Ohio CTE

Information Technology Career Field Technical Content Standards

Business Operations/21st Century Skills: Learners apply principles of economics, business management, marketing, and employability in an entrepreneur, manager, and employee role to the leadership, planning, developing, and analyzing of business enterprises related to the career field. 1

1 **Employability Skills: Develop career awareness and employability skills(e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.** 1.1

1 Identify the knowledge, skills, and abilities necessary to succeed in careers. 1.1.1

2 Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience. 1.1.2

3 Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options. 1.1.3

4 Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships. 1.1.4

5 Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development). 1.1.5

6 Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles. 1.1.6

7 Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions. 1.1.7

8 Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism. 1.1.8

9 Give and receive constructive feedback to improve work habits. 1.1.9

10 Adapt personal coping skills to adjust to taxing workplace demands. 1.1.10

11 Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them. 1.1.11

12 Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior. 1.1.12

2 **Leadership and Communications: Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.** 1.2

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1. Extract relevant, valid information from materials and cite sources of information. 1.2.1
2. Deliver formal and informal presentations. 1.2.2
3. Identify and use verbal, nonverbal, and active listening skills to communicate effectively. 1.2.3
4. Use negotiation and conflict-resolution skills to reach solutions. 1.2.4
5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose. 1.2.5
6. Use proper grammar and expression in all aspects of communication. 1.2.6
7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps. 1.2.7
8. Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships. 1.2.8
9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity). 1.2.9
10. Use interpersonal skills to provide group leadership, promote collaboration, and work in a team. 1.2.10
11. Write professional correspondence, documents, job applications, and resumés. 1.2.11
12. Use technical writing skills to complete forms and create reports. 1.2.12
13. Identify stakeholders and solicit their opinions. 1.2.13
14. Use motivational strategies to accomplish goals. 1.2.14

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3 **Business Ethics and Law: Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.** 1.3

1. Analyze how regulatory compliance affects business operations and organizational performance. 1.3.1
2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment. 1.3.2
3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice). 1.3.3
4. Identify how federal and state consumer protection laws affect products and services. 1.3.4
5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization. 1.3.5

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6 Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance. 1.3.6

7 Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]). 1.3.7

8 Verify compliance with computer and intellectual property laws and regulations. 1.3.8

9 Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational, and professional ethical standards. 1.3.9

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4 **Knowledge Management and Information Technology: Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.** 1.4

1 Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems). 1.4.1

2 Select and use software applications to locate, record, analyze, and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines). 1.4.2

3 Verify compliance with security rules, regulations, and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway. 1.4.3

4 Use system hardware to support software applications. 1.4.4

5 Use information technology tools to maintain, secure, and monitor business records. 1.4.5

6 Use an electronic database to access and create business and technical information. 1.4.6

7 Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books). 1.4.7

8 Use electronic media to communicate and follow network etiquette guidelines. 1.4.8

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5 **Global Environment: Evaluate how beliefs, values, attitudes, and behaviors influence organizational strategies and goals.** 1.5

1 Describe how cultural understanding, cultural intelligence skills, and continual awareness are interdependent. 1.5.1

2 Describe how cultural intelligence skills influence the overall success and survival of an organization. 1.5.2

3 Use cultural intelligence to interact with individuals from diverse cultural settings. 1.5.3

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4 Recognize barriers in cross-cultural relationships and implement behavioral adjustments. 1.5.4

5 Recognize the ways in which bias and discrimination may influence productivity and profitability. 1.5.5

6 Analyze work tasks for understanding and interpretation from a different cultural perspective. 1.5.6

7 Use intercultural communication skills to exchange ideas and create meaning. 1.5.7

8 Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities. 1.5.8

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6 **Business Literacy: Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.** 1.6

1 Identify business opportunities. 1.6.1

2 Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure). 1.6.2

3 Explain the importance of planning your business. 1.6.3

4 Identify types of businesses, ownership, and entities (i.e., individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit). 1.6.4

5 Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments, and interdepartmental interactions. 1.6.5

6 Identify the target market served by the organization, the niche that the organization fills, and an outlook of the industry. 1.6.6

7 Identify the effect of supply and demand on products and services. 1.6.7

8 Identify the features and benefits that make an organization's product or service competitive. 1.6.8

9 Explain how the performance of an employee, a department, and an organization is assessed. 1.6.9

10 Describe the impact of globalization on an enterprise or organization. 1.6.10

11 Describe how all business activities of an organization work within the parameters of a budget. 1.6.11

12 Describe classifications of employee benefits, rights, deductions, and compensations. 1.6.12

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7 **Entrepreneurship/Entrepreneurs: Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.** 1.7

