, proficient students

will be prepared to pursue a variety of postsecondary programs in the computer sciences, sit for industry certification, or apply their skills in a capstone *Web Design Practicum*.

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read, interpret, and demonstrate adherence to safety rules**, including rules published by the (1) National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) Internet safety, (4) Occupational Safety and Health Administration (OSHA) guidelines, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply.

1.2 Responsible Technology Use: Throughout the course, **practice safe habits and procedures when sharing and sending files, navigating websites, and connecting to servers and networks**. As a class, work collaboratively to develop a professional policy that outlines rules regarding responsible technology use in the classroom. The policy must adhere to all school and district technology policies.

1.3 Safe Use and Transfer of Data: Determine **how companies, organizations, and individuals keep their data secure from theft and identity fraud**. Summarize and produce a list of best practices from industry magazines and professional organizations such as the World Wide Web Consortium (W3C). Identify steps for the safe use and transfer of data that can applied in the Web Design classroom.

2. Career Exploration

2.1 Career Growth: Investigate **opportunities for personal and professional growth in the web design and computer science fields**, including but not limited to opportunities to enter design contests, assist with the maintenance or development of the school's website, and participate in initiatives such as the national Hour of Code. In addition, explore postsecondary programs in the computer sciences, such as web design and development, animation and graphics, or website administration, and document the search in the course portfolio.

3. The Design Process

3.1 Website Evaluation: **Select a website whose content is appropriate** and adheres to the course policy, as approved by the instructor. **Critically evaluate the site on the merits of its design features, applying knowledge and skills related to webpage composition** (learned in *Web Design Foundations*) to critique the following:

a. navigational hierarchy;
b. balance;
c. color unity;
d. typography, formatting, and other aspects of text layout and style;

e. compatibility across multiple browsers and devices; and
f. flow and arrangement of content.

Develop a presentation, written paper, or blog post analyzing these elements, supported by screenshots of the website and other specific evidence drawn from the site. Be able to answer the question, "What makes this website compelling, attractive, and functional?"

3.2 Design Process: Synthesize the s**teps of the web design process learned in previous courses with research into emerging or alternative design models**. In groups, produce a sophisticated flowchart, diagram, or other logic model that will serve as a template to guide the development of all projects and activities undertaken in this course. Annotate the model with the inputs, constraints, activities, and target outcomes involved in a given project; demonstrate where inputs flow from one stage of a project to the next.

4. Project Management

4.1 Project Management Tools: Research **how web development teams use project management tools to divide roles and responsibilities among team members, track progress toward goals, and satisfy client specifications**. Explore a variety of such tools and develop systems for applying selected tools to projects and assignments in this course. For example, download a Gantt chart template for a spreadsheet software application and use it to assign tasks and monitor deliverables working toward a given deadline.

5. Coding Skills

5.1 Technical Fluency: Demonstrate **technical fluency in a variety of programming and markup languages**, including but not limited to HTML, XML, CSS, JavaScript, JQuery, PHP, and/or SQL. Describe the particular functions and environments in which each language operates, detailing the benefits, limitations, and unique features of each. Justify when one programming language would be ideal for a given project or design solution, developing the recommendation with specific evidence and reasoning.

5.2 Webpage Elements: **Correctly apply tags, embed links, manipulate space, customize attributes, and incorporate style elements related to typography, margins, and spanning and padding**. Demonstrate the ability to code web page elements such as tables and forms according to the specifications of the client.

5.3 Measurement Units in Website Development: **Distinguish between different units and measurement systems used in website development**. Be able to accurately define terms such as size, aspect ratio, percentage units, and pixels as they relate to specific style commands (i.e., in a cascading style sheet). Given a set of design constraints or client specifications, accurately apply and modify the appropriate units when writing and editing code for objects/text in a programming environment.

