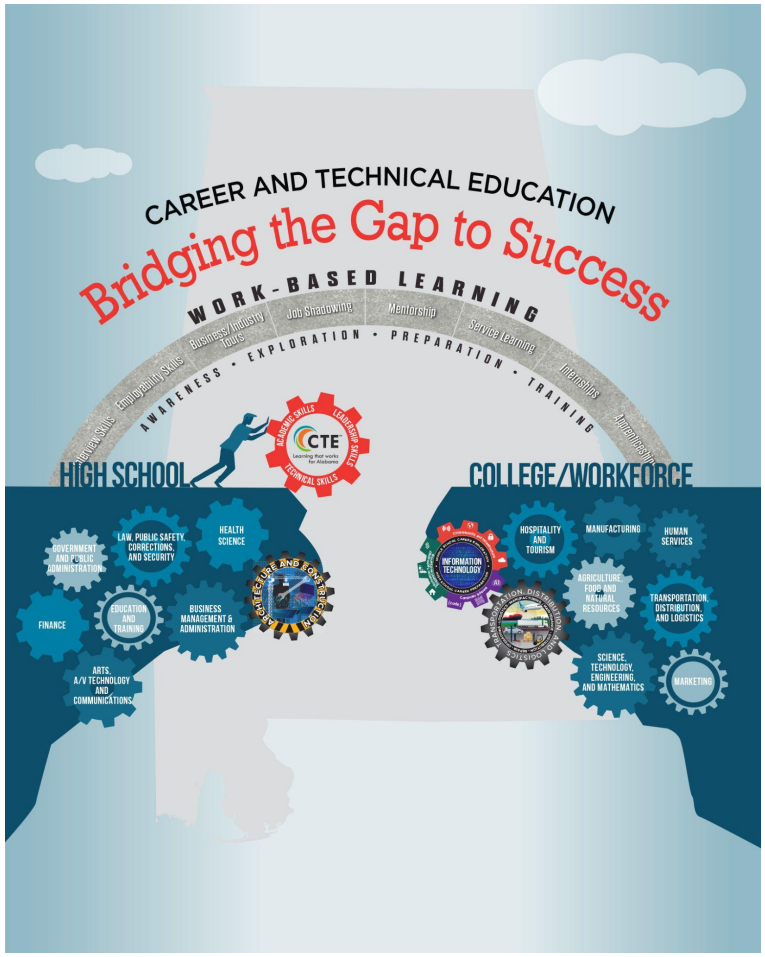
Alabama Course of Study
Career and Technical Education



2022
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Alabama State Department of Education

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Alabama Course of Study
Information Technology

Eric G. Mackey
State Superintendent of Education

STATE SUPERINTENDENT OF EDUCATION'S MESSAGE

Dear Alabama Educator:

The 2022 *Alabama Course of Study: Career and Technical Education, Information Technology* presents standards designed to prepare students for the career and technical demands of the future, both in the workplace and in the postsecondary education setting.

This document contains a set of challenging standards designed to promote students' engagement and career interests in Information Technology fields. I encourage each system to use the document in developing local curriculum guides that determine how its students will achieve and even exceed these standards.

The 2022 *Alabama Course of Study: Career and Technical Education, Information Technology* was developed by educators and business and community leaders to provide a foundation for building quality Information Technology programs across the state. Implementing the content of this document through appropriate instruction will promote students' exploration and enhance preparation for further study and careers in a variety of Information Technology fields.

Eric G. Mackey
State Superintendent of Education

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Alabama Course of Study
Information Technology
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Alabama Course of Study
Information Technology

PREFACE

The 2022 *Alabama Course of Study: Career and Technical Education, Information Technology* provides the framework for Grades 6-12 Information Technology programs in Alabama's public schools. Information Technology education courses are organized by pathways, which are aligned with national standards. Content standards in this document are minimum and required (*Code of Alabama,* 1975, §16-35-4). They are fundamental and specific, but not exhaustive. When developing local curriculum, school systems may include additional content standards to reflect local needs and philosophies. Systems are encouraged to add implementation guidelines, resources, and activities based upon the content standards in the Information Technology Course of Study.

The 2021 Alabama Career and Technical Education Course of Study Committee and Task Force conducted extensive research during the development of the Information Technology Course of Study, analyzing career and technical education standards and curricula from other states, previous versions of Alabama's career and technical education courses of study, and national standards. The Committee and Task Force also reviewed information from professional journals and Internet sites, listened to and read comments from interested individuals and industry groups throughout the state, considered suggestions from independent reviewers, sought input from advisory councils, and thoroughly discussed each issue and standard among themselves. The Committee and Task Force reached consensus and developed what members believe to be the best Information Technology Course of Study for students in Alabama's public schools.

Alabama Course of Study
Information Technology

ACKNOWLEDGMENTS

This document was developed by the Information Technology Committee and Task Force of the 2021 Alabama Career and Technical Education Course of Study Committee and Task Force, composed of middle school, high school, and college educators appointed by the Alabama State Board of Education and business and professional persons appointed by the Governor (*Code of Alabama*, 1975, §16-35-1). The Committee and Task Force began work in February of 2021 and submitted the document to the Alabama State Board of Education for adoption at the January 2022 meeting.

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Alabama Course of Study
Information Technology

GENERAL INTRODUCTION

Alabama's Career and Technical Education programs empower students with the workplace-readiness skills necessary for success in the twenty-first century. As a result, students become productive citizens who are prepared with the necessary knowledge and skills for postsecondary education and employment. Career and Technical Education provides opportunities for students to combine core academic content with rigorous and relevant technical knowledge and skills.

The *Alabama Course of Study: Career and Technical Education* is intended for all students in Grades 6-12. Alabama's Career and Technical Education programs promote students' career awareness through engaging career exploration and development activities. Career and Technical Education programs focus on providing students with the knowledge and skills that reinforce attainment of academic core content through hands-on experiential learning. These programs are organized into the sixteen national career clusters identified by the United States Department of Education, which arrange instruction into groups of similar occupations. Within the sixteen national career clusters, separate course content standards have been developed for more than fifty career pathways.

Because of the interconnected nature of Career and Technical Education programs, some courses will be utilized in more than one cluster. Shared courses are not reprinted in each Course of Study, but are indicated in the clusters' program guides, which are the definitive listings of required courses for each cluster. Program guides can be found on the Alabama State Department of Education website.

Alabama's Career and Technical Education programs are designed to keep abreast of the rapid changes in business and industry and be responsive to current and future workforce demands. Rigor in each course of study is derived from both core academic content and industry-specific knowledge and skills required for students to achieve, maintain, and advance in employment in a particular career pathway. The level of academic and workplace rigor determines the degree to which each Alabama Career and Technical Education program prepares students for high-skill, high-wage, and in-demand careers. For each Career and Technical Education program, industry-recognized credentials of value and certifications have been

established that validate the rigor of the curriculum to students, parents, and members of business and industry. In addition, articulation agreements are developed in partnership with the Alabama Community College System to allow for a seamless transition for students to further their education.

Alabama's growing economy has created the demand for more highly-skilled workers. Alabama's Career and Technical Education programs, through the implementation of each career cluster's course of study, equip students with the employability skills and technical knowledge necessary to meet current and future workforce demands by preparing them for lifelong learning.

Alabama Course of Study
Information Technology
CONCEPTUAL FRAMEWORK

Alabama Course of Study
Information Technology

CONCEPTUAL FRAMEWORK

The conceptual framework is a graphic representation of the broad, challenging, and fascinating fields of study within the Information Technology cluster. The gear denotes the inventive and industrial nature of the human mind to use and infuse the concepts of information technology within all Alabama Career and Technical Education programs. The ones and zeros in the background image in the center of the gear represent the heartbeat of information technology and the computing industry. They are the foundational components of computing -- the binary code with which computers operate and the binary method for storing data and performing calculations.

The black inner circle of the gear highlights the introduction to Information Technology courses in middle school, where students explore computer basics and careers in the field. Middle school courses introduce concepts that allow students to advance to high school and focus on engagement in career preparation leading to work opportunities and/or advancement to postsecondary study in Information Technology.

The colors in the outer circle highlight the three pathways in the Information Technology Cluster: Cybersecurity and Infrastructure (red), Computer Science (purple), and Information Technology Support and Services (green). Each career pathway provides students with opportunities for innovation and fosters their ability to formulate strategies needed to use technology for productivity in safe, secure environments.

The icons on the teeth of the gear represent the concepts taught in the Information Technology Cluster. The Cybersecurity and Infrastructure pathway's icons represent safety and security with the use of technology for global prosperity. Icons for the Computer Science pathway represent coding, networking, and artificial intelligence to foster innovation. The Information Technology and Support Services pathway's icons represent the efficient use of computers for home and business.

As our world becomes increasingly dependent on technology to advance, produce, and communicate, courses in the Information Technology cluster prepare students to meet these challenges head-on. Careers in this pathway will lead to the development of technologies not yet invented and bring humankind closer together despite distance, time, and space.

POSITION STATEMENTS

Information Technology

The Information Technology Cluster of Career and Technical Education focuses on preparing students for careers that relate to artificial intelligence, computer science, cybersecurity, computer maintenance, network infrastructure, programming, and software development. Certain fundamental understandings which support Information Technology programs must be embraced by schools and school districts to provide students with the best possible experiences in the classroom while preparing them for employment in the information technology industry. These position statements summarize the requirements for effective Information Technology programs.

Classroom and Laboratory Environment

The effective Information Technology classroom should be a safe environment which is fully equipped with current and emerging technologies, supplies, and materials needed for instruction, where students can increase their skills. As in other pathways in Career and Technical Education, Information Technology instruction cannot be confined within the four walls of a traditional classroom. Students and teachers should have access to laboratory environments on campus and in the community where students can experience practical, real-world circumstances in the Information Technology field.

Technology, Equipment, and Facilities

Classroom technology must be readily available, efficiently maintained, and routinely upgraded according to a regular schedule. Students and teachers utilize equipment to conduct a variety of classroom instruction and learning activities. Using up-to-date technology with as few

interruptions as possible enhances the learning environment and prepares students for future career opportunities. In addition, students should have ready access to other classroom supplies and materials (such as textbooks, reference materials, and software) in classroom libraries, research areas, and materials centers to support instruction and industry credentialing. Sufficient funds must be allocated each year to provide and maintain the technology equipment and materials necessary for a superior career and technical education program.

Safety

The safety of students and instructors is a prime consideration in every learning environment. Creating and implementing a written safety plan is an essential part of designing, carrying out, and evaluating each career and technical education program. An effective plan may include federal, state, local, school, and program guidelines. Care must be taken to ensure that students are in safe environments both on and off campus. Safety includes not only physical and emotional well-being but also digital and online security. The importance of safety is underscored by its position as the first foundational standard, which is to be included in every course. Teachers must tailor their safety instruction to meet the demands of each specific area.

Professional Development

Because both technology and instructional methods continue to evolve, it is essential for teachers to participate in professional development and technical training opportunities to stay abreast of innovations pertaining to their content area and to the workplaces in which their students will be employed. Teachers who continually expand their pedagogical knowledge and skills are able to adjust the learning environment to reflect current and emerging trends in teaching methods and to address their students' varied learning styles. Regular program assessment by students, administrators, business and industry personnel, and the educators themselves guides professional development, which in turn enhances the instructional program.

Administrative Support

Full support from district and local administrators is essential in providing the necessary components of an Information Technology program. Administrators should recruit highly qualified teachers who possess appropriate credentials and should secure funding for professional development activities and industry certification for those teachers. Administrators must also provide time for professional development and for planning for the integration of academic content areas into the Information Technology Cluster. Administrators should actively promote Information Technology programs within the school and in the community.

Instructional Model

The Information Technology Course of Study is designed to address the challenges of a changing, technological, diverse, and global society in which students must apply knowledge, skills, and ideas to solve problems and make decisions. The Information Technology curriculum designed by each local education agency should be project-based, process-oriented, and work-based so that students can develop their abilities to collaborate, analyze, communicate, manage, and lead.

The content standards contained in this document require students to use innovative critical-thinking skills. Teachers should utilize the course of study to identify the issue or concern addressed in a specific content standard and then use the local curriculum guide to plan appropriate learning experiences. Teachers must understand that there are differences among standards, curriculum, and resources. The Information Technology content standards delineate what students are expected to know or be able to do at the end of each course. A curriculum is a sequence of tasks, activities, and assessments that teachers enact to support students in learning the standards while drawing on a textbook or other resources when appropriate.

Academic core content should be integrated into the Information Technology program. To achieve the solution to a given problem, students must have adequate foundations in reading, writing, speaking, listening, viewing, and presenting; knowledge and skills in mathematics, science, and social studies; and knowledge of current and emerging technologies.

The Information Technology program should also integrate workplace demands and employability skills, incorporating various instructional strategies to accommodate students' learning styles and interests. A variety of assessments should be used to evaluate individual students' interests, aptitudes, and abilities.

When individual needs have been determined for students in special populations, a support service program should be planned cooperatively by Information Technology instructors and other appropriate personnel, because Individual Education Programs are most effective when developed in conjunction with students' career and technical education instructors. Courses and equipment may be tailored to ensure equal access to the full range of learning experiences and skill development in the Information Technology program.

Career and Technical Student Organizations (CTSOs)

Nationally affiliated Career and Technical Student Organizations (CTSOs) such as Technology Student Association (TSA) and SkillsUSA are an integral part of classroom instruction in each career and technical education program and are essential for the growth and development of a career-ready workforce. In conjunction with coursework completed in each cluster, CTSOs make a positive difference in the lives of students by developing their potential for leadership, personal growth, and career success. The purpose of these organizations is to help students develop an understanding of all aspects of industry and technology while learning teamwork and leadership skills. The importance of CTSOs is indicated by their inclusion in the foundational standards to be taught in every Information Technology course. Goals of student organizations include:

- developing individual potential;
- developing effective leadership and citizenship skills through social, economic, scholastic, and civic activities;
- increasing knowledge and understanding of an ever-changing society;
- assisting in the exploration of occupational choices and the development of essential workplace skills;
- participating in career development events; and
- serving the school and community through community service projects.

Business-Industry-School Relationships

Information Technology, by its very nature, requires a close relationship between the school and the business community. Some aspects of this relationship are specified by state and federal laws and regulations, while others are determined by the desires, interests, and willingness of school personnel and business leaders in the local community. The relationship between schools and businesses can be immensely beneficial to all parties involved.

Certification

Maintaining relationships with local businesses and industries is vital to the certification process as well as to federal funding through the Carl D. Perkins legislation. Certain elements of program certification require local industries to participate in the Career and Technical Education program's adoption of industry standards. Representatives from local businesses and industries interact with school programs to address the ever-changing

needs of the competitive global economy. Through this interaction, the program is reviewed to ensure that needs are being met through lesson plans, instructional techniques, facilities, professional development, technical updates, equipment, and implementation of CTSOs.