1 Compare and contrast the four types of business ownership (i.e., individual proprietorships, partnerships, corporations, cooperatives). 1.7.1

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2 Explain the role of profit as the incentive to entrepreneurs in a market economy. 1.7.2

3 Identify the factors that contribute to the success and failure of entrepreneurial ventures. 1.7.3

4 Assess the roles of nonprofit and for-profit businesses. 1.7.4

5 Develop a business plan. 1.7.5

6 Describe life cycles of an entrepreneurial business and an entrepreneur. 1.7.6

7 Create a list of personal strengths, weaknesses, skills, and abilities needed to be successful as an entrepreneur. 1.7.7

8 Explain pathways used to become an entrepreneur. 1.7.8

9 Conduct a self-assessment to determine entrepreneurial potential. 1.7.9

10 Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co- op] education, work placement, internship, job shadowing) related to an entrepreneurial objective. 1.7.10

11 Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID, permits, insurance, licensing). 1.7.11

12 Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors, information resources, educational opportunities). 1.7.12

13 Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets, processes). 1.7.13

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8 **Operations Management: Plan, organize, and monitor an organization or department to maximize contribution to organizational goals and objectives.** 1.8

1 Forecast future resources and budgetary needs using financial documents (e.g., balance sheet, demand forecasting, financial ratios). 1.8.1

2 Select and organize resources to develop a product or a service. 1.8.2

3 Analyze the performance of organizational activities and reallocate resources to achieve established goals. 1.8.3

4 Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies). 1.8.4

5 Use inventory and control systems to purchase materials, supplies, and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN). 1.8.5

6 Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability. 1.8.6

7 Collect information and feedback to help assess the organization's strategic planning and policymaking processes. 1.8.7

8 Identify routine activities for maintaining business facilities and equipment. 1.8.8

9 Develop a budget that reflects the strategies and goals of the organization. 1.8.9

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10 Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability. 1.8.10

9 **Financial Management: Use financial tools, strategies, and systems to develop, monitor, and control the use of financial resources to ensure personal and business financial well-being.** 1.9

1 Create, analyze, and interpret financial documents (e.g., budgets, income statements). 1.9.1

2 Identify tax obligations. 1.9.2

3 Review and summarize savings, investment strategies, and purchasing options (e.g., cash, lease, finance, stocks, bonds). 1.9.3

4 Identify credit types and their uses in order to establish credit. 1.9.4

5 Identify ways to avoid or correct debt problems. 1.9.5

6 Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans. 1.9.6

7 Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk. 1.9.7

8 Identify income sources and expenditures. 1.9.8

9 Compare and contrast different banking services available through financial institutions. 1.9.9

10 Identify the role of depreciation in tax planning and liability. 1.9.10

10 **Sales and Marketing: Manage pricing, place, promotion, packaging, positioning, and public relations to improve quality customer service.** 1.10

1 Identify how the roles of sales, advertising, and public relations contribute to a company's brand. 1.10.1

2 Determine the customer's needs and identify solutions. 1.10.2

3 Communicate features, benefits, and warranties of a product or service to the customer. 1.10.3

4 Identify the company policies and procedures for initiating product and service improvements. 1.10.4

5 Monitor customer expectations and determine product/service satisfaction by using measurement tools. 1.10.5

6 Discuss the importance of correct pricing to support a product's or service's positioning in the marketing mix. 1.10.6

7 Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product. 1.10.7

8 Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations). 1.10.8

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9 Describe how product mix (e.g., product line, product items, bundling) maximizes sales revenues, market, share, and profit margin. 1.10.9

10 Demonstrate sales techniques. 1.10.10

11 Principles of Business Economics: Examine and employ economic principles, concepts, and policies to accomplish organizational goals and objectives. 1.11

1 Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services). 1.11.1

2 Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior. 1.11.2

3 Use economic indicators to identify economic trends and conditions (e.g., inflation, interest rate fluctuations, unemployment rates). 1.11.3

4 Determine how the quality, quantity, and pricing of goods and services are affected by domestic and international competition in a market economy. 1.11.4

5 Analyze factors that affect currency and exchange rates. 1.11.5

6 Explain how financial markets and government policies influence interest rates (credit ratings/debt ceiling), trade deficits, and unemployment. 1.11.6

7 Describe how economic performance and culture are interdependent. 1.11.7

8 Identify the relationships between economy, society, and environment that lead to sustainability. 1.11.8

9 Describe how laws and regulations influence domestic and international trade. 1.11.9

12 Cyber Hygiene: Apply digital information security principles to keep information secure. 1.12

1 Identify the purpose and practices of Cyber Hygiene. 1.12.1

2 Differentiate between appropriate and inappropriate information. 1.12.2

3 Interpret security policies through job specific training and training updates. 1.12.3

4 Apply secure password behavior. 1.12.4

5 Apply physical and virtual situational awareness (e.g., clean desk policies, shoulder surfing, social engineering, tailgating). 1.12.5