5.4 Revision Skills: Throughout the course, **apply, edit, and continually revise code using software approved by the instructor**, ranging from proprietary software such as Dreamweaver to simple applications like Microsoft Notepad. Practice teamwork and revision skills by 1) critiquing the work of peers; and 2) furnishing recommendations for resolving

errors in syntax and improving elements of design. Annotate recommendations in the programming environment to facilitate peer review.

5.5 Graphics and Multimedia Editing: Create and **edit graphics and other multimedia for web pages**, evaluating and **customizing their attributes according to client/instructor specifications**. For example, write code for a scalable vector graphic (SVG) with a predetermined height, width, shape, and color, using appropriate units in order to maximize visibility and continuity of design.

5.6 Plug-Ins: Summarize the **functions of plug-ins for content management systems as well as static websites**. Describe a range of plug-ins and justify when they are needed for a specific application. Demonstrate the ability to download and install plug-ins for selected assignments in support of a specified design goal.

6. Basic Troubleshooting and Validation

6.1 Troubleshooting Strategies: Apply **basic troubleshooting strategies to resolve errors in syntax, fix broken links, edit distorted images, and align website content for seamless navigation**. As part of a course assignment or project, practice troubleshooting techniques to meet the vision or specifications of a mock client. For example, pretend a client complains that the alpha version of his/her website has rendered the dimensions of an interactive form too small for customers to read. Accurately diagnose the problem, then make adjustments to the code to resolve the issue to the client's satisfaction.

6.2 Code Validation: Research **methods of performing code validation on a completed or in-progress web page**. Validate code for compatibility across browsers and devices. Explain the results of the validation test to the class in the form of a brief presentation as would a team of developers.

7. Content Development and Analysis

7.1 Branding Strategies: Conduct a **preliminary investigation of various branding strategies** (i.e., social media marketing, web advertising, etc.) **used by companies that sell their products and services online**. Evaluate selected companies' websites to determine how such strategies are deployed throughout the sites. Describe how one or more of these strategies could be incorporated into a future website for this or another course.

7.2 Web Analysis: **Define web analytics** and discuss the increasingly **sophisticated role that analytics play in the marketing and management of content for websites**. Interpret simple analytics in the dashboard interface of a content management system such as WordPress. Use quantitative reasoning and appropriate terminology to describe trends, analyze performance, and explain to peers how a website's "reach" can be determined with analytics.

7.3 Writing Web Content: Build on the work of previous Web Design courses and **practice writing original web content for a particular audience.** Adhere to client specifications regarding tone, length, and style of language, writing in a manner appropriate for the target

audience. Regularly edit writing and solicit peer feedback for continuity of message and language. Collaboratively work to refine writing to be suitable for web publication.

8. Web Hosting and Publishing

8.1 Website Set-Up: Model the **process for setting up a website. Investigate domain name availability, register with a hosting service, and download a File Transfer Protocol (FTP) program.** As part of a course assignment or project, demonstrate the ability to upload and organize files onto a server and arrange content to map out a simple multi-page website. Maintain accurate and navigable directories for retrieving and storing files. Incorporate original writing content onto the site and publish content online for the instructor or class to see on a standard Internet browser.

9. Trends in Web Design and Development

9.1 Emerging Trends: Explore a range of **new and emerging trends in web design and development**. A trend could be a new software, strategy, programming language, or phenomenon that has seen rising or widespread usage on the Internet in recent years. Examples include the movement toward responsive design to expand website compatibility; the increasing use of HTML5; or the embedding of social media within websites for the purposes of sharing content or crowdsourcing a product idea. Research one or more of these trends in depth and compile a presentation or a paper explaining both the technical aspects involved (i.e., how it works on a web page) and the practical applications it has for customers, webmasters, businesses, or other users.