Student Work Experience

As students begin to plan careers, they must have opportunities to visit, tour, and work at local industries and businesses. Real-world experiences such as cooperative education, internships, apprenticeships, and job shadowing contribute to the work-based, service-based, and project-based learning that enhances classroom instruction. An additional benefit comes from continuous feedback from students and supervisors, who evaluate the program to facilitate changes that satisfy industry needs.

Advisory Councils and Partnerships

In accordance with Alabama State Department of Education guidelines, each Career and Technical Education program has an advisory council made up of representatives of the local business community who provide professional, real-world input regarding equipment needs, curriculum emphases, technical updates, and problem-solving. This link to business and industry may also give external support by supplying equipment, resource materials, or qualified speakers. Community partners may provide program sponsors, judges for student career development events, financial support, scholarships, field trip sites, and other program needs.

Community Involvement and Service

There are many ways for Information Technology students and teachers to become involved with community service projects, providing benefits for students and their communities. Local organizations such as civic clubs, professional educational groups, youth organizations, and community adult education programs are valuable resources for Information Technology programs. Open houses, tours, and presentations allow families and other interested citizens to become more informed about Information Technology and more involved in the education environment.

Postsecondary and Higher Education Credit

Postsecondary and higher education articulation is a significant element in a student's career cluster. Secondary and postsecondary instructors must communicate on a regular basis to ensure a smooth transition for students and to make certain that students are aware of articulation opportunities.

Articulation may occur through Information Technology program alignment with postsecondary programs, early college enrollment, or dual enrollment programs.

Students benefit in a variety of ways when cooperation exists between secondary and postsecondary institutions. One of the benefits is the earning of postsecondary credit in conjunction with work completed while the student is still in secondary school. Postsecondary teachers offer additional benefits by serving as guest speakers, donating equipment, sharing expertise through professional development activities, and addressing other needs appropriate for the school community.

Dual Enrollment for Dual Credit is an enrichment opportunity allowing eligible high school students to earn high school and college credits for courses taken through an Alabama Community College System (ACCS) institution or an Alabama college or university while still enrolled in high school. Articulated credit is awarded when a student enrolls and satisfactorily completes work in a postsecondary institution that has an articulation agreement with that student's participating school.

DIRECTIONS FOR INTERPRETING STANDARDS

The 2022 *Alabama Course of Study: Career and Technical Education, Information Technology* is organized around the following elements: foundational standards, topics, and content standards.

Foundational standards are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership capacity and take advantage of the opportunities afforded by Career and Technical Student Organizations, and learn and practice essential digital skills.

Related content standards are grouped under **Topics**. In the example below, the topic is "Networking Concepts" from the Network Fundamentals course. Standards from different topics may be closely related.

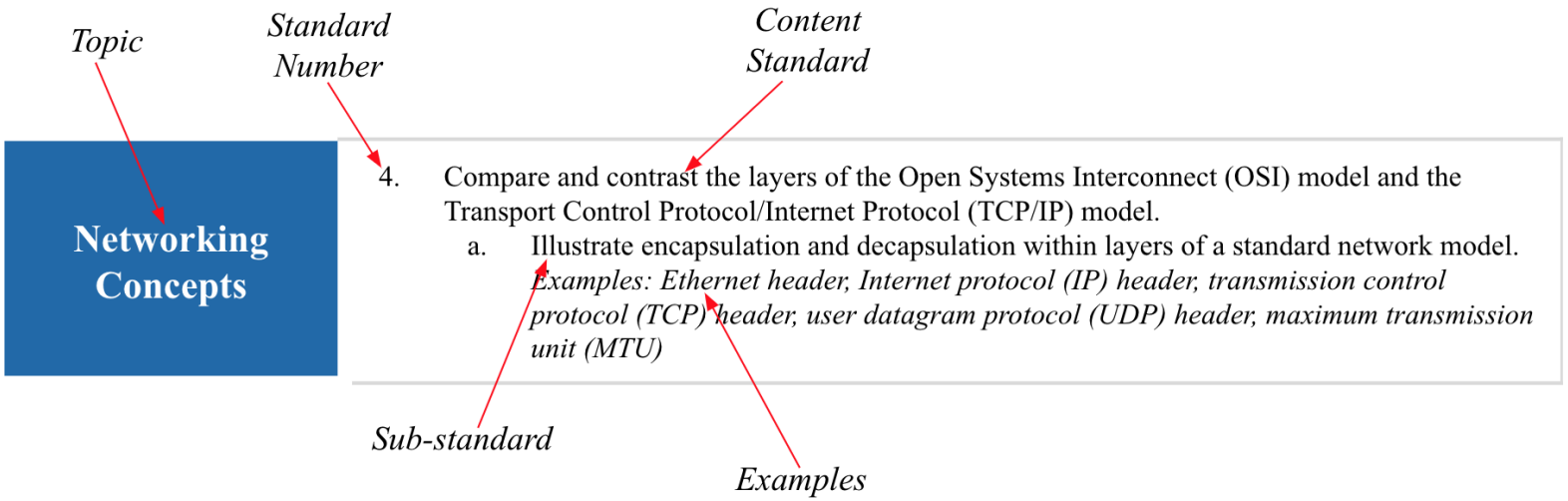
Content Standards contain the minimum required content and define what students should know or be able to do at the conclusion of a course.

Some have **sub-standards**, indicated with a, b, c, d…, which are extensions of the content standards and are also required. When "including" appears in standards, it should be construed as "including but not limited to." The items listed must be taught; others may also be included in instruction.

Some standards are followed by italicized **examples**, which present options that might prove useful in instruction of the standard. Examples are not intended to be exhaustive lists and are not required to be taught.

Local education agencies (LEAs) may add standards to meet local needs and incorporate local resources. Each content standard completes the stem *"Students will..."*

The course of study does not dictate curriculum, teaching methods, or sequence; the order in which standards are listed within a course or grade is not intended to convey the order for instruction. Even though one topic may be listed before another, the first topic does not have to be taught before the second. A teacher may choose to teach the second topic before the first, to teach both at the same time to highlight connections, or to select a different topic that leads to students reaching the standards for both topics. Each local education agency should create its own curriculum and pacing guide based on the Course of Study. The standards in each course are to be used as a minimal framework and should encourage innovation.



CLUSTER OVERVIEW

Information Technology

The Information Technology Cluster contains three career pathways: Cybersecurity and Infrastructure, Computer Science, and Information Technology Support and Services. Specific content standards indicate what students should know and be able to do at the end of each course. It is recommended that a student complete a foundation course (Information Technology Fundamentals or Programming Foundations) as the first course in his/her chosen pathway.

This cluster prepares students for careers in a rapidly changing digital world by engaging them in hands-on learning to advance technical skills. Career opportunities in this cluster are available in every sector of business and industry. In addition to deep technical knowledge, these careers require personal skills such as problem-solving, critical thinking, organization, and the ability to practice ethical behavior. Rigorous instruction is provided to equip students for college and careers. In all courses, students demonstrate appropriate knowledge and behaviors regarding the legal and ethical responsibilities of information technology professionals. This cluster offers opportunities for middle and junior high school students to benefit from the exploration of careers in Information Technology as early as sixth grade.

The knowledge and skills students gain through Information Technology courses prepare them to meet requirements for post-secondary education and industry-based certifications available from trade associations and technology firms, such as CompTIA, Cisco, and Microsoft. Concentration in courses offered through this cluster provides students with the potential to earn globally recognized industry credentials which will enhance their resumés and enable them to jump-start their careers. Courses included in this cluster begin with foundational standards important to job skill development for all career and technical education programs. Foundational Standard 3 focuses on investigating education, training, and credentialing to meet requirements for employment.

Information Technology classrooms and laboratories provide safe and appropriate settings for student exploration and learning. The engaging, structured environment encourages teamwork, stimulates students' creativity, and fosters the essential skills needed for future employment. Students

in any of the three pathways may take advantage of the two capstone courses, Career Pathway Project in Information Technology and CTE Lab in Information Technology.

Cybersecurity and Infrastructure: This pathway provides students with the skills necessary for protecting information technology infrastructure and networks, devices, and data from unauthorized access or criminal use and for ensuring confidentiality, integrity, and availability of information. Cybersecurity is an ever growing field of study, as consumers and businesses share data through online shopping, financial transactions, and social media applications. There is a tremendous demand for cybersecurity practitioners, and the U.S. Bureau of Labor Statistics predicts that jobs for information security analysts will continue to grow exponentially.

Computer Science: This pathway includes the study of theoretical algorithms and the practical problems involved in implementing them through computer hardware and software. This pathway includes artificial intelligence, software engineering, programming, and computer graphics. The need for computer science as a discipline has grown as computers become more integrated into daily life and technology continues to advance. This pathway provides students with skills required for the workforce both now and in the future. Computer science occupations are among the top six careers in Alabama and include jobs such as software developer, computer hardware engineer, and database administrator. Every occupation requires the type of logical reasoning and analytical problem-solving that may be developed by a computational mindset.

Information Technology and Support Services: This pathway provides students with a basic understanding of computer hardware and software and with the skills which could lead them to careers providing IT or technical support services. Students also develop problem-solving and critical thinking skills. Employment opportunities for IT and computer support specialists are projected to grow much faster than the average for all occupations.

Because of the interconnected nature of Career and Technical Education programs, some courses will be utilized in more than one cluster. Shared courses are not reprinted in each Course of Study, but are indicated in the clusters' program guides, which are the definitive listings of required courses for each cluster. They can be found on the Alabama State Department of Education website.

Students in the Information Technology cluster affiliate with SkillsUSA and/or TSA, the co-curricular Career and Technical Student Organizations (CTSOs). These organizations enhance classroom instruction while helping students develop leadership abilities, expand workplace readiness skills, and access opportunities for personal and professional growth. The importance of CTSOs is indicated by their inclusion in the foundational standards to be taught in every Information Technology course. Teachers are encouraged to adapt and use SkillsUSA and TSA resources in their instructional programs.

Courses included in this document represent the minimum required content and are not intended to be the course curriculum. LEAs and local schools should use these standards to create a curriculum that utilizes available resources to meet the specific needs and interests of the local community. All Career and Technical Education courses emphasize the application of knowledge and skills to solve practical problems

CONTENT STANDARDS: MIDDLE SCHOOL COURSES

Exploring Information Technology Careers	
Course Duration (to be determined by LEA)	6 weeks (24 hours) OR 9 weeks (35 hours) OR 1 semester (70 hours) OR 1 year (140 hours)
Grade Levels	6-7
Prerequisites	

Exploring Information Technology Careers is an exploratory course designed to introduce students to pathways in the Information Technology Cluster and to careers in the information technology field. Students will explore foundational concepts, terminology, and skills needed to choose and progress in an IT field. This course is most effective in a project-based environment.

Exploring Information Technology Careers may be offered as a component of a course rotation allowing students to explore different areas of interest. All content standards must be addressed regardless of the duration of the course. The depth of the content standards will be determined by the course duration.

Career and Technical Student Organizations are integral, co-curricular components of each career and technical education course. These organizations enhance classroom instruction while helping students develop leadership abilities, expand workplace readiness skills, and access opportunities for personal and professional growth. Students in the Information Technology cluster affiliate with SkillsUSA and/or TSA.

Foundational standards, shown in the table below, are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership qualities and take advantage of the opportunities afforded by Career and Technical Student Organizations (CTSOs), and learn and practice essential digital literacy skills. The foundational standards are to be incorporated throughout the course.

Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards

1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces.
2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

EXPLORING INFORMATION TECHNOLOGY CAREERS CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Exploring Information Technology Careers	1. List the Alabama career pathways in the Information Technology Cluster. 2. Describe each pathway in the Information Technology Cluster and explain what someone in the field might do. 3. Describe one career from each pathway in the Alabama Career and Technical Education Information Technology Cluster. 4. Research and create a visual presentation outlining the educational requirements and salaries for an entry-level, mid-level, and upper management position within the field of information technology. 5. Research a variety of careers in the field of information technology and define a problem that could be solved by an information technology professional. *Examples: software developer, data scientist, IT technician, IT director, information security analyst, systems analyst, network engineer, database administrator, web developer, computer support specialist, computer scientist* a. Create a presentation that defines a problem in the information technology field and suggests a possible solution which incorporates some form of information technology.
Job Search	6. Explain the process of finding and applying for jobs in the field of information technology. 7. Explain where information technology jobs may be found. 8. List the personal documents needed when applying for various job and career opportunities. 9. Create a personal career plan which leads to meeting requirements for a mid-level position in information technology.

Employability Skills	10. List and describe skills needed for posted positions in information technology. 11. Discuss how a person can demonstrate essential skills needed for workplace and career success. 12. Describe a scenario to illustrate a strong work ethic. 13. Assess personal strengths and weaknesses that would impact successful employment.
Stress and Time Management	14. Discuss the relationship between stress and time management. 15. Research and discuss effective time management strategies for reducing stress levels and improving workplace productivity. 16. Utilize a plan to implement effective time management skills.
Leadership	17. Explore the Career and Technical Student Organizations (CTSOs) available in Alabama relating to information technology and explain how they enhance the skills and knowledge needed in information technology fields. a. List the goals of selected CTSOs. b. Outline the history of selected CTSOs. c. Describe the student leadership positions available at the local and state levels in selected CTSOs. d. Research and prepare an entry for a CTSO competitive event at the local and state levels. e. Describe local, state, and national CTSO programs, events, and conferences. f. Utilize research to create and present a recruitment video for a selected CTSO that presents interesting facts, describes the benefits of membership, and outlines the leadership, educational, and service opportunities it affords.

Introduction to Cybersecurity

Course Duration (to be determined by LEA)	6 weeks (24 hours) OR 9 weeks (35 hours) OR 1 semester (70 hours) OR 1 year (140 hours)
Grade Levels	6-8
Prerequisites	

Introduction to Cybersecurity is designed to acquaint middle school students with the technology and methods of modern information and system protection. This course presents basic knowledge of computer structure and functions as well as ethics and security concepts which can be applied in everyday life. Standards introduce basic computer security principles and procedures and allow students to explore hardware and software components.

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Foundational standards, shown in the table below, are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership qualities and take advantage of the opportunities afforded by Career and Technical Student Organizations (CTSOs), and learn and practice essential digital literacy skills. The foundational standards are to be incorporated throughout the course.

Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards

1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces.
2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

INTRODUCTION TO CYBERSECURITY
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Computer Basics	1. Investigate and report on the history and evolution of computers. 2. Identify computer peripherals and common ports related to input and output. 3. Identify the internal components of a computer and explain their functions. *Examples: central processing unit (CPU), random access memory (RAM), motherboard, hard drive, heat sinks* 4. Locate, disassemble, and reassemble the internal components of a computer. 5. Diagnose common issues related to computer hardware, utilizing the troubleshooting process.
Software Basics	6. Describe the binary, hexadecimal, and ASCII notational systems used in computers. 7. Identify different types of software. *Examples: application software, operating systems, utility software* 8. Compare and contrast different types of operating systems. *Examples: Windows, Linux, Windows server* 9. Describe virtual machines and their purposes. 10. Contrast command line interface (CLI) and graphical user interface (GUI). 11. Describe various kinds of software licenses and their uses.