IT Fundamentals: Learners apply fundamental principles of IT, including the history of IT and its impact on society, common industry terms, systems theory, information storage and retrieval, database ma co software, and peripheral

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1 Security, Risks, and Safeguards: Describe the need for security and explain security risks and security safeguards. 2.1

1 Explain the need for confidentiality, integrity, and availability (CIA) of information. 2.1.1

2 Describe authentication, authorization, and auditing. 2.1.2

3 Describe multilevel security. 2.1.3

4 Identify security risks and describe associated safeguards and methodologies (e.g., auditing). 2.1.4

Describe major threats to computer systems (e.g., insider threats, viruses, worms, spyware, ransomware, spoofing, hacking, social engineering, phishing). 2.1.5

device configuration and installation. This base of knowledge and skills may be applied across the career field. 2

6 Describe the components of the physical environment (e.g., wiring closets, server rooms) and physical security systems. 2.1.6

7 Describe the need for security in networking (e.g., firewall, access controls, encryption, demilitarized zone). 2.1.7

8 Describe the need for security in application development. 2.1.8

9 Track and catalogue physical assets. 2.1.9

10 Describe computer forensics, its importance in information security and cybersecurity, and its relevance to law enforcement. 2.1.10

11 Identify the need for personal security in digital information and describe how personal information can be safeguarded. 2.1.11

12 Practice information security per job requirements. 2.1.12

13 Describe privacy security compliance on systems (e.g., Health Insurance Portability and Describe privacy security compliance on systems (e.g., Health Insurance Portability and Accountability Act [HIPAA], Payment Card Industry [PCI], Sarbanes Oxley Act [SOX], Americans with Disabilities Act [ADA], General Data Protection Regulation [GDPR], European Union Data Protection Regulation [EUDPR]). 2.1.13

2 **Networking Fundamentals: Apply networking fundamentals to infrastructure systems.** 2.2

1 Differentiate between Local Area Networks (LANs), Wide Area Networks (WANs), Wireless Local Area Networks (WLANs), and Near Field Communication (NFC). 2.2.1

2 Select the basic point-to-point (PTP) and point-to-multipoint (PTMP) network topologies (e.g., star, ring, tree, network, mesh, irregular) and broadband and baseband transmission methods. 2.2.2

3 Select network storage techniques (e.g., fiber channel, Internet Small Computer System Interface [iSCSI], Fiber Channel over Ethernet [FCoE], Serial Attached SCSI [SAS], Network File Systems [NFS], Network Attached Storage/Server Message Blocks [NAS/SMB]). 2.2.3

4 Differentiate between the Internet, intranets, and extranets. 2.2.4

5 Identify and apply Transmission Control Protocol and Internet Protocol (TCP/IP), Internet Protocol Version 4 (IPv4), Internet Protocol Version 6 (IPv6) applications and services (e.g., rlogin, Simple Mail Transfer Protocol [SMTP], Telecommunications Network [Telnet], File Transfer Protocol [FTP], Domain Name System [DNS], Network File System [NFS], Voice over Internet Protocol [VoIP], Internet Control Message Protocol [ICMP]). 2.2.5

6 Differentiate between cable types (e.g., fiber optic, twisted pair, coaxial) and interfaces. 2.2.6

7 Identify the top-level domains (e.g., .gov, .com, .edu). 2.2.7

8 Describe the characteristics and uses of networks, network devices, and components (e.g., hubs, switches, routers, firewalls). 2.2.8

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3 **Alphanumeric Encoding: Explain and describe data encoding basics.** 2.3

1. Identify and explain coding information and representation of characters (e.g., American Standard Code for Information Interchange [ASCII], Extended Binary Coded Decimal Interchange Code [EBCDIC], Unicode). 2.3.1
2. Convert between numbering systems (e.g., binary, hexadecimal, decimal). 2.3.2

4. **Emerging Technologies: Identify trending technologies, their fundamental architecture, and their value in the marketplace.** 2.4
   1. Investigate the scope and the impact of mobile computing environments on society. 2.4.1
   2. Describe the differences, advantages, and limitations of cloud computing (e.g., public cloud, private cloud, hybrid cloud) and on-premises computing. 2.4.2
   3. Utilize cloud computing applications (e.g., services, applications, virtual environments). 2.4.3
   4. Describe emerging technologies (e.g., Bring your Own Device [BYOD], Services Virtualization, Augmented Reality [AR], SMART Devices, Additive Manufacturing [3D Printing]). 2.4.4