Standards Alignment Notes

*References to other standards include:

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

Web Design Practicum

Primary Career Cluster:	Information Technology (IT)
Course Contact:	CTE.Standards@tn.gov
Course Code:	C10H18
Prerequisite:	*Web Site Development* (C10H17)
Credit:	1
Grade Level(s):	11-12
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *IT* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the fourth course in the *Web 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 Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	037, 041, 055, 056, 057, 070, 173, 203, 204, 230, 231, 232, 233, (042 and 043), (042 and 044), (042 and 045), (042 and 046), (042 and 047), (042 and 077), (042 and 078), (042 and 079), (043 and 044), (043 and 045), (043 and 046), (043 and 047),(043 and 077), (043 and 078), (043 and 079), (044 and 045), (044 and046), (044 and 047), (044 and 077), (044 and 078), (044 and 079), (045and 046), (045 and 047), (045 and 077), (045 and 078), (045 and 079),(046 and 047), (046 and 077), (046 and 078), (046 and 079), (046 and047), (047 and 079), (047 and 077), (047 and 078), (077 and 078), (077and 079), (078 and 079), 153, 157, 311, 435, 436, 470, 475, 476, 477, 516, 519, 582, 583, 595, 543, 711, 740, 037, 041, 055, 056, 057, 434, 953, 982
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	If students are assigned to work-based learning settings, teachers must attend WBL training and earn the WBL Certificate provided by the Tennessee Department of Education.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-information-technology.html

	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-information-technology.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 demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as Student2Student Mentoring, National Week of Service, Officer Training, and Community Action Project.

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** | Invite an industry expert in to discuss career planning.
- **Standards 2.1-2.2** | Invite an attorney to discuss ethics and legal responsibilities.
- **Standards 3.1-5.4** | Complete an integrated project with multiple interactions with professionals in the web design field of study.
- **Standards 6.1-7.2** | Present a portfolio to an industry partner for evaluation.

Course Description

Web Design Practicum is a capstone course intended to provide students with the opportunity to apply the skills and knowledge learned in previous *Web Design* courses toward the completion of an in-depth project with fellow team members. Students who have progressed to this level in the *Web*

Design program of study take on more responsibilities for producing independent work and managing processes involved in the planning, designing, refinement, and launch of a website. In addition to developing an understanding of the professional and ethical issues encountered by web design professionals in the workplace, students learn to refine their skills in problem-solving, troubleshooting, teamwork, marketing and analytics, and project management. Upon completion of the practicum, proficient students will be prepared for postsecondary study and career advancement in web design.

Work-Based Learning Framework

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.

The Tennessee Department of Education provides a *Personalized Learning Plan* template to ensure compliance with the Work-Based Learning Framework, state and federal Child Labor Law, and Tennessee Department of Education policies, which must be used for students participating in WBL opportunities.

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. Web Design Career Planning

1.1 Personalized Learning Plan: A student will have 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.

1.2 Career Research: **Research a company or organization that provides web design/development services for clients**. Companies could range from large design firms serving corporate clients, to independent freelance businesses operating in the local community. For the chosen company, cite specific textual evidence from the company's literature, as well as available press coverage (if available) 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.

1.3 Career Requirements and Qualifications: Analyze the **requirements and qualifications for various web design job postings identified from specific company websites or online metasearch engines**. Gather information from multiple sources, such as sample resumes, interviews with web design professionals, and job boards, to determine effective strategies for realizing career goals. Create a personal resume modeled after elements based on the findings above, then complete an authentic job application as part of a career search or work-based learning experience.

1.4 Mock 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**. Upon completion of the interview, write a thank you letter to the interviewer in a written or email format.

2. Professional Ethics and Legal Responsibilities

2.1 Ethical and Legal Responsibilities: **Investigate a range of unethical and illegal behaviors frequently encountered by web design professionals**. Summarize the legal and professional consequences for engaging in these behaviors, developing claims and counterclaims about the potential ramifications for clients, users, the public, and one's reputation. Deliver findings in the form of a summary document or presentation supported by evidence from news media, company policies, and state and federal laws. Potential issues include spam, flaming, cyberbullying, libel, slandering, and the mining of personal data for profit.