Security Fundamentals

12. Explain the importance of cybersecurity for individuals, organizations, businesses, and governments.

13. Compare and contrast various types of malware.
    Examples: virus, worm, ransomware

14. Explain the use of cryptography in ensuring the confidentiality and integrity of both data in transit and data at rest.
    a. Gather and report on historic ciphers used in early cryptography.
    b. Investigate the role of encryption methods in emerging technologies.
       Example: quantum computing

15. Explain the importance of the CIA triad (confidentiality, integrity, and availability) and how it applies to cybersecurity.

16. Demonstrate effective practices for protecting personal information and securing transactions.
    a. Explain the importance of password security.

17. Explain system access controls and the difference between authentication and authorization.

18. Describe various means of accessing a computing system.
    Examples: biometrics, key cards, multi-factor authentication

19. Describe various methods of protecting access to computer systems and data, including physical security and electronic entry systems.
    Examples: locked doors, key entry doors, guard, receptionist, mantraps

Digital Safety and the Internet	20. Describe the concept of a digital footprint. 21. Describe and discuss online etiquette and safety. 22. Identify the types of facts about individuals that are considered personally identifiable information (PII). 23. Explain what types of information should and should not be shared online and on social media. 24. Discuss the responsible and legal use of technology systems and digital content. 25. Describe cyberbullying and its consequences. 26. Explain the importance of using safety procedures with mobile devices. *Example: downloading safe mobile apps* 27. Configure safe web browser settings to protect personal privacy.
Software and Network Security	28. Identify the key components that allow users to access the Internet. *Examples: hardware, software, protocols* 29. Compare and contrast clients, servers, and databases. 30. Identify networking cable media technologies. *Examples: copper cabling, optical fiber* 31. Perform calculations to identify location of the logical and physical address of a computing device, including MAC and IP addresses. 32. Describe various ways to connect to wireless networks and explain how consumers may determine the best devices to use for accessing them. *Examples: Bluetooth, NFC, access point*

33. Explain the purpose of the Domain Name System (DNS).
    a. Outline methods for ensuring the safe use of mobile devices.
       Example: using trusted hardware

34. Explain how network systems are connected and used.
    a. Identify the basic components of a computer network and their functions.
       Examples: routers, hubs, switches

CONTENT STANDARDS: HIGH SCHOOL COURSES

Artificial Intelligence	
Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Artificial Intelligence is designed to introduce students to the simulation of intelligent behavior in computers and to various applications which use artificial intelligence (AI). Students will apply knowledge and use advanced technologies to solve real-world problems as they interact with and develop artificial intelligence solutions in a variety of settings. Topics include historical authenticity of AI, AI programs, current applications, data science, and ethics. This course extends the standards of the *Alabama Course of Study: Digital Literacy and Computer Science.*

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3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

ARTIFICIAL INTELLIGENCE CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Overview of AI	1. Describe the history and evolution of artificial intelligence, including contributors to its development and their significant accomplishments. *Examples: Alan Turing, Allen Newell, Herbert Simon; first neural net machine (SNARC), Weka, IBM Watson* 2. Explain the five big ideas in artificial intelligence (perception, representation and reasoning, learning, natural interaction, and societal impact).
Current Applications	3. Identify and describe current applications of artificial intelligence, including the problems artificial intelligence is designed to solve. *Examples: virtual assistants, online shopping, smartphones, gaming* 4. Research and present information on ways artificial intelligence can be used to enhance the future of student learning and to impact business and real-world issues. *Example: Gather and share information on how AI has been used to discover new antibiotics.*
AI Programs	5. Describe and write computer code using algorithmic and heuristic processes for artificial intelligence programs. *Examples: sequencing, selection, iteration, mathematical operations, using pseudocode to plan out the program* 6. Describe a few of the major branches of artificial intelligence. *Examples: expert systems, natural language processing, machine perception, machine learning* 7. Resolve artificial intelligence programming issues via a collaborative problem-solving process. *Example: team approach to AI programming to solve a current technical issue*

8. Research and present information on how quantum computing is being utilized with artificial intelligence programs.

9. Create a project using web tools that train machine learning without coding to train a model to recognize data in various formats and distinguish among at least three different categories.
   Examples: Google Teachable Machine, Weka; photo, video, or audio formats

10. Identify and research artificial intelligence development solutions and development tools.
    Examples: neural networks, Edgi AI, Tensorflow, Scikit-Learn, Spark ML, Microsoft Azure AI, Google AI, IBM Watson

11. Identify and use integrated development environments (IDEs) and packages in program development to build and train machine learning models.
    Examples: VS Code, PyCharm, Hupyter, Fast AI, Scikit-Learn, Tensorflow, Make Code

Data Science

12. Describe different types of data and explain how they are used in artificial intelligence.
    Examples: format types: numeric, text, date, graphic, video, audio

13. Explain how big data is used in artificial intelligence.
    Examples: Collect, organize, and analyze data using appropriate tools to construct informed summaries, decisions, or predictions related to the data.

14. Construct an experiment using small datasets of a given scenario to predict performance outcomes, utilizing varying machine learning models.
    Examples: binary classification model, multiclass classification model, regression model
    a. Collect, manipulate, and display data to improve relevant business practices, utilizing a given machine learning model.
       Examples: chatbots, voice assistants in customer services
    b. Gather, evaluate, and share information on the role of data science in artificial intelligence.

Ethics in AI

15. Research and describe the social and ethical impacts of artificial intelligence.
    Examples: bias, perceptions, privacy, and accuracy in context of AI, ethical and legal implications of AI

16. Investigate and develop potential solutions to social and ethical issues related to artificial intelligence.
    Examples: ethical use of facial recognition for public safety or government use

17. Analyze current and emerging technologies specific to artificial intelligence and summarize the ethical and legal effects on humanity.

Career Pathway Project in Information Technology

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Successful completion of any two courses in the Information Technology career cluster

Career Pathway Project (CPP) in Information Technology is a capstone course designed for career and technical education students who have completed two or more courses in the Information Technology career cluster. This course allows students to utilize the knowledge and skills gained through their secondary coursework in a practical, real-world experience that showcases their learning. It provides an opportunity for a student to choose an area of interest and explore it in depth while demonstrating problem-solving, decision-making, and independent learning skills. The CPP contributes to an educational plan of challenging courses and practical experiences that prepares students for the workplace or for pursuing further education.

During the CPP, the student works with his or her coordinating teacher, academic teachers, and a product or process mentor who has expertise in the student's field of study. At the conclusion of the CPP, the student presents or demonstrates the knowledge gained to an audience consisting of the coordinating teacher, academic teachers, the mentor, peers, and community and business representatives.

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CAREER PATHWAY PROJECT IN INFORMATION TECHNOLOGY CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Project Proposal	1. Create a formal, narrative proposal that communicates a specific concept, creates a process, or develops a product related to information technology. *Example: Create a business plan for a start-up venture in computer or mobile device repair.*
Research	2. Conduct independent research related to the selected information technology project. *Examples: Internet research, related reading*
Project Report	3. Write a detailed report on the chosen information technology project, following established conventions for format, grammar, and usage.
Presentation	4. Produce an original multimedia presentation based upon career pathway project research and results. *Examples: producing a digital presentation and oral explanation, creating a documentary, presenting a project model and explanation*
Portfolio	5. Design and create a project portfolio that documents all components of the information technology pathway project and demonstrates the validity of the process.

Cloud and Virtualization Technologies

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Cloud and Virtualization Technologies introduces the hardware and software components of cloud computing and virtualization with emphasis on basic skills for using internal networks and the Internet to access resources and comprehend the terminology, tools, and technologies associated with today's top cloud platforms, including cloud-based devices, software, and security. The course also includes the uses and procedures of digital software versions of resources (virtualization).

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CLOUD AND VIRTUALIZATION TECHNOLOGIES CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Cloud Computing Concepts

1. Gather and share information on the history and evolution of cloud computing.
2. Describe the public, private, community, and hybrid deployment models for cloud computing.
3. Summarize the main service models for cloud computing.
   Examples: software as a service (SaaS), infrastructure as a service (IaaS), platform as a service (PaaS)
4. Explain the advantages and disadvantages of cloud computing.
   Examples: high availability, scalability, elasticity, agility, disaster recovery

5. Research and disseminate information about features and functions of commonly used cloud services.

6. Identify cloud connectivity types, including direct connect and virtual private network (VPN), and list advantages and disadvantages of each type.

7. Describe common types of access for cloud networks.
   Examples: Remote Desktop Protocol (RDP), Secure Shell (SSH), Hypertext Transfer Protocol Secure (HTTPS)

8. Identify and describe cloud networking concepts.
   Examples: software-defined networking (SDN), load balancing

9. Identify and describe cloud storage features and characteristics.
   Examples: compression, hot vs. cold storage, content delivery network

10. Differentiate among cloud storage types.
    Examples: object storage, file storage, block storage

Business Aspects of Cloud Computing

11. Evaluate and assess cloud services based on a business scenario, including a feasibility study, gap analysis, and benchmarks.

12. Summarize the expenses incurred by utilizing cloud computing.
    Examples: variable costs, fixed costs, licensing models, billing, training costs

13. Differentiate among common types of cloud computing contracts and agreements.
    Examples: statement of work (SOW), service level agreement (SLA), cloud services agreement (CSA)

14. Describe governance policies and principles relating to cloud computing.

Cloud Operations and Management	15. Describe procedures for data management, availability, monitoring, and optimization of cloud service operations. *Examples: replication, backup, zones, geo-redundancy, alerts, logging, auto-scaling, right-sizing* 16. Describe common development operations used in cloud environments. *Examples: provisioning, sandboxing, load testing, regression testing, configuration management, API integration*
Cloud Security Concepts	17. Explain risk management concepts specific to cloud environments. *Examples: risk assessment, risk response, risk register* 18. Differentiate among risk responses in cloud computing, including mitigation, acceptance, avoidance, and transfer. 19. Summarize the availability concepts of cloud design. *Examples: redundancy, disaster recovery, recovery point objective (RPO), recovery time objective (RTO)* 20. Explain policies and procedures specific to cloud environments. *Examples: standard operating procedures, change management, resource management, access and control policies* 21. Describe the legal restrictions and regulatory requirements specific to cloud environments. *Examples: data sovereignty, international standards, data privacy laws* 22. Explain security concerns, measures, and concepts specific to cloud environments. *Examples: data breaches, data sanitization, cloud security audits*

Virtualization Concepts and Procedures

23. Explain the role and purposes of virtualization and when it should be implemented.
24. Prepare and install an operating system in a virtual environment.
25. Install hardware in a given virtualization scenario.
26. Research and discuss emerging cloud technologies.
    Examples: quantum cloud computing, artificial intelligence

Computer Maintenance and Troubleshooting

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Computer Maintenance and Troubleshooting presents the problem-solving skills needed to perform maintenance, troubleshooting, and upgrades to various computer systems in home or office settings. Topics in this course include operational procedures, operating systems maintenance, software troubleshooting, and security.

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4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
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COMPUTER MAINTENANCE AND TROUBLESHOOTING CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Operating Systems

1. Compare and contrast common operating systems.
   Examples: Microsoft Windows, Mac OS, Android, IOS, Chrome OS
2. Evaluate and critique features of a given operating system used by a client and determine system requirements for upgrading to a more recent version of the operating system.
3. Demonstrate methods for installing and upgrading operating systems in actual or simulated settings.
   Examples: clean install, repair installation, multiboot, remote network installation
4. Select and use system utilities and tools and evaluate the results in an actual or simulated work environment.
   Examples: computer management, MSConfig, task manager, disk management

5. Resolve common connectivity issues and explain how to use utilities and tools as part of this process.
   Examples: Internet options, display/display settings, user accounts, folder options, system, Windows firewall, power options

6. Configure Microsoft Windows network settings on a computer in an actual or simulated work environment.
   Examples: homegroup, workgroup, DNS, proxy settings, domain setup, establish networking connections

7. Use features and tools of Mac and Linux operating systems.
   Examples: force quit, screen sharing, Backup/Time Machine, Key Chain, Boot Camp, basic Linux commands

Network Troubleshooting

8. Use the best practice methodology to install, replace, and upgrade system components.
   Example: troubleshooting process

9. Troubleshoot problems related to motherboards, RAM, CPUs, expansion cards, and power.
   Examples: unexpected shutdowns, system lockups, continuous reboots, no power, overheating

10. Troubleshoot hard drive failures and RAID array issues.
    Examples: read/write failure, slow performance, RAID not found

11. Troubleshoot technical problems common to mobile devices, using effective safety procedures.
    Examples: no display, no power, apps not loading, swollen battery

12. Solve common problems with wired and wireless networks.
    Examples: limited connectivity, intermittent connectivity, IP conflict

13. Explain how system utilities are used to maintain optimum computer performance.

14. Troubleshoot common problems with various operating systems, using industry standard solutions.

15. Resolve PC security issues including pop-ups, security alerts, slow performance, connectivity issues, and crashes or failures in the computer system.

16. Troubleshoot common mobile operating system application issues.
    Examples: dim display, no connectivity, apps not loading, system lockout, app log errors, no sound

17. Resolve mobile operating system security issues.
    Examples: unauthorized camera or microphone use, slow data speeds

Security

18. Explain how physical security measures enhance the safety of devices, systems, and networks, including badge readers, smart cards, door locks, biometrics, privacy screens, hardware tokens, cable locks, server locks, USB locks, entry control rosters, key fobs, and mantraps.

19. Explain how logical security tools protect networks.
    Examples: active directory, software tokens, certificates, firewalls, email filtering, multi-factor authentication, VPNs

20. Explain wireless security protocols and authentication methods.
    Examples: WEP, WPA, WPA2, TKIP, AES, single-factor, multi-factor

21. Perform maintenance to detect, remove, and prevent malware.

22. Describe how social engineering threats and vulnerabilities impact users, including phishing, spear phishing, impersonation, shoulder surfing, tailgating, dumpster diving, DDos, DoS, zero-day, man-in-the-middle, brute force, dictionary, rainbow table, spoofing, non-compliant systems, and zombie.

23. Explain differences in security settings, including user authentication and administrator rights.
    Examples: BitLocker, BitLocker To Go, EFS

24. Implement best practices to secure a workstation.
    Examples: password best practices, account management, disable autorun, data encryption, update

management

25. Explain and use effective methods for securing mobile devices.
    Examples: screen locks, remote wipes, locator applications, remote backup, login restrictions, updates, biometric authentication, encryption, multi-factor authentication, firewalls

26. Summarize methods of data destruction and disposal.

27. Configure security of wireless and wired networks including assigning IP addresses, firewall settings, updates, and physical security.