5. **Operating Systems: Install and maintain operating systems (OSs).** 2.5
   1. Compare Operating Systems for computer hardware (e.g., personal computers, servers, mainframes, and mobile devices). 2.5.1
   2. Describe uses and functions of virtual machines. 2.5.2
   3. Identify the properties of open and proprietary systems. 2.5.3
   4. Maintain file structures in Operating Systems. 2.5.4
   5. Use system utilities to maintain an Operating System. 2.5.5
   6. Describe Operating System interfaces (e.g., command line, Graphic User Interface [GUI]). 2.5.6
   7. Install and test updates and patches to Operating Systems. 2.5.7

6. **Installation and Configuration: Install and configure hardware and software.** 2.6
   1. Comply with license agreements for software and hardware and describe the consequences of noncompliance. 2.6.1
   2. Identify hardware requirements for software applications. 2.6.2
   3. Verify software compatibility and troubleshoot any software incompatibility. 2.6.3
   4. Install and test new software and software upgrades on stand-alone, mobile, and networked systems. 2.6.4
   5. Preserve, convert, or migrate existing data files to a new format. 2.6.5
   6. Determine compatibility of software and hardware and resolve any conflicts. 2.6.6
   7. Install and test hardware peripherals. 2.6.7
   8. Document installation, configuration, and compatibility of hardware and software. 2.6.8

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7 **Web Architecture: Explain the fundamentals of delivering information and applications using web architecture.** 2.7

1 Describe methods of securely transmitting data. 2.7.1

2 Describe ways to present data (e.g., responsive web design, mobile applications, desktop applications, web applications). 2.7.2

3 Differentiate between a client and a server. 2.7.3

4 Identify how the use of different browsers and devices effects the look of a webpage (e.g., Americans with Disabilities Act [ADA]). 2.7.4

5 Explain the relationship between data transmission volumes, bandwidth, and latency. 2.7.5

6 Describe the characteristics and use of browser plug-ins. 2.7.6

7 Compare the advantages and disadvantages of running an in-house server or using a service provider. 2.7.7

8 Describe the difference between static and dynamic sites and the reasons for using each. 2.7.8

8 **Databases: Describe the fundamentals of databases.** 2.8

1 Identify emerging database technology (e.g., Not only Structured Query Language [NoSQL], New Structured Query Language [NewSQL], graph databases). 2.8.1

2 Describe the use and purpose of a database and a Database Management System (DBMS). 2.8.2

3 Compare databases (e.g., flat file, hierarchical, relational). 2.8.3

4 Describe the elements of a database (e.g., table, record/row, field, relationships, transactions). 2.8.4

5 Describe the elements of a database user interface (e.g., form, queries, filters, reports). 2.8.5

6 Describe Structured Query Language (SQL). 2.8.6

7 Describe how data can be stored in and extracted from a database. 2.8.7

8 Explain the importance of data integrity and security. 2.8.8

9 Differentiate between a front-end interface and a back-end database. 2.8.9

9 **Project Concept Proposal: Develop a project concept proposal.** 2.9

1 Identify and incorporate branding strategies. 2.9.1

2 Determine the scope and purpose of the project. 2.9.2

3 Determine the target audience, client needs, expected outcomes, objectives, and budget. 2.9.3

4 Develop a conceptual model and design brief for the project. 2.9.4

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Develop a timeline, a communication plan, a task breakdown, costs (e.g., equipment, labor), deliverables, and responsibilities for completion. 2.9.5

6 Develop and present a comprehensive proposal to stakeholders. 2.9.6

10 Equipment: Select, operate, and maintain equipment. 2.10

1 Identify hardware platforms, configurations, and support models. 2.10.1

2 Identify processor, memory, storage, power and environmental requirements. 2.10.2

3 Identify architecture requirements. 2.10.3

4 Identify software application requirements. 2.10.4

5 Prepare and operate equipment per project design specifications. 2.10.5

6 Monitor equipment operation and troubleshoot issues and problems. 2.10.6

7 Backup, restore, test, archive, and manage data. 2.10.7

8 Prepare equipment for storage or decommissioning. 2.10.8

9 Perform routine maintenance per manufacturer specifications. 2.10.9

11 Troubleshooting: Select and apply troubleshooting methodologies for problem solving. 2.11

1 Identify the problem. 2.11.1

2 Select troubleshooting methodology (e.g., top down, bottom up, follow the path, spot the differences). 2.11.2

3 Investigate symptoms based on the selected methodology. 2.11.3

4 Gather and analyze data about the problem. 2.11.4

5 Design a solution. 2.11.5

6 Test a solution. 2.11.6

7 Implement a solution. 2.11.7

8 Document the problem and the verified solution. 2.11.8

12 Performance Tests and Acceptance Plans: Develop performance tests and acceptance plans. 2.12

1 Create a written procedure agreed by the stakeholders and project team for determining the acceptability of the project deliverables. 2.12.1