2.2 Intellectual Property Rights Ethical Issues: Research a case study involving an ethical issue related to intellectual property rights. Examine a variety of perspectives surrounding the issue, then **develop an original analysis explaining the impact of the issue on those involved, using persuasive language and citing evidence from the research**. Potential issues include copyright infringement, piracy, plagiarism, art licensing, creative commons, and the state/federal laws that govern them.

3. Course Project

3.1 Written Proposals: Meet with a potential or mock client who requires a web-based digital product, and discuss the client's wants and needs for the product. In teams or individually, **work to develop a project plan, set goals, delegate responsibilities, and determine deadlines to meet the client's specifications**. Analyze available resources, then formulate and present a written proposal for the potential client detailing the following:

a. summary of product solutions that can be offered;
b. strategy for addressing the needs of the client;
c. schedule of completion; and
d. cost to the client, including justification of expenses.

3.2 Site Map: In teams or individually, **develop a site map outlining the architecture of the web page(s) to be created in the project**. Demonstrate the ability to group content in the form of a flowchart or other visual representation, and apply principles related to continuity of design.

3.3 Project Documentation: Work together to **assemble adequate documentation of project activities, including end-user documentation**. Be able to explain to both lay and technical audiences how various aspects of the site and/or digital product were developed and how they function. For example, annotate code where appropriate such that another web designer could replicate it; or explain to a first-time user how a form developed for the site, retrieves and stores information in a remote database.

3.4 File Management and Agreements: **Maintain accurate and accessible directories of files relevant to the project and develop agreements among team members and clients surrounding data management, naming conventions, version control, editing permissions, and sharing of files** (for example, through cloud-based services or shared drives).

3.5 Project Plan Expectation: Use appropriate authoring software to **execute the project plan in line with budget constraints, server size, deadlines, and all other specifications in order to meet the vision of the client**. In the course of development, apply coding skills to design, organize, create, maintain, and update the site or digital product as needed.

4. Advanced Troubleshooting, Critiquing, and Problem Solving

4.1 Advanced Troubleshooting: In the course of developing the web-based project, **regularly test the site for functionality, navigability, browser and device compatibility, and other design aspects related to user-friendliness**. Conduct and document the proper code validation to fix broken links, distorted images, and similar errors.

4.2 Critiquing: **Analyze the code written by another team member or peer and create a flowchart for suggesting changes to improve functionality**. Cite specific examples in the code to support recommendations.

4.3 Problem Solving: Apply **coding skills learned in previous courses to novel contexts and development environments**. For example, investigate methods for scaling the site or

digital product onto a mobile device using responsive design. Where appropriate, incorporate the proper CSS code to render a site compatible on multiple web platforms.

5. Web Marketing and Analytics

5.1 Sale and Distribution Factors: Research **factors that affect the sale and distribution of products and services over the Internet**, such as the wide availability of customer feedback on sites like Amazon, Yelp, and Google. Select a company whose products/services are purchased online; describe how the factors identified above influence the design of the company's website. Critique the effectiveness of the site in promoting the company's product/service, citing evidence related to user-friendliness, accessibility, tone, and composition.

5.2 Web Marketing Strategies: Analyze a **range of web marketing strategies** and cite examples of **how businesses use them to drive web traffic**. Strategies include but are not limited to social media marketing, image-centric content marketing, search engine optimization (SEO), email marketing, or mobile-friendly content. Deliver a mock presentation to "peer clients" outlining how one or more of these strategies could be incorporated to increase the web presence of a real or fictitious business. Drawing on success stories of similar companies, pitch the chosen strategy using persuasive language and relevant supporting data.

5.3 Data Collection: Describe **how companies collect data using web analytics**. Summarize a range of statistics used when tracking web traffic, such as unique page views, session duration, and bounce rate. Demonstrate the ability to collect and interpret analytics to achieve marketing goals; if applicable, incorporate such analysis into the course project.