Operational Procedures

28. Explain the concept of technical change management in a given, industry-related scenario.
    Examples: rise of remote work for employees, mergers and acquisitions, digital transformation

29. Create and implement a plan for technical documentation.
    Examples: network topology diagrams, knowledge base/articles, incident documentation, acceptable use policy

30. Create and implement processes and options for basic disaster prevention and recovery.
    Examples: surge protector, cloud storage, account recovery options

31. Create and implement safety procedures for grounding, handling, and storing sensitive devices, maintaining personal safety, and handling toxic waste.

32. Explain the impact of the environment on devices and summarize effective controls to address issues with temperature, humidity, ventilation, power surges, airborne particles, dust, and debris.

33. Summarize effective processes for addressing privacy, licensing, and policy issues and prohibited content and activities.
    Examples: licensing/EULA, incident response, best practices

34. Describe scripting file types, environment variables, comment syntax, basic script constructs, and data types.
    Examples: .bat, .ps1, .vbs, .sh, .py, .js, basic loop variables, integers, strings

35. Utilize remote access technologies including RDP, Telnet, SSH, screen share, and file share.

36. Summarize the security vulnerabilities of remote access technologies.

CTE Lab in Information Technology

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Successful completion of any two courses in the Information Technology career cluster

CTE Lab in Information Technology is designed to enhance the student's general understanding and mastery of the cluster. This course is designed as a learning laboratory to support students' individual interests and goals. This laboratory may take place in a traditional classroom, in an industry setting, or in a virtual learning environment.

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	3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing. 4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway. 5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork. 6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience. 7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

CTE LAB IN INFORMATION TECHNOLOGY CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Occupational Expertise	1. Demonstrate expertise in a specific occupation within the Information Technology cluster. a. Meet benchmarks selected by the instructor from the appropriate curriculum frameworks, based upon the individual student's assessed needs.
Research and Presentation	2. Conduct investigative research on a selected topic related to information technology using approved research methodology, interpret findings, and prepare a presentation to defend results. a. Select an investigative study based on research and prior knowledge. b. Collect, organize, and analyze data accurately and precisely.

c. Design procedures to test the research.
d. Report, display, and defend the results of investigations to audiences that may include professionals and technical experts.

3. Demonstrate higher order critical thinking and reasoning skills appropriate for a career in information technology.
    a. Use mathematical and/or scientific skills to solve problems encountered in the chosen occupation.
    b. Locate, evaluate, and interpret information related to the chosen occupation in oral, print, and digital formats.
    c. Analyze and apply data and/or measurements to solve problems and interpret documents.
    d. Construct charts, tables, or graphs using functions and data.

Leadership

4. Apply enhanced leadership and professional career skills needed in information technology careers.
    a. Develop and present a professional presentation offering potential solutions to a current issue.
    b. Demonstrate leadership and career skills in job placement, job shadowing, entrepreneurship, or internship, or by obtaining an industry-recognized credential of value.
    c. Participate in leadership development opportunities available through the appropriate student organization and/or professional organizations in the information technology field.
    d. Demonstrate written and oral communication skills through presentations, public speaking, live or virtual interviews, and/or an employment portfolio.

Cybersecurity I

Course Credit	1.0
Grade Levels	9-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Cybersecurity I is designed to provide an entry into the quickly growing field of cybersecurity. It focuses on building key concepts and exploring the range and scope of the cybersecurity field. The course also looks at best practices, the importance of maintaining a high level of ethical behavior, the provisions and rationale for government regulations and laws, and the consequences of failure to abide by these rules. The course builds on students' basic knowledge of computers and networks to create a deeper understanding of how computer systems, devices, and other networks are interconnected through secure data networks. This course will continue to help prepare students for industry-level exams.

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Foundational standards, shown in the table below, are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership qualities and take advantage of the opportunities afforded by Career and Technical Student Organizations (CTSOs), and learn and practice essential digital literacy skills. The foundational standards are to be incorporated throughout the course.

Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards

1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces.
2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

CYBERSECURITY I
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Technology Laws, Ethics, and Digital Safety	1. Identify and discuss ethical considerations and consequences resulting from technological advances. *Examples: deepfake, facial recognition, big data, privacy concerns* 2. Research and discuss federal laws, regulations, and agencies that govern online activities and individual and corporate network use. *Examples: Computer Security Act, Sarbanes-Oxley Act, Gramm-Leach-Bliley Act, Computer Fraud and Abuse Act, Payment Card Industry Data Security Standard (PCI DSS); COPPA, HIPAA, FERPA, and CMMC regulations* 3. Gather and share information regarding ethical standards which apply to cybersecurity professionals. 4. Describe national and international standards and frameworks related to security operations. *Examples: Center for Internet Security (CIS), National Institute of Standards and Technology (NIST) RMF/CSF, International Organization for Standardization (ISO)* 5. Identify security policies related to the employees of organizations or businesses and discuss the importance of establishing such policies. *Examples: personnel policies, acceptable use, non-disclosure agreements, credential policies*
Access Controls	6. Explain and differentiate among identification, authentication, authorization, and accounting for controlling access. a. Identify and describe authentication types and attributes. b. Compare and contrast authorization access control models. *Examples: mandatory access control (MAC), discretionary access control (DAC), role-based access control (RBAC), lattice*

7. Explain the principle of least privilege as it relates to account policy.
8. Perform the specific duties associated with using an administrator/root account in a given computer system.
9. Select and implement user account management controls for a given scenario.
10. Implement secure password and account policies in an operating system.
11. Perform basic system audits and analyze log files in a given scenario.
12. Use the command/terminal line to configure security settings.
13. Perform basic system administration tasks in more than one operating system.

Network Foundations

14. Differentiate among types of networking cable mediums and standards to determine which type to use in a given situation.
    Examples: copper cabling, fiber optic
15. Compare and contrast notational systems, including binary, hexadecimal, decimal, and ASCII.
16. Identify and describe common TCP and UDP ports and services.
    Examples: DNS, HTTP, SSH, TELNET, TLS, FTP, SMTP, IMAP, POP, DHCP, LDAP, NTP, SNMP, RDP, SCP, RTP
17. Classify IP addresses according to IPv4 and IPv6, private and public IP ranges, and special IPs.
18. Use subnetting to determine the number of hosts and/or subnets on a given network.
19. Differentiate between the OSI and TCP/IP models, layers, encapsulation, and decapsulation.

20. Use various network tools in computer operating systems environments.
    Examples: ipconfig, ifconfig Ping, nslookup, tracert, netstat, iptables; Windows, Linux, Apple

21. Perform an install of an operating system in a virtual environment.

Security Foundations

22. Apply the parts of the CIA triad (confidentiality, integrity, and availability) to a given security scenario.

23. Describe various types of physical security controls and explain their importance.

24. Analyze attributes of various types of malware and other attacks to determine the key characteristics of each type.
    Examples: virus, worm, brute force, backdoor, spyware, remote access tool (RAT)

25. Describe various types of social engineering.

26. Describe various types of application attacks and threats.
    Examples: cross-site scripting, SQL injection, buffer overflow

27. Analyze types of network attacks.
    Examples: man in the middle, layer 2 attacks, denial of service, DNS poisoning
    a. Identify and analyze wireless network threats.
       Examples: evil twin, bluesnarfing, jamming, disassociation

28. Describe different types of threat actors and threat vectors.
    Examples: APT's; black hat, white hat, and gray hat hackers; supply chain; social media

29. Predict security concerns and possible vulnerabilities associated with system hardening.
    Examples: weak configurations, open ports and services, third-party risks

30. Describe the techniques used in security assessments.
    Examples: threat hunting, vulnerability scans, security information and event management (SIEM)

31. Explain basic cryptographic concepts.
    Examples: historic ciphers, symmetric, asymmetric, hashing, quantum computing uses

32. Describe the purpose and scope of a cybersecurity disaster recovery plan for a given simulated or actual work environment.

Cybersecurity II

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Cybersecurity I

Cybersecurity II is aimed at providing students with an in-depth look into what it means to be a cybersecurity professional. Emphasis is placed on best practices for secure networking and computing, along with other practical exercises for developing security standards that govern organizational compliance, risk management, access control, and identity management. Students will have the opportunity to prepare for a core industry standard certification exam related to security and can use these techniques, tools, and methodologies to prepare for a career within the cybersecurity field.

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Foundational Standards	
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3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
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CYBERSECURITY II
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Secure Networking

1. Identify and integrate secure protocols and services in a given scenario.
   Examples: SSH, tunnel and transport, IMAP, S/MIME, SFTP, FTPS
2. Differentiate among firewall technologies.
   Examples: stateful vs. stateless, web application firewall
3. Illustrate secure network designs, creating diagrams by hand or with networking software.
   Examples: load balancing, network segmentation, virtual private network, network based intrusion systems

4. Configure wireless security settings.
   Examples: WPA3, SAE, PEAP, RADIUS, site surveys, WAP, WPS, IEEE 802.1x

5. Apply secure mobile solutions in a given environment.
   Examples: NFC, mobile application management (MAM), BYOD, rooting, jailbreaking, sideloading

6. Describe the value of implementing security concepts in an enterprise environment.
   Examples: configuration and baseline management, IP schema, data loss prevention, honeypots

7. Identify and explain equalization and cloud computing concepts.
   Examples: platform as a service (PaaS), software-defined networking visibility (SDN), virtual machine (VM)

8. Compare and contrast cloud security controls.
   Examples: cloud native controls vs. third-party solutions, virtual networks

Security Principles

9. Compare and contrast secure application development, deployment, and automation concepts.
   Examples: server-side vs. client-side execution and validation, automation/scripting

10. Summarize types of authentication protocols and authorization design concepts used in network security.
    Examples: Kerberos, attribute-based access control (ABAC)

11. Explain the security vulnerabilities and constraints of embedded and specialized systems.
    Examples: system control and data acquisition (SCADA), industrial control system (ICS), Internet of Things (IoT), inability to patch

12. Explain penetration testing techniques and exercise types.
    Examples: white box, black box, red team, blue team

13. Explain the importance of having policies, processes, and procedures for carrying out incident response plans.
    Examples: attack frameworks, cyber kill chain, incident response process

	14. Compare and contrast symmetric and asymmetric algorithms and their security uses. 15. Describe the primary components of public key infrastructure and explain why these structures are critical to organizations. *Examples: Pretty Good Privacy (PGP), establishing confidentiality in email*
Digital Forensics	16. Use the appropriate tool to assess organizational security in a given scenario. *Examples: netstat, nmap, FTK imager, Nessus* 17. Identify and utilize appropriate data sources to support an investigation of a given security incident. *Examples: metadata, protocol analyzer output, syslog, rsyslog, syslog-ng* 18. Explain the fundamental concepts of digital forensics. *Examples: documentation and evidence, acquisition, on-premises versus cloud* 19. Analyze risk management policies and procedures in a given organizational environment. *Examples: risk management strategies, business impact analysis* 20. Explain the procedures involved in creating a digital forensics investigation report and provide examples of report formats. *Examples: Use word processing software to write reports which include the purpose of the investigation, the process of securing documents obtained as evidence, and conclusions.*

Cybersecurity III

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Cybersecurity II

Cybersecurity III is designed to prepare students to enter into the specialized professions of cybersecurity analysis, network penetration testing, cybersecurity forensics, and related careers, including law enforcement support at the local, state, and federal levels. This course highlights the required technical training and aims to prepare students for the appropriate industry certification exams. The course focuses on the frameworks, tools, regulations, and techniques involved in this field along with emphasis on both offensive and defensive security.

This course requires access to computers that are able to run virtual machines (VMs) or have a strong, high-speed Internet connection and a cyber range environment with online access to virtual machines. Students must work toward having a strong ethical grounding before moving forward with the more active, hands-on elements of the course; therefore, it is recommended students take this course in 11th or 12th grade.

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Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards

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2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

CYBERSECURITY III
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Threats, Attacks, and Vulnerabilities	1. Compare and contrast different types of social engineering attack techniques. *Examples: baiting, scareware, pretexting, phishing, spear-phishing, watering hole, whaling* 2. Analyze potential indicators which can be used to determine the type of attack taking place. *Examples: adversarial artificial intelligence, automated learning, ransomware, remote access Trojan (RAT)* 3. Analyze potential indicators associated with application and network attacks. *Examples: race conditions, error handling, buffer overflow, distributed denial of service (DDoS), domain name system (DNS), OSI Model Layer 2 Attacks* 4. Differentiate among specific threat actors, threat vectors, and intelligence sources. 5. Evaluate concerns associated with types of security vulnerabilities within an enterprise work environment. *Examples: network vulnerabilities, operating systems vulnerabilities, human vulnerabilities*
Operations and Incident Response	6. Investigate and explain the importance of implementing security concepts within an enterprise environment. *Examples: configuration management (diagrams, baseline configuration, standard naming conventions, IP schema), data protection and redundancy, secure sockets layer (SSL) and transport layer security (TLS) inspection, hashing, API considerations, site resiliency, honeypots, fake telemetry* 7. Describe the purpose and scope of a cybersecurity business continuity plan. 8. Apply mitigation techniques or controls to secure an environment in a given security incident. *Examples: application approved/denied list, quarantine, firewall rules, mobile device management (MDM), data loss prevention (DLP), update or revoke certificates*

9. Collect and present information on the historical meanings and uses of key concepts of digital forensics.
   Examples: documentation and evidence, acquisition, on-premises versus cloud, integrity, data recovery, non-repudiation

10. Explain the importance of following every detail of an incident response plan, including communication, response coordination with relevant employees and involved parties, and factors contributing to data criticality.
    Examples: communicating only with trusted parties, disclosing information based on requirements, preventing inadvertent release of information, following requirements for reporting incidents
    a. Describe the activities that make up the detection and analysis phase of the incident response life cycle, including identification of indication sources, analysis of an intrusion event, documentation, and notification of the incident.
       Examples: unusual outbound network traffic or geographical irregularities, which indicate a possible breach or compromise
    b. Describe the activities that make up the post-incident activity phase of the incident response life cycle, including identification of lessons learned and evidence retention.
       Examples: cyber incident planning and response (CIPR) action checklist

11. Utilize basic digital forensics techniques and tools to collect data for use as evidence in an investigation.
    Examples: network traffic analyzers, endpoint disk and memory, mobile, cloud, virtualization, legal hold, hashing, data carving, data acquisition

Governance, Risk, and Compliance

12. Compare and contrast various kinds of controls by type and category as they relate to governance, risk, and compliance.
    Examples: managerial, operational, technical, control type (preventive, detective, corrective, deterrent, compensating, physical)

13. Research and share information on current, applicable regulations, standards, or frameworks that impact organizational security posture.
    Examples: General Data Protection Regulation (GDPR), Payment Card Industry Data Security Standard (PCI DSS), Center for Internet Security framework (CIS); the National Institute of Standards and Technology (NIST), Risk Management Framework (RMF) and Cybersecurity Framework (CSF); benchmarks and security configuration guides

14. Critique organizational and security policies regarding businesses, personnel, and data. ,
    Examples: acceptable use policy, job rotation, mandatory vacation, least privilege, non-disclosure agreement, third-party vendors and risk management, service level agreement, memorandum of understanding, measurement systems analysis, end of life, credentialing policies, change management, asset management

15. Summarize risk management processes and concepts including risk types, management strategies, and analysis.
    Examples: external, internal, legacy systems, acceptance, avoidance, transference, mitigation, risk matrix, heat map, risk control assessment, asset value, single-loss expectancy, annualized loss expectancy, annualized rate of occurrence

16. Describe the consequences of applying security protocols related to Internet privacy and sensitive data.
    Examples: avoiding reputation damage, identity theft, IP theft, and fines; preventing privilege escalation, public disclosures, and data breaches

Organizational Security

17. Explain the importance of cyber threat intelligence and data security to organizations.
    Examples: Gather and report on current information from the Department of Homeland Security, the FBI, or SANS Internet Storm Center and explain how applying the information benefits an organization.
    a. Summarize threat hunting techniques used proactively by organizations to secure their networks.