2 Develop a test system that accurately mimics external interfaces. 2.12.2

3 Develop test cases that are realistic, compare with expected performance, and include targeted platforms and device types. 2.12.3

4 Develop, perform, and document usability and testing integration. 2.12.4

5 Make corrections indicated by test results. 2.12.5

6 Seek stakeholder acceptance upon successful completion of the test plan. 2.12.6

Rollout and Handoff: Plan rollout and facilitate handoff to customer. 2.13

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1 Include overall project goals and timelines in the rollout plan. 2.13.1

2 Communicate rollout plans to key stakeholders in a timely manner. 2.13.2

3 Conduct final review and approvals according to company standards. 2.13.3

4 Identify support staff, training needs, and contingency plans in the rollout plan. 2.13.4

5 Test delivered application to assure that it is fully functional for the customer or user and meets all requirements. 2.13.5

6 Deliver support and training materials. 2.13.6

Information Security: Learners apply principles of information security to implement and maintain security compliance and network security. Learners select components and mechanisms required for a multilayer defense structure and evaluate and minimize security risks to wired and wireless networks and devices. 3

1 **Components of Information Security: Describe the components associated with information security systems.** 3.1

1 Differentiate between authentication and authorization. 3.1.1

2 Compare and contrast authentication techniques (e.g., single factor, multifactor, passwords, biometrics, certificates, Radio Frequency Identification [RFID] cards). 3.1.2

3 Compare and contrast methods of achieving information assurance and integrity and confidentiality (e.g., digital signatures, digital certifications, hashing algorithms, encryption). 3.1.3

4 Describe Virtual Private Networks (VPNs) using tunneling protocols (e.g., Layer 2 Tunneling Protocol [L2TP], Secure Socket Tunneling Protocol [SSTP], Point-to-Point Tunneling Protocol [PPTP]) and encrypting techniques). 3.1.4

5 Discuss the role of certificate authorities (CAs) and Public Key Infrastructure (PKI). 3.1.5

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2 **General Security Compliance: Implement and maintain General security compliance.** 3.2

1 Identify and implement data and application security. 3.2.1

2 Implement backup, restore, and verification procedures. 3.2.2

3 Describe and assign permissions (e.g., read-only, read-write). 3.2.3

4 Provide user authentication (e.g., assign and reset user accounts and passwords). 3.2.4

5 Install, test, implement, and update virus and malware detection and protection software. 3.2.5

6 Identify sources of virus and malware infection and remove viruses and malware. 3.2.6

7 Provide documentation, training, and support to users on established security procedures. 3.2.7

8 Identify the need for disaster recovery policies and procedures. 3.2.8

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3 **Network Security: Implement and maintain network security.** 3.3

Describe network security policies (e.g., acceptable use policy). 3.3.1

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2 Identify security appliances and describe the role of each in a networked environment. 3.3.2

3 Devise account administration functions to support network security. 3.3.3

4 Describe Access Control Lists (ACLs) and explain why they are used. 3.3.4

5 Assess risks based on vulnerability of the organization, likelihood of risk, and impact on the organization. 3.3.5

6 Describe the functions and uses of patch management. 3.3.6

7 Train users in network security procedures. 3.3.7

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4 Multilayer Defense Structure: Explain information technology mechanisms as they apply to a multilayer defense structure. 3.4

1 Describe available systems for intrusion prevention, detection, and mitigation. 3.4.1

2 Analyze system log files to identify security risks. 3.4.2

3 Compare network analysis software (e.g., network analyzer) and hardware tools to identify security risks and vulnerabilities. 3.4.3

4 Identify the components of human security (e.g., social engineering) and techniques to mitigate human security threats (e.g., policies, procedures, training). 3.4.4

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5 Wireless Security: Implement secure wireless networks. 3.5

1 Describe wireless security risks (e.g., unauthorized access) and how to mitigate them. 3.5.1

2 Compare methods of increasing the security of wireless networks and devices (e.g., Media Access Control [MAC] address filtering, Wi-Fi Protected Access [WPA], 802.1x, Remote Authentication Dial In User Service [RADIUS]). 3.5.2