5.4 Web Data Analyzation: Investigate the **ways companies use web data to analyze demographic and psychographic information about their customers**. Model to a "peer client" how an ordinary business owner can use IP geolocation, surveys, forms, and other tools to make strategic marketing decisions.

6. Portfolio

6.1 Portfolio: **Create a portfolio, or similar collection of work, that illustrates 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 steps of the design process. The following documents will reside in the student portfolio:

personal code of ethics;

a. career and professional development plan;
b. resume;
c. links to web pages designed or contributed to;
d. list of responsibilities undertaken through the course;
e. examples of visual materials developed and used during the course (such as graphics, drawings, models, presentation slides, videos, and demonstrations);
f. description of the technology used, with examples if appropriate;
g. periodic journal entries reflecting on tasks and activities; and
h. feedback from the instructor and/or supervisor based on observations.

7. Communication of Project Results

7.1 Technical Report: **Produce a technical report highlighting the purpose, content, use, and intended audience of the web-based project**. Cite evidence from the code and web development best practices in order to justify design decisions and maximize client satisfaction. Include appropriate documentation of license agreements, copyright protections, non-disclosure statements, and other legal issues if dealing with the ideas or data of others.

7.2 Technology Presentation: Upon completion of the practicum, **develop a technology-enhanced presentation showcasing highlights, challenges, and lessons learned from the experience**. The presentation should be delivered orally, but supported by relevant graphic illustrations, such as diagrams, flowcharts, sample code, and/or summary data generated from the site. Prepare the presentation in a format that could be presented to both a technical and a non-technical audience, as well as for a career and technical student organization (CTSO) competitive event.

Standards Alignment Notes

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    - 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.

Data Science I

Primary Career Cluster:	Information Technology
Course Content:	CTE.Standards@tn.gov
Course Code:	TBD
Suggested Prerequisite:	Computer Science Foundations (C10H11) and Algebra I
Credit:	1 credit
Grade Level(s):	10-11
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Information Technology courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses to 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 Data Science program of study.
Aligned Student Organization(s):	Technology Student Association (tsaweb.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.
Available 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/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	013, 017, 173, 203, 214, 413, 414, 417, 477, 740, 742
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Teacher Training:	None
Teacher Resources:	Information Technology (tn.gov) Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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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 demonstration such as Data Science Analytics, Engineering Design, and Coding.
- Participate in leadership activities such as Prepared Presentation, Debating Technological Issues, and Audio Podcasting.

Using Work-Based Learning (WBL) in Your Classroom

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

- **Standards 1.1-1.2** | Conduct an informational interview with an industry partner.
- **Standard 2.4** | Complete an integrated project on ethical concerns in data science with multiple interactions with professionals in the field.
- **Standards 3.1-3.5** | Review and discuss datasets provided by a local industry.

Course Description

Data Science I is the second course designed to prepare students to pursue careers in the fields of data-related industries. Upon completion of this course, proficient students will be able to describe the attributes of data and its uses and perform basic programming tasks. In addition, students will add artifacts to a portfolio, which they will continue to build throughout the program of study.

Course Standards

1. Career Planning and Professionalism

1.1 Career Exploration: **Research information surrounding careers in data science and analysis.** Identify specific roles of data scientists in industry and research. Investigate and compare the range of skills, competencies, and professional traits required for such careers.

1.2 Data Professional Needs in the Labor Market: **Illustrate state and nationwide needs for data science professionals** in the various career clusters.

2. Introduction to Data

2.1 Understanding Data: **Research the various types of data**, including categorical, numerical, ordinal, and nominal. Differentiate between primary and secondary data.

2.2 Structured and Unstructured Data: **Compare and contrast structured and unstructured data**, including the following:

a. organization,
b. characterizations of schema,
c. ease of analysis, and
d. applications.

2.3 Basic Data Collection Methods: **Summarize the various methods of data collection**, including surveys, experiments, and observations.