18. Utilize threat intelligence to support organizational security in a given scenario, using frameworks, threat research, intelligence sharing, and threat modeling methodologies.
    Examples: MITRE ATT&CK, Diamond Model, kill chain, indicator of compromise, Common Vulnerability Scoring System, total attack surface, attack vector, adversary capability

19. Perform vulnerability management activities and analyze the output from common vulnerability assessment tools.
    Examples: active versus passive scanning, mapping, enumeration, criticality of assets, validation outcomes (true positive, false positive, true negative, false negative), baseline configuration, patching, hardening, scanning parameters, web application scanners, wireless and infrastructure vulnerability scanners

20. Investigate the threats and vulnerabilities associated with specialized technologies, including operating within a cloud-based environment.
    Examples: mobile, Internet of Things, embedded, real-time operating system, System-on-Chip, field programmable gate array, physical access controls, building automation systems, drones and vehicles, supervisory control and data acquisition systems (SCADA), cloud deployment models; insecure application programming interfaces, improper key management, unprotected storage, insufficient logging and monitoring

21. Identify network vulnerabilities that threat actors use to exploit an organization's security and implement control measures to avoid such attacks.
    Examples: malware, unpatched security vulnerabilities, hidden backdoor programs, superuser or Admin Account privileges

22. Analyze real-time data and apply security solutions for infrastructure management in real-world scenarios.
    Examples: cloud versus on-premises, asset management, segmentation, network architecture, change management, virtualization, containerization, identity and access management, honeypot, certificate management, monitoring and logging, active best practices defense, encryption

23. Research and detail the use of current cybersecurity frameworks, policies, procedures, and controls.
    Examples: code of conduct, acceptable use policy, password policy, data ownership and retention, account management, continuous monitoring, work product retention, control types

24. Apply security concepts that mitigate organization-specific risk and explain their effectiveness.
    Examples: business impact analysis, risk identification process, risk calculation, communication of risk factors, risk prioritization, systems assessment, documented compensating controls, training and exercises, supply chain assessment

Data Security

25. Compare and contrast hardware and software quality assurance practices and determine their effectiveness in a given scenario.
    Examples: software development life cycle, DevSecOps, software assessment methods (user acceptance testing, stress test application, security regression testing, code review), secure coding best practices, static and dynamic analysis tools, hardware root of trust, trusted firmware updates

26. Analyze data as part of security monitoring activities.
    Examples: heuristics, trend analysis, endpoint, network, log review, impact analysis, security information and event management (SIEM) review, query writing, e-mail analysis, Sender Policy Framework, digital signature, embedded links

27. Implement configuration changes to network hardware and software controls to improve and increase security.
    Examples: antivirus software installation, firewalls, multi-factor authentication, administrative controls

28. Compare and contrast automation concepts and technologies.
    Examples: workflow orchestration, scripting, application programming interface integration, automated signature creation, data enrichment, threat feed combination, machine learning and artificial intelligence, automation protocols and standards, continuous integration

29. Justify the importance of data privacy and protection in the context of privacy versus security, non-technical controls, and technical controls in a given scenario.
    Examples: classification, ownership, retention, data types, retention standards, confidentiality, legal requirements, data sovereignty, data minimization, purpose limitation, non-disclosure agreement, encryption, data loss prevention, data masking, de-identification, tokenization, watermarking and digital rights management, geographic access requirements, access controls

Penetration Testing

30. Describe the tools and procedures used during the main phases of a penetration test.

31. Perform passive and active reconnaissance and analyze the results.
    Examples: DNS lookups, identify technical and administrator contacts, cloud versus self-hosted, social media scraping, cryptographic flaws, company reputation and security posture, enumeration, website reconnaissance, packet crafting, defense detection, tokens, wardriving, network traffic, cloud asset discovery, detection avoidance, third-party hosted services
    a. Use empirical data and evidence strategically to perform vulnerability scanning, social engineering and physical attacks, and post-exploitation techniques.
       Examples: considerations and limitations of vulnerability scanning, scan identified targets for vulnerabilities, set scan settings to avoid detection, multiple scanning methods, Nmap, pretexting for social engineering or physical attacks, impersonation techniques, social engineering tools, methods of influence, post-exploitation tools, Pass the Hash, network segmentation testing, horizontal and vertical privilege escalation
    b. Investigate common vulnerabilities and attacks against specific, specialized types of systems and report findings to peers.
    c. Research attack vectors and determine the detailed steps used in performing network, wireless, application-based, and cloud-specific attacks based on experimentation data.
       Examples: stress testing for availability, exploit resources, tools

32. Outline the key components of written reports regarding the procedures and results of penetration testing, and explain the importance of maintaining transparent communication during the entire penetration testing process.

    Examples: report audience, report contents, length of storage time for report, secure distribution, note-taking and ongoing documentation during testing including screenshots, common themes, root causes, communication path and associated triggers, reasons for communication, goal reprioritization, presentation of findings

    a. Analyze final penetration testing data and recommend appropriate remediation.

        Examples: technical controls, administrative controls, operational controls, physical controls

    b. Choose the most effective activities to be implemented after results are reported in relation to the client, post-engagement cleanup, attesting to findings, and the data destruction process.

33. Summarize the basic concepts of scripting and software development for offensive and defensive security purposes.

    Examples: logic constructs, data structures, libraries, classes, procedures, functions

    a. Analyze a script or code sample for use in a penetration test.

Foundations of Operating Systems

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Foundations of Operating Systems allows students to explore the characteristics and features of a variety of computer operating systems. It focuses on techniques used to install and monitor operating systems; manage access, hardware, and applications; configure networks, security, and storage; and maintain, update, and recover devices. The course presents skills in desktop support including establishing access for users and groups, managing hardware, and working within an enterprise environment to establish and maintain a robust computer network. Additional topics include how to configure local and remote network connectivity and storage, data security, device security, and network security.

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FOUNDATIONS OF OPERATING SYSTEMS CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Operating Systems

1. Compare and contrast various operating systems.
   Examples: Android iOS, Windows, Mac, Linux
2. Compare and contrast the functions of operating systems, environments, and platforms and explain how they are related.
3. Contrast different types of computer hardware platforms.
   Examples: IBM PC hardware platform, Apple hardware platform
4. Research various types of operating systems (OS) and indicate the hardware platform(s) required for each system to perform well.
   Examples: Xbox, Playstation OS and video game consoles; Windows, Linux OS, and standard computer platforms
5. Compare and contrast Windows and Linux file systems using a graphical user interface (GUI) and command line interpreter.
6. Explain how system processes work and how to manage them, using a flow chart.
   Examples: executable file, memory/RAM
7. Describe the functions, structures, and evolution of operating systems.
8. Evaluate design choices and trade-offs in the implementation of different operating systems, and decide which type of operating system would be most appropriate for a given situation.
9. Explain data structures, algorithms, computer architecture, and programming in the context of operating systems.
   Examples: simple structure, layered approach, modules, hybrid systems, microkernels

Installation, Configuration, and Administration

10. Install, configure, and upgrade desktop computer modules and peripherals, following established basic procedures for system assembly and disassembly in an actual or simulated environment.
    a. Describe the functions of a computer's main processing board.
    b. Describe the purpose and functions of communication ports on standard computers and laptops.
    c. Illustrate and explain the operation and purpose of hardware components using application software.
        Examples: Describe hardware components in terms of device type, device functions, and interaction of components.
    d. Install and customize operating system software in an actual or simulated environment.
11. Explain the steps to install and configure operating systems.
    Examples: primary boot disk, BIOS, Redundant Array of Independent/Inexpensive Disks (RAID)
12. Analyze the program development and execution utilities related to operating systems.
    Examples: antivirus, file management system, disk defragmenter, backup utility
13. Explain the boot process and perform post-installation configuration tasks for given operating systems.
14. Compare and contrast cloud and virtualization concepts and technologies in given operating systems.
15. Create a virtual image on a physical computer to run more than one operating system on the same device.

Hardware

16. Compare and contrast display devices and their characteristics.
    Examples: liquid crystal display (LCD), plasma display, light emitting diode (LED)
17. Implement procedures to optimize hardware performance for client or server applications.
    Examples: use control panel to set large icons, enhance write caching to boost the normal performance of ATA and SATA drives

	18. Summarize the functions and types of adapter cards with PCIe standard. *Examples: video cards, network cards, sound cards* a. Explain advantages of using PCIe adapter cards. 19. Install and configure printers and add network printers using a static or dynamic IP address.
Storage	20. Manage and configure storage devices, file systems, partitions, volumes, and RAID arrays. 21. Categorize storage devices and backup media as primary, secondary, or tertiary storage. 22. Illustrate and explain storage technologies and configurations in an actual or simulated work environment, using application software. a. Configure and manage user profiles in a networking environment in either an actual or simulated application. b. Configure data compression in a networking environment in either an actual or simulated application. c. Create, modify, redirect, back up, restore, and compress files in a networking environment in either an actual or simulated application.
Security and Access Control	23. Configure client access to work in a network environment in an actual or simulated work environment. 24. Manage users, groups, and user and group access. 25. Apply or acquire user and/or group policies, permissions, and ownership. 26. Configure and implement effective access and authentication methods, including logging services, remote access, and firewalls.

	27. Configure operating system updates, including securing a system from potential threats. 28. Summarize security best practices for network services in a given industry environment.
Networking and Printing	29. Implement network printing utilizing a given server operating system in an actual or simulated work environment. a. Manage access to printers by using shared printer permissions. b. Configure and troubleshoot IPv4 and IPv6 addressing. c. Change the location of the print spooler and set printing priorities. 30. Configure printing for wired and wireless devices in a network environment for an actual or simulated work environment.
Troubleshooting and Diagnostics	31. Troubleshoot end user issues to restore system functionality. 32. Describe search procedures used to identify possible solutions when troubleshooting software and hardware problems. 33. Perform local network support using various troubleshooting and diagnostic techniques.

Information Technology Fundamentals

Course Credit	1.0
Grade Levels	9-12
Prerequisites	

Information Technology Fundamentals introduces the knowledge base and technical skills for information technology careers. The course presents the basics of computer technology and the functions of information systems. Topics include applications and software, infrastructure, database fundamentals, security, and software development. Emphasis is placed on maintaining a safe working environment and on building technology skills needed for working in the information technology environment.

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4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

INFORMATION TECHNOLOGY FUNDAMENTALS CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Applications and Software

1. Explain the purposes of operating systems, including interfaces between applications and hardware, process management and scheduling, access control protection, and management of applications, memory, disks, and devices.
2. Describe different types of operating systems and explain the advantages and disadvantages of each.
   Examples: mobile vs. computer, proprietary, Linux, Microsoft Operating System
3. Compare and contrast components of operating systems, including file systems, features, file management, services, processes, drivers, utilities, and interfaces.
4. Select and use productivity software for real-world applications.
   Examples: office tools, open source tools

5. Describe various types of applications and delivery models.
   Examples: locally installed, local network hosted, cloud hosted, one-tier, two-tier, three-tier, n-tier, low-code or no-code programming, WYSIWYG web development

6. Configure and manage web browsers, including caching, clearing a cache, deactivating client-side scripting, utilizing browser add-ons and extensions, private browsing, proxy settings, certificates, popup blockers, script blockers, and compatible browsers for various applications.

7. Compare and contrast common data storage units of measurement used for computing.
   Examples: bytes, bits, throughput rate

Infrastructure

8. Compare the purposes of common devices used for networking and peripheral input and output interfaces.
   Examples: scanners, digital cameras, webcams, routers, switches
   a. Distinguish between input and output devices, including monitor, keyboard, mouse, and printer.
      Example: Create a table to categorize devices.

9. Set up and install common peripheral devices to a laptop or desktop PC.
   Examples: external storage, printers, cameras

10. Explain the purposes and functions of common internal computing components.
    Examples: motherboard, hard drive, RAM, expansion card, CPU

11. Compare and contrast the characteristics, advantages, and disadvantages of common Internet service infrastructure, including fiber optic, cable, wireless, and DSL.

12. Compare and contrast cloud computing and traditional computing, including how data elements are organized and where data is stored.
    a. Explain why businesses regard critical data and information as assets.
       Examples: data-driven decisions, crown jewels analysis, trade secrets/proprietary data, patent information
    b. Explain the importance of promoting and protecting the intellectual property of a business.

	13. Compare and contrast common computing devices and their purposes. *Examples: mobile phones, tablets, laptops, servers, game consoles* 14. Explain and illustrate basic networking concepts. *Examples: establishing network communications, inputting device addresses, connecting network devices* 15. Summarize and explain the troubleshooting methodology. 16. Install, configure, and secure a basic wireless network. *Examples: 802.11a/b/g/n/ac standards, modems, routers, cable media*
Database Fundamentals	17. Explain the concept of a database and how its use may increase productivity. *Examples: flowcharts, storage, records, managed database* 18. Compare and contrast various database management systems, including structured, semi-structured, and non-structured, and relational and non-relational types. *Examples: JSon, SQL, XML* 19. Design, create, and manage a database structure using various systems. 20. Summarize methods used to interface with databases, including relational, access, and import/export methods.
Security	21. Research and share information on the importance of data confidentiality and security. 22. Explain methods to secure various electronic devices in a network environment. 23. Summarize end-user behavioral security practices.

24. Compare and contrast methods of applying authentication, authorization, accounting, and non-repudiation procedures in a network environment.

25. Explain why an employer may require employees to change passwords regularly.

26. Explain the importance of encryption for data security and describe ways it is commonly used.

27. Explain cybersecurity concepts as they relate to a network.

28. Explain why it is important for businesses to secure and protect their data and describe scenarios which might result in compromised data.
    Examples: human error (social engineering, sharing password), physical compromise of devices (spoofing devices)

Software Development

29. Compare and contrast notational systems.
    Examples: binary, hexadecimal, decimal, ASCII, Unicode

30. Compare and contrast interpreted, compiled, query, and assembly programming language categories.
    Examples: *scripting languages, scripted languages, markup languages*

31. Use programming organizational techniques and demonstrate programming procedures.
    Examples: *scripting languages, scripted languages, markup languages, branching, looping*

32. Explain the purpose and use of programming concepts including identifiers, containers, functions, and objects.

33. Compare and contrast fundamental data types and their characteristics.
    Examples: characters, strings, integers, floats, Boolean

34. Design a step-by-step plan (algorithm) to solve a given problem.
    Example: Recipe for creating brownies from a box mix: Follow the three to five step process written

on the back of the box.