3 Research security enhancements provided by Institute of Electrical and Electronics Engineers (IEEE). 3.5.3

4 Describe practices and policies for preventing and detecting installation of rogue networks. 3.5.4

5 Describe security practices and policies for personal devices. 3.5.5

6 Implement and test the security of a wireless network. 3.5.6

Infrastructure Systems: Learners apply principles of networking and infrastructure related to the installation, administration, and ma co

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1 Network Infrastructure: Build a multinode network. 4.1

1 Determine the basic point-to-point (PTP) and point-to-multipoint (PTMP) network topologies (e.g., star, ring, tree, mesh, hybrid) and identify broadband and baseband (e.g., Ethernet) transmission methods and standards. 4.1.1

2 Explain packet-switching techniques. 4.1.2

3 Compare the characteristics of connection-oriented and connectionless protocols and select protocols based on given criteria. 4.1.3

Knowledge and skills may be applied to network connectivity, cabling, protocols, architecture, classification, topologies, operating systems, Open Systems Interconnection (OSI) standards, data encoding, Quality of Service (QoS), Internet Protocol (IP) addressing, and wide area network (WAN) design. 4

4 Identify standard and emerging network technologies (e.g., broadband, satellite, optic, cellular, Local-Area Network (LAN) and WiFi). 4.1.4

5 Describe how Unified Communication (UC) integrates voice, data, and video communications. 4.1.5

6 Configure and build a network. 4.1.6

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2 Open Systems Interconnection: Describe the Open Systems Interconnection (OSI) standard (International Organization for Standardization [ISO] Standard 7498). 4.2

1 Identify the benefits of using a layered network model. 4.2.1

2 Compare Open Systems Interconnection stack positions and their relationships to one another. 4.2.2

3 Compare the seven layers of the Open Systems Interconnection stack to the four layers of the Transmission Control Protocol/Internet Protocol (TCP/IP) stack. 4.2.3

4 Compare the basics of Transmission Control Protocol/Internet layers, components, and functions. 4.2.4

5 Describe actions to be performed at each of the Open Systems Interconnection layers. 4.2.5

6 Explain how the Open Systems Interconnection layers relate to the elements of network communication. 4.2.6

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3 Network Media: Select, assemble, terminate, and test media. 4.3

1 Identify the criteria used in selecting media (e.g., physical properties, transmission technologies, transmission span, bandwidth, topology, security, noise immunity, installation considerations, cost). 4.3.1

2 Differentiate between media types (e.g., coaxial, twisted pair, fiber optic) and interfaces. 4.3.2

3 Compare media categories (e.g., single mode, multimode, CAT5, CAT5E, CAT6+). 4.3.3

4 Describe types of media connectors (e.g., Bayonet Neill-Concelman [BNC], Registered Jack [RJ]-45, LC, ST) and grounding techniques. 4.3.4

5 Identify media standards (e.g., American National Standards Institute [ANSI], Electronic Industries Alliance/Telecommunications Industry Association [EIA/TIA]-568, EIA/TIA-568A and 568B). 4.3.5

6 Identify the advantages and disadvantages of cabling systems. 4.3.6

7 Describe typical problems associated with cable installation. 4.3.7

8 Assemble and test Ethernet cable (e.g., straight-through, crossover, loopback). 4.3.8

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4 Wireless Communications: Explain wireless communications. 4.4

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1. Compare wireless standards in common use (e.g., Institute of Electrical and Electronics Engineers [IEEE] 802.11, Cellular, Bluetooth, Worldwide Interoperability for Microwave Access [WiMAX], Radio Frequency Identification [RFID], Near Field Communication [NFC]). 4.4.1
2. Compare characteristics of wireless signals (e.g., reflection, diffraction, scattering, fading). 4.4.2
3. Differentiate media access methods used by wireless. 4.4.3
4. Describe appropriate applications of wireless technologies to specific communication scenarios. 4.4.4
5. Compare Radio Frequency (RF) functions and principles. 4.4.5

5 **Wireless Network Solutions: Design and implement wireless network solutions.** 4.5

1. Compare secure wireless solutions operating in ad-hoc mode and infrastructure mode. 4.5.1
2. Describe the frequency ranges and associated rules in the wireless spectrum as managed by the Federal Communication Commission (FCC). 4.5.2
3. Describe the Service Set Identifier (SSID) as used in wireless communications. 4.5.3
4. Select and install access points, wireless Network Interface Cards (NICs), antennas, and other hardware and software components to provide a wireless networking solution as determined by a site and customer survey. 4.5.4
5. Troubleshoot Wireless Local Area Networks (WLANs) using system logs, vendor-provided utilities, and diagnostic tools. 4.5.5
6. Secure the wireless network. 4.5.6