2.4 Ethics in Data Collection: **Outline ethical and privacy issues** related to data collection, including the following:

a. privacy and confidentiality,
b. bias and fairness in data analysis, and
c. responsible use of data.

3. Exploratory Data Analysis (EDA)

3.1 Techniques for EDA: **Explore data analysis techniques**, including histograms, box plots, and scatter plots.

3.2 Data Preprocessing: **Research data preprocessing techniques**, including cleaning, transforming, and encoding. Determine methods of dealing with missing values and outliers.

3.3 Basic Data Visualization: **Determine principles of effective data visualizations**. Utilize simple tools to practice visualization techniques such as Excel or Google Sheets. Create various types of plots and charts for data exploration.

3.4 Datasets: **Interact with real-world datasets** to explore relations and patterns in data.

3.5 Inferential Statistics: **Explore probability distributions**, including normal, binomial, and Poisson. Discuss hypothesis testing.

4. Prediction and Modeling

4.1 Algebraic Functions for Modeling: **Explore the algebraic functions** used to analyze relationships within datasets, including the following:

a. linear regression,
b. polynomial regression,

c. exponential regression, and
d. logarithmic regression.

4.2 Fitting Linear Functions to Data: **Determine how to find the best fitting line** to describe a relationship between two variables.

4.3 Fitting Exponential and Logarithmic Functions to Data: **Determine how to find the best fitting curves** to describe a relationship between two variables.

4.4 Models with Multi-Variables: Based on the nature of the data and the problem to be solved, **select the appropriate model for multi-variable data.**

5. Introduction to Programming

5.1 Reading CSV files: **Interact with comma-separated value (CSV) files and structured query language (SQL)** to practice the reading and interpretation of each.

5.2 Data Types and Syntax: Explore **basic syntax and data types,** including numbers, strings, lists, tuples, and dictionaries.

5.3 Conditional Statements and Loops: **Interact with control structures and functions,** including conditional statements and looping constructs. Explore writing and calling functions.

6. Introduction to Python

6.1 Basics of Python Programming: **Practice Python fundamental programming concepts**, including the following:
a. variables,
b. data types,
c. control structures,
d. functions,
e. object-oriented programming,
f. hands-on coding exercises, and
g. algorithm development.

7. Introduction to Machine Learning

7.1 Basic Concepts: **Research the basic concepts of machine learning** and differentiate between supervised and unsupervised learning.

7.2 Optimization and Calculus: **Explore the roles of optimization and calculus** in machine learning, including the calculation of gradient descent and derivatives of objective functions.

7.3 Overview of Algorithms: **Explore popular machine learning algorithms**, such as linear regression, logistic regression, and decision trees.

7.4 Simple Machine Learning Models: **Interact with simple machine learning models**.

Standards Alignment Notes

*References to other standards include:

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

Data Science II

Primary Career Cluster:	Information Technology
Course Content:	CTE.Standards@tn.gov
Course Code:	TBD
Suggested Prerequisites:	Computer Science Foundations (C10H11), Data Science I, and Algebra I; AP Statistics is an encouraged co-curricular course at this level.
Credit:	1 credit
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 Information Technology courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses to 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 Data Science program of study.
Aligned Student Organization(s):	Technology Student Association (tsaweb.org)
Coordinating WorkBased 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.
Available 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/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	013, 017, 173, 203, 214, 413, 414, 417, 477, 740, 742
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	Information Technology (tn.gov) 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 demonstration such as Data Science Analytics, Engineering Design, and Coding.
- Participate in leadership activities such as Prepared Presentation, Debating Technological Issues, and Audio Podcasting.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities related 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 an industry partner to share statistical analysis as part of the decision-making process in business.
- **Standard 4.3** | Request big data files from a local corporation to utilize meaningful data for processing and analysis.
- **Standard 6.1**| Partner with a local business for the course project.

Course Description

Data Science II is the third course designed to prepare students to pursue careers in the fields of data-related industries. Upon completion of this course, proficient students will be able to perform basic statistical analysis, interact with big data, and utilize Python for data processing and interpretation. In addition, students will add artifacts to a portfolio, which they will continue to build throughout the program of study.