35. Identify decision structures that control program flow.
    Examples: *Determine the exact output of a program from a flow chart.*
36. Explain techniques for code commenting and documentation.
    Example: inserting meta text in source code

37. Design a program that uses mathematical operations, data, functions, looping and iteration, sequencing, abstraction, lists, and selection.
    Examples: if-else statements, comparison, other operators

Career Opportunities

38. Gather and interpret research data to predict changes in the information technology labor market.

Linux Fundamentals

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Linux Fundamentals is designed to give students an overview of Linux-based operating systems. Standards are written to provide students with the experiences needed to understand specific programs and commands of Linux and the opportunity to take a deep dive into the hierarchy of its core filing system and kernel. Students will have the opportunity to gain an understanding of the major components of the Linux operating system (OS) through the development of skills for installation and setup, application of techniques to improve hardware performance, and demonstration of knowledge to apply network security measures to protect clients' interests. The course also presents the basics of Linux hardening and Linux server security best practices in simulated and real-world learning environments. This course is designed to help students prepare for industry-recognized credentials outlined in the CTE program guide.

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Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards

1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces.
2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
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LINUX FUNDAMENTALS
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

System Configuration	1. Install and configure kernel modules based on given requirements. 2. Explain the Linux boot process. *Examples: boot loaders, boot options, boot modules and files* 3. Create and ensure an effective network connection in the Linux environment. *Examples: using diagnostic tools to check network connectivity, running network commands in the terminal to show device information such as IP address* 4. Gather and share information on virtualization and cloud solutions in a Linux environment. 5. Identify and manage storage technologies used in Linux environments. *Examples: file system types, device mapper, tools, file system hierarchy* 6. Configure localization options within the Linux environment. *Examples: file locations, commands, environment variables, character sets*
System Management	7. Install and configure software used in the Linux environment based on computer specifications and user's needs. *Examples: package types, installation tools, build tools, repositories, acquisition commands* 8. Create and manage users and groups in the Linux environment given various sets of criteria. *Examples: creation, modification, profiles, queries, quotas* 9. Create and manage files in the Linux environment, including modifying and redirecting. *Examples: text editors, file and directory operations, output redirection. text processing, file readers*

10. Manage services within Linux based on given scenarios.
    Examples: system management, sysVinit

11. Explain the role of servers in a Linux environment.

12. Explain the graphical user interfaces available in Linux.
    Examples: servers, remote desktop, console redirection, accessibility

13. Automate and schedule jobs in a Linux environment in given scenarios.

14. Configure a Linux device in a given scenario.
    Examples: use monitoring and configuration tools, hot pluggable devices

Troubleshooting

15. Analyze Linux system properties and rectify any system issues in a given scenario.
    Examples: monitoring and configuration of network, command line prompt, storage, memory

16. Improve Linux system processes based on analysis of problems within the system.

17. Troubleshoot user issues in a Linux operating system.
    Examples: permissions, access, authentication, environment, shell issues

18. Evaluate and troubleshoot Linux application issues in given scenarios.
    Example: SELinux context violations storage

19. Evaluate and troubleshoot Linux hardware issues in given scenarios.
    Examples: memory, communications ports, storage

Security	20. Create and apply suitable access, ownership, and authentication techniques for Linux systems in given scenarios. *Examples: privilege escalations, file, directory, and context-based permissions; pluggable authentication module (PAM), Secure Shell (SSH), teletypes (TTYs), pseudo terminal (PTYs), public-key infrastructure (PKI)* 21. Configure logging services for a Linux environment in given scenarios. 22. Configure and apply Linux firewalls. *Examples: access control lists, IP forwarding, application firewall configurations* 23. Compress, back up, and restore files in a Linux operating system. *Examples: archiving and restoring utilities, backup types, integrity checks* 24. Evaluate and implement security best practices in a Linux environment. *Examples: boot security, password-less login, disabling and uninstalling services and features*
Scripting and Automation	25. Implement primary Bash scripts in a Linux environment. *Examples: looping constructs, conditional statements, shell expansions, exit codes* 26. Use Git execute version control in given scenarios in a Linux environment. 27. Explain the concepts and processes related to orchestration in Linux. *Examples: agent vs. agentless, infrastructure automation, automated configuration management*

Network Fundamentals

Course Credit	1.0
Grade Levels	9-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Network Fundamentals introduces the architecture, structure, functions, components, and models of the Internet and other computer networks. The course allows students to examine devices, equipment, topologies, communication protocols, and virtual and cloud technologies and to simulate networks in order to explore properties, settings, and capabilities. Routing and switching protocols will be explored as well as various connectivity media. Additional topics include network management, security, and troubleshooting.

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Foundational Standards

1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces.
2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.
3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
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NETWORK FUNDAMENTALS
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Networking Concepts

1. Compare and contrast the functions and applications of common physical and logical network topologies.
   Examples: mesh, bus, ring, star, hybrid

2. Differentiate among common network infrastructures.
   ExamplesWas : LAN, WAN, WLAN, PAN, MAN, CAN, SAN, SDWAN

3. Identify and formulate binary, decimal, and hexadecimal numbers.
4. Compare and contrast the layers of the Open Systems Interconnect (OSI) model and the Transport Control Protocol/Internet Protocol (TCP/IP) model.
   a. Illustrate encapsulation and decapsulation within layers of a standard network model.
      Examples: Ethernet header, Internet protocol (IP) header, transmission control protocol (TCP) header, user datagram protocol (UDP) header, maximum transmission unit (MTU)

5. Compare and contrast the services and applications used to perform basic network operations.

6. Differentiate among network categories, technologies, and topologies.

7. Explain the purpose of routing and switching and their associated technologies and protocols.
   Examples: dynamic routing, bandwidth management, virtual local area network (VLAN), spanning tree protocol

8. Summarize the purpose of common TCP/IP protocols.

9. Differentiate between public and private IP addressing schemes.

10. Compare and contrast IPv4 and IPv6 addressing features, methods, and characteristics.
    Examples: APIPA, EUI-64, multicast, unicast, anycast, broadcast, link local, loopback, default gateway

11. Categorize classful addresses according to specific network use.

12. Interpret classless inter-domain routing (CIDR) notation (subnetting).

Networking Hardware

13. Explain the functions and applications of common networking devices.
    Examples: router, bridge, switch, hub, firewall, access point, content filter, modem

14. Compare and contrast common local area network (LAN) and wide area network (WAN) connection types.
    Examples: copper twisted pair, coaxial, fiber-optic, wireless, synchronous optical network (SONET)

15. Identify common network connectors.
    Examples: RJ-45, LC, SC, ST, MT-RJ, F-type

16. Demonstrate the use of common networking tools in a given scenario.
    Examples: RJ-45 crimping tool, cable tester, tone probe, punchdown tool

17. Differentiate among common network wiring termination standards.
    Examples: EIA/TIA 568A, EIA/TIA 568B

18. Identify transceivers and media converters and explain their uses.
    Examples: SFP, SFP+, QSFP, QSFP+

19. Compare and contrast copper and fiber Ethernet standards.
    Examples: 10BASE-T, 100BASE-TX, 1000BASE-T, 10GBASE-T, 40GBASE-T, 100BASE-FX, 100BASE-SX, 1000BASE-SX, 10GBASE-SR, 10GBASE-LR, CWDM, DWDM, WDM

20. Differentiate among virtualization and network storage technologies.

Network Management	21. Interpret and explain technical network documents and text. 22. Interpret network documentation and diagrams. 23. Compare and contrast business continuity and disaster recovery concepts based on current industry practices. *Examples: policies, procedures* 24. Explain common scanning, monitoring, and patching processes and summarize their expected outputs.
Wireless Networking	25. Compare and contrast media access control techniques used in networks. 26. Configure a router with basic settings. 27. Differentiate among common wireless communication methods. *Examples: infrared, radio waves, satellite, microwave* 28. Describe wireless networking industry standards. *Examples: IEEE 802.11ac, 802.11ax*
Network Security	29. Explain common security concepts. *Examples: awareness, risk assessment, ethics* 30. Compare and contrast common types of attacks. *Examples: malware, phishing, SQL injection attack, cross-site scripting (XSS), denial of service (DoS), session hijacking, man-in-the-middle attacks* 31. Apply network hardening techniques in a given scenario. *Examples: reduce attack surface, limit access, change passwords frequently, patch management*

	32. Analyze remote access methods and associated security consequences. *Examples: site-to-site VPN, virtual network computing (VNC), remote desktop connection* 33. Identify risks and vulnerabilities related to physical security within a network. *Examples: personnel access and risks, hardware access, data access and availability* a. Investigate and report on current best practices for mitigating physical security threats to the network.
Network Troubleshooting	34. Utilize common network troubleshooting methodologies to resolve issues within a network in a given scenario. 35. Utilize network software tools and commands to troubleshoot network issues. *Examples: ping, netstat, arp, nbtstat, hostname, tracert, ipconfig, ifconfig, nslookup* 36. Troubleshoot common wireless connectivity issues.

Network Systems Administration

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Network Systems Administration can be taught with physical hardware in the classroom or with virtual equipment. The course gives students the opportunity to gain and apply a variety of fundamental skills utilized in entry-level computer network systems administration positions. Exposure to various aspects of network hardware and software maintenance and monitoring, configuring and supporting a local area network (LAN) and a wide area network (WAN), Internet systems and segments of network systems will allow students to develop a strong knowledge base for networking systems and administration. The course involves designing, implementing, upgrading, managing, and working with computer systems and network technologies.

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Foundational Standards

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3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
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NETWORK SYSTEMS ADMINISTRATION
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Hardware Installation	1. Install server hardware and connect to a network based on a given scenario. *Examples: rack server, blade server, hyperconverged infrastructure (HCI)* 2. Identify and apply the most effective storage type in a server environment. 3. Perform server hardware maintenance to ensure that the system remains operational.
Administration	4. Apply network services to a server environment, including configuring DHCP settings, setting up DNS, and setting up server-based firewalls. 5. Install, configure, and maintain a server operating system based on specific requirements and organizational roles. 6. Explain the concepts and related practices needed to ensure high availability for servers. *Examples: clustering, fault tolerance, load balancing* 7. Describe various types of software licensing concepts and models. *Examples: site based, open source, per-concurrent user, subscription, version compatibility* 8. Use virtualization technology in a server environment. *Example: using VMware, Hyper-V, KVM, or XenServer to allow the setup of virtual machines* 9. Summarize the significance of utilizing asset management and documentation. 10. Manage accounts in domain and local environments.

	11. Set up and maintain shared file system resources in a networked system. 12. Administer disk storage, including allocations and permissions in a networked system.
Security	13. Detect physical security controls and data security risks. 14. Apply access control management to server administration. 15. Summarize the importance of data security and explain how security concepts are used to mitigate risk. 16. Perform server hardening techniques in a given scenario. 17. Explain the importance of proper server configuration and ways to mitigate the risk of server compromise. 18. Use effective tools to store, retrieve, evaluate, and synthesize information. 19. Create a disaster recovery plan, emphasizing the importance of backups and restore points. 20. Explain the process of decommissioning a server.
Troubleshooting	21. Perform end user support and assistance by troubleshooting and diagnosing through telephone, e-mail, remote access, or direct contact. 22. Troubleshoot network and security problems in a given operating system. 23. Describe search procedures used to identify possible solutions when troubleshooting software and hardware problems.

Object-Oriented Programming I

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Object-Oriented Programming I is designed to provide students with a conceptual understanding of Object-Oriented Programming (OOP), a programming paradigm that relies on the concept of classes and objects. It is used to structure a software program into simple, reusable pieces of code blueprints (usually called classes), which are used to create individual instances of objects. It emphasizes the fundamentals of computer programming. Topics include technical knowledge, programming foundations, program documentation, program design and development, compilation and debugging, and practical experience in programming, using modern, object-oriented languages. This course extends the standards of the *Alabama Course of Study: Digital Literacy and Computer Science.*

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OBJECT-ORIENTED PROGRAMMING I
CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Technical Knowledge	1. Describe the differences between structured programming and object-oriented programming (OOP).
Object-Oriented Programming Foundations	2. Describe the use of a main method in an application. *Examples: signature of main, how to consume an instance of your own class, command line arguments* 3. Perform basic input and output using standard input and output streams. *Examples: print statements, import and use the scanner class* 4. Evaluate the scope of a variable and declare a variable within a block, class, or method.
Object-Oriented Language-Specific Basics	5. Define the inputs and outputs of a computer program. 6. Declare and use primitive data type variables. *Examples: byte, char, int, double, short, long, float, Boolean* a. Identify precision loss in primitive data types. *Examples: double, float* b. Explain how primitives differ from wrapper object types. *Examples: integer, Boolean* 7. Outline and explain the logical steps necessary for the development of a computer program. *Examples: software development life cycle, structured programming*

	8. Create a basic algorithm using plain language (pseudocode). 9. Use flowcharts to represent logic graphically. 10. Explain the basic functions of the integrated development environment (IDE). *Examples: inputting the code, saving the code, executing the code*
Object-Oriented Language-Specific Syntax	11. Describe the functions of different objects and their purposes in a program. 12. Describe the function and purpose of a computer program event procedure. 13. Write property assignment statements in computer code. 14. Utilize comments in the program code to document the logic and enhance the readability of the code. 15. List and explain computer program operator types and the precedence (order of operation) of program operators. *Examples: Boolean, relational, arithmetical* 16. Differentiate between commands and statements in computer programming. 17. Write valid declaration statements using an approach to global static scope with appropriate data types, including constants, variables, and logical reasoning.
Practical Programming	18. Construct a program that will perform calculations on a set of given data. 19. Generate random numbers through the use of built-in functions in a program. 20. Utilize accumulators and counters in a program. 21. Identify and utilize various looping and iteration structures that control the flow of a program.