6 **Network Protocols: Compare and contrast network protocols.** 4.6

1. Explain network protocols (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], User Datagram Protocol [UDP], Internet Protocol Version 4 [IPv4], Internet Protocol Version 6 [IPv6]). 4.6.1
2. Identify the advantages of protocols (e.g., Domain Name System [DNS], File Transfer Protocol [FTP], Hypertext Transfer Protocol [HTTP], Telecommunications Network [Telnet], Remote Desktop Protocol [RDP]], Secure Shell [SSH]) and associated port numbers. 4.6.2
3. Explain the purposes of encapsulation and decapsulation and their relationship to the Open Systems Interconnection (OSI) model. 4.6.3
4. Explain the difference between User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). 4.6.4
5. Identify Transmission Control Protocol (TCP)and User Datagram Protocol (UDP) conventional ports (e.g., Simple Mail Transfer Protocol [SMTP], Telnet, Hypertext Transfer Protocol [HTTP], File Transfer Protocol [FTP]). 4.6.5

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6 Explain Transmission Control Protocol/Internet Protocol (TCP/IP) protocol details (e.g., Internet addresses, Address Resolution Protocol [ARP], Reverse Address Resolution Protocol [RARP], IP datagram format, routing IP datagrams, TCP segment format, IPv4, IPv6). 4.6.6

7 Describe a Virtual Private Network (VPN) and identify associated protocols (e.g., Layer 2 Tunneling Protocol [L2TP], Point-to-Point Tunneling Protocol [PPTP]). 4.6.7

8 Capture and analyze data packets. 4.6.8

7 Transmission Control Protocol/Internet Protocol (TCP/IP): Describe IP addressing schemes and create subnet masks. 4.7

1 Explain Fully Qualified Domain Names (FQDNs) and how they are used. 4.7.1

2 Explain the IP addressing scheme and how it is used. 4.7.2

3 Identify Class A, B, and C reserved (i.e., private) address ranges and why they are used. 4.7.3

4 Identify the class of network to which a given address belongs. 4.7.4

5 Differentiate between default subnet masks and custom subnet masks. 4.7.5

6 Explain the relationship between an IP address and its associated subnet mask. 4.7.6

7 Identify the differences between classful and classless addressing schemes. 4.7.7

8 Identify multicasting addresses and explain why they are used. 4.7.8

9 Create custom subnet masks to meet network design requirements. 4.7.9

10 Compare Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6). 4.7.10

8 Network Architecture: Describe network architecture. 4.8

1 Describe media-access protocols (e.g., Carrier Sense Multiple Access with Collision Detection [CSMA/CD], Carrier Sense Multiple Access with Collision Avoidance [CSMA/CA]). 4.8.1

2 Identify the components and relationships within the Institute of Electrical and Electronics Engineers (IEEE) 802 standards. 4.8.2

3 Identify Local Area Network (LAN) performance factors (e.g., signal attenuation, signal propagation delay). 4.8.3

4 Explain the role of the Internet Engineering Task Force (IETF) in facilitating protocol development. 4.8.4

5 Implement and maintain Virtual Local Area Networks (VLANs). 4.8.5

9 Network Operating Systems: Describe and install network operating systems (OSs). 4.9

1 Explain how the components of a network operating system (i.e., server platform, network services software, network redirection software, communications software) support network operations. 4.9.1

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2 Identify licensing requirements. 4.9.2

3 Describe the characteristics of the tiered model (e.g., peer-to-peer, thin client, thick client, cloud). 4.9.3

4 Analyze the advantages and disadvantages of the client/server model. 4.9.4

5 Select network, desktop, and mobile Operating Systems. 4.9.5

6 Install, test, and patch network Operating Systems manually and using automation. 4.9.6

7 Log in to a network device (e.g., router, Secure File Transfer Protocol [SFTP] server, directory server). 4.9.7

8 Evaluate the performance of the network Operating System. 4.9.8

---

10 Network Administration: Administer network operating systems and services. 4.10

1 Select physical and logical topology. 4.10.1

2 Connect devices to network systems. 4.10.2

3 Create domain trusts. 4.10.3

4 Maintain domain controllers. 4.10.4

5 Create user accounts, groups, and login scripts. 4.10.5

6 Establish shared network resources. 4.10.6

7 Define and set access controls on files, folders, shares, and directories. 4.10.7

8 Configure network domain accounts and profiles. 4.10.8

9 Create roaming user profiles and use Group Policy Objects (GPO) to manage the user environment. 4.10.9

10 Troubleshoot network performance connectivity (e.g., performance monitor, command line utilities). 4.10.10

11 Explain the fundamentals of Quality of Service (QoS). 4.10.11

12 Securely delegate standard management tasks. 4.10.12

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11 Cloud Computing: Implement a hypervisor. 4.11