Course Standards

1. Programming with Python

1.1 Programming: **Write Python code** to perform basic operations, control flow, and data manipulation. Utilize built-in data structures, including lists, dictionaries, tuples, and sets.

1.2 Libraries: **Interact with libraries** as the student progresses through standards, including NumPy, Pandas, MatPlotLib, and Seaborn. Explore data loading and importing, manipulation, cleaning, preprocessing, visualization, and analysis.

1.3 Advanced Data Visualization: **Interact with data visualization tools,** such as Plotly, as the students progress through the standards to perform the following:

a. exploratory data analysis (ADA),
b. statistical analysis,
c. time series analysis,
d. machine learning model evaluation, and
e. geospatial data visualization.

2. Statistical Analysis

2.1 Hypothesis Testing and Significance: **Research hypothesis testing and significance level**, including the following concepts:

a. null and alternative hypotheses in research questions;
b. random sampling and its implications in hypothesis testing;
c. basic principles of statistical distributions;
d. parametric and non-parametric hypothesis tests; and
e. common errors.

2.2 Correlation and Causation: **Compare and contrast correlation and causation** as they apply to data analysis and evaluate the assumptions underlying hypothesis tests. Indicate examples of correlation and causation in different scenarios.

2.3 Statistics in Practice: **Conduct hypothesis tests** and analyze data. Communicate the results of the tests to both technical and non-technical audiences.

3. Feature Engineering

3.1 Machine Learning: **Research the importance of Feature Engineering in Machine Learning.** Explain the role of features and their impact on model performance.

3.2 Feature Selection: **Explore techniques for feature selection and extraction**, including the various types of features: numerical, categorical, text, and spatial. Practice preparing raw data for feature engineering.

3.3 Extract Information: **Extract relevant information** from raw data through techniques such as parsing, tokenization, and regular expressions.

3.4 Techniques: **Implement feature engineering techniques** on real-world datasets using Python.

4. Big Data

4.1 Big Data Concepts: **Define big data and explain its characteristics,** including volume, velocity, variety, and veracity. Identify challenges and opportunities associated with processing and analyzing large-scale datasets.

4.2 Computing Frameworks: **Describe the architecture of distributed computing frameworks**, and compare big data frameworks, including batch processing, stream processing, and interactive query systems. Explore systems such as Apache Hadoop and Spark.

4.3 Big Data Tools: **Interact with real-world datasets utilizing big data tools** and explore real-time processing frameworks for handling data. Perform analysis tasks using big data tools and frameworks.

5. Time Series Analysis

5.1 Time Series Data: **Explore time series data** and explain its characteristics, including trend, seasonality, and autocorrelation. Explore methods for visualizing data and perform time series decomposition.

5.2 Smoothing Techniques: **Apply smoothing techniques** to estimate trends and remove noise from time series data.

5.3 Forecasting Techniques: **Research forecasting techniques** using ARIMA, seasonal decomposition of time series (STL), and machine learning-based approaches.

5.4 Detecting Anomalies: **Utilize techniques to detect anomalies and outliers** in time series data, including statistical methods.

6. Course Project

6.1 Data Analysis: Choose a **data analysis project**, and apply concepts learned in the program of study to meet your objectives. Present your hypothesis, data analysis processes, and findings to a stakeholder group.