22. Utilize built-in properties and functions to manipulate classes and structures within a program.
    Example: string

23. Describe the purpose and function of a class.

24. Construct and evaluate class definitions.
    Examples: constructors, constructor overloading, one class per java file, this keyword, basic inheritance, overriding

25. Describe the purposes and functions of general sub procedures in a program.

26. Explain the uses of parameters and arguments and how they control the flow of a program.

27. Create a program using one or more classes and/or functions.

28. Create a program using a general sub procedure passing arguments to another sub procedure.

29. Construct and evaluate code that uses branching statements.
    Examples: if, else, else if, switch; single-line vs. block; nesting; logical, relational operators

30. Construct and evaluate code that uses loops.
    Examples: while, for, for each, do while; break and continue; nesting; logical, relational, and unary operators

31. Declare, implement, and access methods.
    Examples: private, public, protected; method parameters; return type; void; return value; instance methods; static methods; overloading

Compilation and Debugging

32. Troubleshoot syntax errors, logic errors, and runtime errors.
    Examples: print statements, java command output, logic errors, console exceptions, stack trace

evaluation

33. Utilize debugging tools to suspend program execution and to examine, step through, and reset execution of code.
    Examples: Visual Debugger, brute force method, backtracking, program slicing

34. Utilize common error recovery strategies to detect errors and write a strategy to implement and handle the error.
    Examples: statement mode, error productions

Object-Oriented Programming II

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Object-Oriented Programming I

Object-Oriented Programming II extends the content in Object-Oriented Programming I to provide students with an in-depth look into the programming process and the skills required to perform advanced computer operations. The course utilizes the higher order functions of computer programming such as fundamentals and instantiation, inheritance, composition, encapsulation, polymorphism, and abstraction. Topics include ethics, program design and development, and practical experience in programming using modern, object-oriented languages. This course extends the standards of the *Alabama Course of Study: Digital Literacy and Computer Science.*

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3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
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OBJECT-ORIENTED PROGRAMMING II CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Ethical Practices

1. Identify potential abuses and unethical uses of computers and/or networks.
2. Research and discuss legal issues and the terms of use related to copyright laws, fair use laws, and ethics pertaining to the downloading and personal use of elements including images, photographs, documents, video, sounds, music, and trademarks.
3. Describe ethical and legal practices for securing the confidentiality of business-related information.

Object-Oriented Program Design	4. Create an effective graphical representation of logic using Unified Modeling Language (UML) diagrams. 5. Explain the advanced functions of the integrated development environment (IDE). *Examples: interpreting IDE feedback and errors, debugging the code for all type errors* 6. Explain the higher-order functions of object-oriented programming, including encapsulation, abstraction, inheritance, polymorphism, composition, and instantiation. 7. Describe a program's general use and purpose in the program documentation so the end user can execute the product successfully. 8. Identify all objects that need to be called and their functions in a computer program. 9. Describe the functions of different objects and their purposes in a program.
Object-Oriented Data Manipulation	10. Describe the purpose and function of various types of arrays. *Examples: single, multidimensional* 11. Construct and evaluate arithmetic expressions in a program or class. *Examples: arithmetic operators, assignment, compound assignment operators, operator precedence* 12. Explain the purpose and function of a data structure as it relates to object-oriented programming. *Examples: array, linked list, stack, queue, binary tree, binary search tree, heap, hashing, graph* 13. Construct and evaluate code that creates, iterates, and manipulates arrays and array lists. *Examples: one- and two-dimensional arrays, including initialization, null, size, iterating elements, accessing elements; adding and removing array list elements, traversing the list* 14. Construct and evaluate code that performs parsing, casting, and conversion. *Examples: cast between primitive data types, convert primitive types to equivalent object types, parse strings to numbers, convert primitive data types to strings*

15. Create an external file for data storage and manipulation through a program.

16. Differentiate among types of sorting algorithms.
    Examples: linear, bubble, selection, insert, binary

Object-Oriented Practical Programming

17. Construct a program that uses appropriate sorting algorithms.
    Examples: binary sort, bubble sort, merge sort, selection sort

18. Write a program using advanced programming features.
    Examples: multiple windows, splash screens, menus, dialogs

19. Write a program that integrates multiple external applications, including spreadsheets, databases, and word processing documents.

20. Create an advanced macro for applications software.

21. Describe the purpose and function of web controls.

22. Create a web application that includes input validation.

23. Create an interactive program which gathers input from the user and provides appropriate output and feedback based on the user's input.

24. Describe decision structures and how they control the flow of a program.

25. Describe the conversion to and from ASCII and Unicode using hexadecimal and binary number systems.

26. Declare, implement, and access data members in classes.
    Examples: private, public, protected; instance data members; static data members; use static final to create constants; describe encapsulation

27. Instantiate and use class objects in programs.
    Examples: initialization, null, access and modify data members, access methods, access and modify static members, import packages and classes

28. Debug a program for errors.
    Examples: run-time, exception, logic, semantic, try/catch/finally, exception class, exception class types, display exception information

Programming Design and Development

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Programming Design and Development is designed to introduce students to the design and development processes of programming; structured elements of object-oriented languages such as classes, data, abstractions, inheritance, polymorphism, and storage management; and the program development environment. This course extends the standards of the *Alabama Course of Study: Digital Literacy and Computer Science.*

Career and Technical Student Organizations are integral, co-curricular components of each career and technical education course. These organizations enhance classroom instruction while helping students develop leadership abilities, expand workplace-readiness skills, and access opportunities for personal and professional growth. Students in the Information Technology cluster affiliate with SkillsUSA and/or TSA.

Foundational standards, shown in the table below, are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership qualities and take advantage of the opportunities afforded by Career and Technical Student Organizations (CTSOs), and learn and practice essential digital literacy skills. The foundational standards are to be incorporated throughout the course.

Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards	
	1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces. 2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork.

3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

PROGRAMMING DESIGN AND DEVELOPMENT CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Customer Service

1. Research and collect data to create a solution that aligns with the client's needs and goals.
   Example: Design and utilize a questionnaire to assess customers' needs.
2. Design an information technology-based project plan utilizing researched strategies to solve a given problem, including aspects of planning and cybersecurity, design implementation, and project management.

3. Perform quality assurance protocols to enable the delivery of working software products according to specifications.
   Examples: quality audits, quality testing, inspection, checkpoint reviews
4. Deliver and evaluate basic technical documents, presentations, and group interactions, using a variety of authoring tools and desktop and cloud-based software.

Software Design

5. Demonstrate the effective use of tools for software development.
   Examples: IDEs, professional and amateur repositories
6. Classify program structure, blocks, and storage types according to operational efficiency.
7. Construct console and file input and output, functions, arrays, and strings.
8. Develop a software program that demonstrates input/output, processing, and storage in order to outline the flow of data for each phase.
9. Create an advanced algorithm using plain language and incorporating pseudocode to solve a real-world programming problem.
10. Design a program that uses data, functions, looping and iteration, sequencing, abstraction, list, and selection.
    Examples: if-else statements, comparison
11. Integrate mathematical concepts into a program by writing the code, performing unit testing, and debugging the program.
    Examples: logical reasoning, order of operations, functional reasoning, proportional reasoning
12. Utilize Boolean operators, mathematical operators, and relational operators in creating program code.
13. Create an algorithm that includes an input and an output to solve a real-world problem.
14. Debug processes within a program by identifying and locating the problem, removing the faulty source code, and repairing the code.

15. Utilize efficient searching algorithms to solve a given problem.
    Examples: linear, binary, jump, interpolation, exponential, ternary

16. Utilize mathematical formulas to assess the efficiency of sorting and searching algorithms and choose the more efficient one to use in a given situation.
    Example: Use BigO notation to determine whether an algorithm is both correct and efficient.

17. Create complex applications using input, calculations, output, control structures, and data structures.

18. Construct recursive algorithms to solve a problem.

19. Develop class constructors using method overloading concepts.
    Examples: changing the number of arguments to determine which instance of the class will be created

20. Construct multidimensional arrays and use the input and output data to solve a problem.

Programming Foundations

Course Credit	1.0
Grade Levels	9-11
Prerequisites	

Programming Foundations focuses on the fundamentals of computer programming with an emphasis on computational thinking and problem-solving. Students will create authentic artifacts and engage with programming as a medium for creativity, communication, problem-solving, and fun. Students will be expected to develop logical thinking skills that pertain to programming. This course extends the standards of the *Alabama Course of Study: Digital Literacy and Computer Science.*

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Each foundational standard completes the stem *"**Students will**..."*

Foundational Standards	
	1. Incorporate safety procedures in handling, operating, and maintaining tools and machinery; handling materials; utilizing personal protective equipment; maintaining a safe work area; and handling hazardous materials and forces. 2. Demonstrate effective workplace and employability skills, including communication, awareness of diversity, positive work ethic, problem-solving, time management, and teamwork. 3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.

4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

PROGRAMMING FOUNDATIONS CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Digital Literacy

1. Describe ethical and legal practices for safeguarding the confidentiality of business-related information.
2. Describe possible threats to a laptop, tablet, computer, and/or network and methods for avoiding attacks related to programming.
3. Explain the consequences of social engineering, illegal, and unethical uses of technology.
   Examples: piracy, illegal downloading, licensing infringement; inappropriate use of software, hardware, or mobile devices in the work environment
4. Describe computing innovations which have the potential to advance programming or other aspects of computer science.
   Examples: artificial intelligence, quantum computing, low- or no-code programming

Computer Systems

5. Describe the flow of data and instructions through computer systems.
6. Explain how data is represented, manipulated, and stored in a computer.
7. Describe the components of the programming development environment (the hardware and software used by programmers).
   Examples: text editor, compiler, debugging, profiler, IDE, modeling

Software Design and Programming

8. Compare and contrast current programming languages utilized by business and industry and determine features, functions, and benefits of each.
9. Identify and explain various kinds of cryptographic algorithms.
   Examples: hashing, symmetric, asymmetric
10. Explain why any input-processing algorithm must correctly handle all problem variants.
11. Write an algorithm to solve mathematical problems using formulas, equations, and functions.
12. Represent the logical flow of a program graphically.
    Examples: *flowcharts, data traces, input/output charts*
13. Utilize and explain techniques for code commenting and documentation.
    Example: inserting meta text in source code
14. Design a program that uses mathematical operations, data, functions, looping and iteration, sequencing, abstraction, lists, and selection.
    Examples: if-else statements, comparison
    a. Design a program using visual modeling software to illustrate abstraction of languages from the solutions.
       Examples: Appian, Claris FileMaker, DWkit, Google AppSheet, Looker 7, Mendix, Microsoft PowerApps, OutSystems, Robocoder Rintagi, Salesforce Lightning, Sisense, Skyve Foundry, Temenos (formerly Kony), SIB Visions VisionX, Wix Editor X, Yellowfin 9, Zoho Creator

15. Design a program that passes arguments and parameters (variables).
16. Evaluate algorithms based on given designs to discuss their efficiency, correctness, and clarity.
    Examples: analyzing and comparing execution times, testing with multiple inputs or data sets, debugging
17. Construct programs that utilize logical algorithms from specifications and requirement statements.
18. Create a model software program which involves coding, testing, and documenting according to industry coding standards and guidelines.

Computer Numbering Systems

19. Explain how strings of 0s and 1s are used in programming.
20. Summarize how numerical values are represented using different bases, including decimal and binary.
21. Demonstrate how numbers with decimals can have fixed-point or floating-point representations in binary.
22. Compare and contrast quantum and classical computing notation systems.
    Example: qubits

Technology Support and Services

Course Credit	1.0
Grade Levels	10-12
Prerequisites	Information Technology Fundamentals OR Programming Foundations

Technology Support and Services is designed to build on students' knowledge of computer hardware, operating systems, and computer software applications by providing the additional skills necessary to effectively plan, develop, and troubleshoot computer systems for end users. Topics addressed in this course include customer service, troubleshooting, system design and upgrading, and ethics.

Career and Technical Student Organizations are integral, co-curricular components of each career and technical education course. These organizations enhance classroom instruction while helping students develop leadership abilities, expand workplace readiness skills, and access opportunities for personal and professional growth. Students in the Information Technology cluster affiliate with SkillsUSA and/or TSA.

Foundational standards, shown in the table below, are an important part of every course. Through these standards, students learn and apply safety concepts, explore career opportunities and requirements, practice the skills needed to succeed in the workplace, develop leadership qualities and take advantage of the opportunities afforded by Career and Technical Student Organizations (CTSOs), and learn and practice essential digital literacy skills. The foundational standards are to be incorporated throughout the course.

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3. Explore the range of careers available in the field and investigate their educational requirements, and demonstrate job-seeking skills including resume-writing and interviewing.
4. Advocate and practice safe, legal, responsible, and ethical use of information and technology tools specific to the industry pathway.
5. Participate in a Career and Technical Student Organization (CTSO) to increase knowledge and skills and to enhance leadership and teamwork.
6. Use technology to collaborate with peers and/or experts to create digital artifacts that can be published online for a target audience.
7. Formulate new ideas, solve problems, or create products through the design and engineering process by utilizing testing, prototypes, and user feedback.

TECHNOLOGY SUPPORT AND SERVICES CONTENT STANDARDS

Each content standard completes the stem *"**Students will**..."*

Customer Service

1. Develop short- and long-term budgets for information technology services for a given customer.
   Example: Research and price out a spending plan including amounts for supplies, preventive maintenance, repairs, hardware replacement, and hardware and software upgrades.
2. Apply active listening to determine customer needs and tailor a response that communicates resolutions to meet the needs of diverse clients and environments.

Troubleshooting	3. Document the resolution of problems, including both successful and unsuccessful steps taken when attempting to reach solutions. 4. Describe the process of incident reporting and explain its importance. 5. Identify potential safety hazards and take preventive action to maintain a safe environment. *Examples: cable management, surge protection, static discharge* 6. Formulate and document a support plan for a given situation, including the identification of system support requirements.
System Design and Upgrading	7. Manage network user accounts, assign account privileges, produce required documentation, and maintain training manuals in a given simulated environment. 8. Manage software systems, system configurations, and virus protection software. 9. Develop and produce a system design to meet end-user system requirements in a given scenario. 10. Evaluate software to recommend products that meet various system specifications and user requirements. 11. Install antivirus and malware software. 12. Perform routine and preventive maintenance on laptops and portable devices to maintain security and optimal operation. 13. Evaluate the technology equipment and requirements of a given business scenario to determine what upgrades are needed. *Examples: select new components, determine best purchase options to unify the type of computers considered*

Ethics and Security

14. Research and explain the importance of appropriate use of various electronic media and communication devices by individual employees within an enterprise organization.
    Example: role play or simulate a work scenario around current ethical issues, use of social media to promote organization mission or goals

15. Examine the advantages and disadvantages for employers of maintaining network security policies and protocols for network users within a given organization.
    Example: review of internet traffic, acceptable use policy, code of ethics, company security protocols

16. Demonstrate ethical customer service skills in a simulated work environment where personal identifiable information (PII) is accessible.
    Examples: network group policies ensuring that all PII is stored on secure systems
    a. Describe methods of protecting customers' privacy and confidential information.

17. Explain how technical support employees ensure confidentiality for an organization's other employees and give examples of unintentional security breaches and their consequences.

18. Explain the importance of information privacy practices for individual employees within an organization to ensure data integrity.
    Examples: protecting employee and customer information, disposing of confidential information appropriately

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GLOSSARY

10BASE-T: An ethernet standard for local area networks with a maximum transmission speed of 10 Mbps and baseband signaling using twisted pair cables.

10GBASE-LR: A 10 Gigabit Ethernet standard specified to transmit data over long distance ("LR" refers to "long reach") through single mode fiber.

10GBASE-SR: A 10 Gbps fiber optic-based Gigabit Ethernet standard. In 10GBase-SR standard, multi-mode fiber optic medium and 850 nm lasers are used. 10GBase-SR has bandwidth up to 10.3 Gbps, but the supported distance varies according to the type of cable used.

100Base-FX: A type of standard for implementing Fast Ethernet networks. 100BaseFX and a related standard, 100BaseTX, are sometimes collectively referred to as 100BaseX.

100BASE-TX: The technical name of Fast Ethernet (100 Mbps) over twisted pair cables.

1000Base-SX: A type of standard for implementing Gigabit Ethernet networks. The SX ("short") indicates that this version is intended for use with short-wavelength transmissions over short cable runs of fiber-optic cabling.

1000Base-T: A shorthand designation by the Institute of Electrical and Electronics Engineers (IEEE) indicating a cable's transmission speed (1,000 Mbps), baseband signaling (Base), and type of cable (T for twisted).

10GBASE-T: A type of Ethernet signaling providing speeds over twisted-pair cabling that go beyond one Gigabit per second (Gbps) for distances up to 100 meters.

802.11ac (also called 5G Wi-Fi): The fifth generation of Wi-Fi technology, standardized by the IEEE, which provides greater bandwidth and more simultaneous spatial streams.

802.11ax (also called Wi-Fi 6)**:** An IEEE draft amendment that defines modifications to the 802.11physical layer (PHY) and the medium access control (MAC) sublayer for high-efficiency operation in frequency bands between 1 GHz and 6 GHz. The technical term for an 802.11ax is High Efficiency (HE).

Advanced Encryption Standard (**AES):** A widely supported encryption algorithm type for all wireless networks that contain any confidential data.

American Standard Code for Information Interchange (ASCII): A character encoding that uses numeric codes to represent characters. It uses 7 bits to represent each character since the first bit of the byte is always 0.

Application Programming Interface (API) : A set of commands, functions, protocols, and objects that programmers can use to create software or interact with an external system. It provides developers with standard commands for performing common operations so they do not have to write the code from scratch.

Artificial Intelligence (AI) : The ability of a computer to act like a human being. It has several applications, including software simulations and robotics; most commonly used in video games, where the computer is made to act as another player.

Automatic Private IP Addressing (APIPA): A feature or characteristic in operating systems which enables computers to self-configure an IP address and subnet mask automatically when their DHCP (Dynamic Host Configuration Protocol) server isn't reachable.

Big O notation: The most common metric for calculating time complexity. It describes the execution time of a task in relation to the number of steps required to complete it.

Boolean Logic (Boolean): A subset of algebra used for creating true/false statements. Boolean expressions use the operators AND, OR, XOR, and NOT to compare values and return a true or false result.

Campus Area Network (CAN): A network that covers an educational or corporate campus.

Center for Internet Security (CIS): An independent, nonprofit organization with a mission to create confidence in the connected world by developing best practices for securing IT systems and data.

Central Processing Unit (CPU): The primary component of a computer that processes instructions. It runs the operating system and applications, constantly receiving input from the user or active software programs.

Children's Online Privacy Protection Act (COPPA): Legislation which imposes certain requirements on operators of websites or online services directed to children under 13 years of age, and on operators of other websites or online services that have actual knowledge that they are collecting personal information online from a child under 13 years of age.

Classless Inter-Domain Routing (CIDR): A method of reducing the size of a routing table by utilizing IP aggregation.

Cloud Service Agreement (CSA): A set of terms governing the relationship between the cloud customer and the cloud service provider.

Coarse wavelength division multiplexing (CWDM): A wavelength division multiplexing (WDM) technology that combines multiple signals at various wavelengths for simultaneous transmission over fiber cables.

Cross-Site Scripting (XSS): A type of injection in which malicious scripts are injected into otherwise benign and trusted websites. XSS attacks occur when an attacker uses a web application to send malicious code, generally in the form of a browser side script, to a different end user.

Cybersecurity Framework (CSF): Voluntary guidance, based on existing standards, guidelines, and practices, for critical infrastructure organizations to better manage and reduce cybersecurity risk.

Cybersecurity Maturity Model Certification (CMMC) : A unified standard for implementing cybersecurity across the defense industrial base (DIB), which includes over 300,000 companies in the supply chain.

Denial of Service (DoS): An effort to make one or more computer systems unavailable. It is typically targeted at web servers, but it can also be used on mail servers, name servers, and any other type of computer system.

Dense Wavelength Division Multiplexing (DWDM): An optical multiplexing technology used to increase bandwidth over existing fiber networks by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber.

Digital Subscriber Line (DSL): A communications medium used to transfer digital signals over standard telephone lines.

Domain Name System (DNS): Memorizable names for websites and other services on the Internet. DNS translates domain names into IP addresses, allowing users to access an Internet location by its domain name.

Dynamic Host Configuration Protocol (DHCP): A protocol used to assign an IP address to a computer or device connected to a network automatically.

Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA)-568-B（EIA/TIA-568-B): Widely employed telecommunications cable standard that sets minimum requirements for various categories of cabling to support operability.

Encrypted File System (EFS): An additional level of security for files and directories that provides cryptographic protection of individual files on NTFS file system volumes using a public-key system.

End-User License Agreement (EULA): A legal contract entered into between a software developer or vendor and the user of the software, often where the software has been purchased by the user from an intermediary such as a retailer.

Enhanced small form-factor pluggable (SFP+): An enhanced version of the SFP that supports data rates up to 16 Gbit/s. SFP+ supports 8 Gbit/s Fibre Channel, 10 Gigabit Ethernet and Optical Transport Network standard OTU2.

Extended Unique Identifier (EUI): A feature which allows a host to assign itself a unique 64-Bit IP Version 6 interface identifier (EUI-64). This feature is a key benefit over IPv4 as it eliminates the need for manual configuration or DHCP.

Family Educational Rights and Privacy Act (FERPA): A federal law that affords parents the right to have access to their children's education records, the right to seek to have the records amended, and the right to have some control over the disclosure of personally identifiable information from the education records.

File Allocation Table (FAT, FAT32): A table that keeps track of all user files and helps the computer locate them on the disk.

File Transfer Protocol Secure (FTPS): A secure file transfer protocol that allows businesses to connect securely with their trading partners, users, and customers.

Fourth extended filing system (Ext4): A journaling file system for Linux, developed as the successor to Ext3.

Graphical User Interface (GUI): A user interface that includes graphical elements, such as windows, icons, and buttons.

Health Insurance Portability and Accountability Act (HIPAA): A 1996 federal law that requires the creation of national standards to protect sensitive patient health information from being disclosed without the patient's consent or knowledge.

Hierarchical File System (HFS): A file system used for organizing files on a Macintosh hard disk.

HyperText Transport Protocol (HTTP): The data transfer protocol used on the World Wide Web.

HyperText Transport Protocol Secure (HTTPS): A data transfer protocol like HTTP which uses a secure socket layer (SSL) for security purposes.

Infrastructure as a service (IaaS): A type of cloud computing service that offers essential computer, storage, and networking resources on demand, on a pay-as-you-go basis. IaaS is one of the four types of cloud services, along with software as a service (SaaS), platform as a service (PaaS), and serverless.

Integrated Development Environment (IDE): Visual tools that allow programmers to develop programs more efficiently.

International Organization for Standardization (ISO): An international standard-setting body composed of representatives from various national standards organizations which develops and publishes worldwide technical, industrial and commercial standards.

Internet Protocol (IP): The fundamental protocol for communications on the Internet which specifies the way information is packetized, addressed, transferred, routed, and received by networked devices.

IPv4: The most widely used version of the Internet Protocol. It defines IP addresses in a 32-bit format.

IPv6: The next planned version of the Internet Protocol, which provides 128-bit addresses. Also called IPng (or IP Next Generation).

Local Area Network (LAN): A wired, wireless, or combination network of connected devices that exist within a specific location such as a home, office, or educational institution.

Maximum Transmission Unit (MTU): The maximum packet size the local machine is capable of transmitting.

Mechanical Transfer Registered Jack (MT-RJ): A small connector for fiber optic cables used in small-sized devices.

Metropolitan Area Network (MAN): A network that spans a large area, such as a town or city. It is larger than a campus area network (CAN), but smaller than a wide area network (WAN).

National Institute of Standards and Technology (NIST): A national organization that promotes innovation and industrial competitiveness in the U.S. by advancing measurement science, standards, and technology in ways that enhance economic security and improve quality of life.

New Technology File System (NTFS): A file system introduced by Microsoft with Windows NT which is supported by subsequent versions of Windows, such as Windows 2000 and Windows XP.

Object-Oriented Programming (OOP): A programming language paradigm in which the code can be structured as reusable components, some of which may share properties or behaviors.

Open Systems Interconnection (OSI): An AI model created by the International Organization for Standardization (ISO) to help standardize communication between computer systems.

Operating System (OS): A software that communicates with the hardware and allows other programs to run. It is composed of system software, or the fundamental files computers need to boot up and function. Common desktop operating systems include Windows, OS X, and Linux.

Payment Card Industry Data Security Standard (PCI DSS): A set of security standards designed to ensure that all companies which accept, process, store, or transmit credit card information maintain a secure environment.

Personal Area Network (PAN): A network of connected devices used by one person which allows devices such as computers, tablets, smartphones, and smartwatches to communicate with each other.

Personally identifiable information (PII): Information that can be used to distinguish or trace an individual's identity, either alone or when combined with other personal or identifying information that is linked or linkable to a specific individual.

Platform as a service (PaaS): A complete development and deployment environment in the cloud, with resources that enable a user to deliver everything from simple cloud-based apps to sophisticated, cloud-enabled enterprise applications.

Prototype: A simple experimental model of a proposed solution used to test or validate ideas, design assumptions, and other aspects of its conceptualisation quickly and cheaply, so that the designer(s) involved can make appropriate refinements or possible changes in direction.

PyCharm: A dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers.

Quad (4-channel) Small Form-factor Pluggable (QSFP, QSFP+): A compact, hot-pluggable fiber optical transceiver used for 40 Gigabit Ethernet (40GbE) data communications applications.

Random Access Memory (RAM): A common hardware component found in electronic devices, including desktop computers, laptops, tablets, and smartphones. The amount of RAM in a device determines how much memory the operating system and open applications can use.

Recovery Point Objective (RPO): The maximum acceptable amount of data loss after an unplanned data-loss incident, expressed as an amount of time.

Recovery Time Objective (RTO): The maximum acceptable amount of time for restoring a network or application and regaining access to data after an unplanned disruption.

Redundant Array of Independent/Inexpensive Disks (RAID): A technology that allows storing data across multiple hard drives.

Registered Jack 45 (RJ45): A type of connector commonly used for Ethernet networking. Since Ethernet cables have an RJ45 connector on each end, they are sometimes also called RJ45 cables.

Remote Desktop Protocol (RDP): A technical standard for using a desktop computer remotely.

Risk Management Framework (RMF): A process that integrates security, privacy, and cyber supply chain risk management activities into the system development life cycle.

Secure File Transfer Protocol (SFTP): A file transfer protocol that leverages a set of utilities that provide secure access to a remote computer to deliver secure communications.

Secure/Multipurpose Internet Mail Extensions (S/MIME): A widely accepted protocol for sending digitally signed and encrypted messages.

Secure Shell (SSH): A network protocol that gives users, particularly system administrators, a secure way to access a computer over an unsecured network.

Service-Level Agreement (SLA): An agreement that defines the level of service expected from a vendor, laying out the metrics by which service is measured, as well as remedies or penalties should agreed-on service levels not be achieved.

Small Form-factor Pluggable (SFP): A small transceiver that plugs into the SFP port of a network switch and connects to Fibre Channel and Gigabit Ethernet (GbE) optical fiber cables at the other end.

Software as a service (SaaS): Software that is deployed over the Internet rather than installed on a computer, often used for enterprise applications that are distributed to multiple users.

Software-defined networking (SDN): An architecture designed to make a network more flexible and easier to manage.

Software-defined Wide Area Network (SDWAN, SD-WAN): A wide area network that utilizes software components to control network operations.

Spatial-numerical association of response codes (SNARC): A reference to the phenomenon that responses involving small numbers are faster with the left hand and responses involving large numbers are faster with the right hand.

Statement of Work (SOW): A legally binding work contract that captures and defines all the aspects of the execution of a project scope of work, including activities, deliverables, and timetable for the project. It defines the terms and conditions agreed upon between parties and lays the groundwork for the project plan.

Storage Area Network (SAN): A subnetwork of storage devices that are shared with one another over a high-speed network connection.

Structured Query Language (SQL) injection attack: A type of cyber attack in which a hacker uses a piece of SQL code to manipulate a database and gain access to potentially valuable information.

Synchronous Optical Network (SONET): A standard for connecting fiber-optic networks. It is a physical network layer used to carry a large amount of data over long distances in a broad range of high-level network protocols.

Temporal Key Integrity Protocol (TKIP): An encryption protocol for wireless LANs (WLANs) designed to provide more secure encryption than the original WLAN security protocol, Wired Equivalent Privacy (WEP).

Transmission Control Protocol (TCP): A standard that dictates how to establish and maintain a connection through which two programs may exchange data.

Transport/Transmission Control Protocol/Internet Protocol (TCP/IP): A set of rules (protocols) governing communications among all computers on the Internet.

Troubleshoot: To discover and correct faults in a mechanical or electronic system.

Unified Modeling Language (UML): A standardized modeling language enabling developers to specify, visualize, construct and document artifacts of a software system.

User Datagram Protocol (UDP): A communications protocol that is primarily used for establishing low-latency and loss-tolerating connections between applications on the internet.

Virtual Local Area Network (VLAN): A logical group of workstations, servers. and network devices that appear to be on the same LAN despite their geographical distribution.

Virtual Network Computing (VNC): A graphical desktop-sharing application that uses remote framebuffer protocol to remotely control another computer.

Virtual Private Network (VPN): A network "tunneled" through a wide area network such as the Internet which scrambles all the data sent through the wide area network, so that the network is "virtually" private.

Visual Studio Code (VS Code): An integrated development environment made by Microsoft for Windows, Linux and MacOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

Wavelength division multiplexing (WDM): A technology or technique modulating numerous data streams (optical carrier signals of varying wavelengths [colors] of laser light) onto a single optical fiber.

Wide Area Network (WAN): A multi-location network of connected devices, larger than a Local Area Network (LAN). Many wide area networks span long distances via telephone lines, fiber optic cables, or satellite links. They can also be composed of smaller LANs that are interconnected.

Wi-Fi Protected Access (WPA): A security protocol designed to create secure wireless (Wi-Fi) networks. It is similar to the WEP protocol, but offers improvements in the way it handles security keys and the way users are authorized.

Wi-Fi Protected Access 2 (WPA2): The second version of the WPA security protocol designed to create secure wireless networks.

Wired Equivalent Privacy (WEP): A security protocol for Wi-Fi networks which aims to make wireless networks as secure as wired networks.

Wireless Local Area Network (WLAN or wireless LAN): A network that allows devices to connect and communicate wirelessly.