Standards Alignment Notes

*References to other standards include:

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

Data Science III: Applications

Primary Career Cluster:	Information Technology
Course Content:	CTE.Standards@tn.gov
Course Code:	TBD
Suggested Prerequisites:	Computer Science Foundations (C10H11), Data Science I (TBD), Data Science II (TBD), Algebra I, Geometry, and Algebra II
Credit:	1 credit
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 Information Technology courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses to 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 Data Science program of study.
Aligned Student Organization(s):	Technology Student Association (tsaweb.org)
Coordinating WorkBased 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.
Available 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/content/tn/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	013, 017, 173, 203, 214, 413, 414, 417, 477, 740, 742
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	Information Technology (tn.gov) 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 demonstration such as Data Science Analytics, Engineering Design, and Coding.
- Participate in leadership activities such as Prepared Presentation, Debating Technological Issues, and Audio Podcasting.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities related 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 4.1** | Partner with a local business or agency for the final project.
- **Standard 5.1-5.3**| Participate in a mock interview using the finalized portfolio.

Course Description

Data Science III is the fourth course designed to prepare students to pursue careers in the fields of data-related industries. Upon completion of this course, proficient students will be able to explain advanced machine learning concepts and natural language processing. In addition, students will add artifacts and finalize a portfolio, for use when applying for scholarships and/or jobs.

Course Standards

1. Advanced Machine Learning

1.1 Algorithms: **Interact with popular machine learning algorithms**, including decision trees, random forests, and neural networks.

1.2 Model Evaluation Techniques: **Practice common model evaluation techniques**, including the following:

a. train-test split,
b. cross-validation,
c. resampling,
d. performance metrics,
e. confusion matrix, and
f. learning curves.

1.3 Overfitting and Underfitting: **Define overfitting and underfitting** and explore actions that cause each. Determine mitigating techniques to reduce these occurrences in advanced machine learning models.

1.4 Model Tuning and Optimization: **Explore methods used to tune hyperparameters** of machine learning models, such as grid search and random search.

2. Natural Language Processing (NLP)

2.1 Applications: **Interact with NLP and its applications,** exploring text preprocessing, NLP techniques and algorithms, evaluation metrics, and performance analysis.

2.2 Libraries: **Interact with NLP libraries**, such as NLTK and spaCy.

2.3 Case Studies: **Discuss case studies** highlighting successful NLP projects and challenges faced in implementing NLP solutions.

3. Ethics and Artificial Intelligence (AI)

3.1 Ethical Considerations: **Research the ethical and unethical practices in data science and AI.** Create a user code of ethics for data analysts.

3.2 Bias: **Explore issues of bias and fairness** in machine learning models and determine methods for mitigating bias to ensure fairness.

3.3 Responsible AI Principles: **Research responsible AI principles,** such as transparency and explanations, accountability, privacy and data protection, safety in minimizing the risk of unintended consequences, human-centered design, and societal impact.

4. Final Project

4.1 Data Analysis: Choose or build on a prior **data analysis project** and apply advanced data science techniques to solve a real-world problem, including the following:

a. define project objectives;
b. select a dataset or datasets;
c. outline analysis tasks;
d. explain methodologies and techniques;
e. include evidence of ethics and responsible AI; and
f. present your objectives, data analysis processes, and findings to a stakeholder group.

5. Personal Portfolio

5.1 Portfolio Development: **Create a personal digital portfolio**, or similar collection of work, that illustrates mastery of skills and knowledge in the program of study.

5.2 Artifact Collection: Identify and **collect artifacts and/or work products that reflect the skills** developed and knowledge gained through the program of study. Artifacts might include projects such as the following:

a. demonstrate ability to extract insights from data;
b. showcase proficiency in data manipulation;
c. highlight projects deploying machine learning models;
d. showcase an interactive data visualization dashboard;
e. demonstrate proficiency with libraries;
f. highlight forecasting or trend analysis abilities;
g. demonstrate partnerships with business and industry; and
h. document the earning of an industry credential.

5.3 Self-Assessment: **Assess personal growth** through thoughtful reflection and accurately self-assess to identify opportunities for further growth and development in the future. Products may include but are not limited to the following:

a. career and professional development plan;
b. resume and/or references;
c. examples of materials developed and used throughout the program;
d. project planning documents;
e. journal entries reflective of tasks and activities; and
f. projects that document skill development.

Standards Alignment Notes

*References to other standards include:

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