1 Differentiate between public, private, and hybrid clouds and describe the fundamental cloud components (e.g., shared or dedicated processing, storage, memory, networking, hypervisor). 4.11.1

2 Provision cloud services (e.g., Software as a Service [SaaS], Platform as a Service [PaaS], Infrastructure as a Service [IaaS], Security as a Service). 4.11.2

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12 Wide Area Network: Design a wide area network (WAN). 4.12

1 Select Wide Area Network (WAN) connections (e.g., satellite, broadband, lease line, cellular, Multiprotocol Label Switching [MPLS], SD-WAN, Asynchronous Transfer Mode [ATM]). 4.12.1

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2 Describe point-to-point (PTP) and point-to-multipoint (PTMP) interconnection. 4.12.2

3 Evaluate and select basic telecommunications services (e.g., satellite, circuit switching, wireless, packet switching) and carriers for WAN requirements. 4.12.3

4 Identify advantages to a software defined WAN (SD-WAN). 4.12.4

5 Determine availability from Local Area Network (LAN) to meet WAN requirements. 4.12.5

6 Determine the speed needed between sites to access applications. 4.12.6

7 Determine the subnets needed on the WAN (e.g., Variable Length Subnet Masking [VLSM]). 4.12.7

8 Evaluate and select transmission options. 4.12.8

9 Evaluate and select routing protocols (e.g., Border Gateway Routing Protocol [BGRP], Open Shortest Path First [OSPF], Routing Information Protocol Version 2 [RIPv2]). 4.12.9

10 Implement and maintain routing tables (e.g., static, default and dynamic routes). 4.12.10

11 Implement and maintain Network Address Translation (NAT) and Port Address Translation (PAT). 4.12.11

13 Disaster Recovery Recommend disaster recovery and business continuity plans. 4.13

1 Differentiate between disaster recovery and business continuity. 4.13.1

2 Identify common backup devices. 4.13.2

3 Identify the criteria for selecting a backup system. 4.13.3

4 Establish a process for archiving files. 4.13.4

5 Develop a disaster recovery plan. 4.13.5

Programming and Software Systems Learners apply principles of computer programming and software development to develop code; build, test, and debug programs; create finished products; and plan, analyze, design, develop, implement, and support software applications. 5

1 Programming Concepts: Describe programming concepts. 5.1

1 Describe how computer programs and scripts can be used to solve problems (e.g., desktop, mobile, enterprise). 5.1.1

2 Explain how algorithms and data structures are used in information processing. 5.1.2

3 Model the solution using both graphic tools (e.g., flowcharts) and pseudocode techniques. 5.1.3

4 Describe, compare, and contrast the basics of procedural, structured, object-oriented (OO), and event-driven programming. 5.1.4

5 Describe the concepts of data management through programming languages. 5.1.5

Analyze the strengths and weaknesses of different languages for solving a specific problem. 5.1.6

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7 Compare the functions and operations of compilers and interpreters. 5.1.7

8 Describe version control and the relevance of documentation. 5.1.8

2 Computational and String Operations: Develop code that performs computational and string operations. 5.2

1 Compare primitive types of numeric and nonnumeric data (e.g., integers, floats, Boolean, strings). 5.2.1

2 Identify the scope of data (e.g., global versus local, variables, constants, arrays). 5.2.2

3 Write code that uses arithmetic operations. 5.2.3

4 Write code that uses subtotals and final totals. 5.2.4

5 Write code that applies string operations (e.g., concatenation, pattern matching, substring). 5.2.5

3 Logical Operations and Control Structures: Develop code that uses logical operations and control structures. 5.3

1 Explain Boolean logic. 5.3.1

2 Solve a truth table. 5.3.2

3 Write code that uses logical operators (e.g., and, or, not). 5.3.3

4 Write code that uses relational operators and compound conditions. 5.3.4

5 Write code that uses conditional control structures (e.g., if, if-then-else). 5.3.5

6 Write code that uses repetition control structures (e.g., while, for). 5.3.6

7 Write code that uses selection control structures (e.g., case, switch). 5.3.7

8 Write code that uses nested structures and recursion. 5.3.8

9 Write code that creates and calls functions. 5.3.9

10 Code error handling techniques. 5.3.10

11 Write code to access data repositories. 5.3.11

12 Write code to create classes, objects, and methods. 5.3.12

4 Integrated Development Environment: Build and test a program using an integrated development environment (IDE). 5.4

1 Configure options, preferences, and tools. 5.4.1

2 Write and edit code in the integrated development environment (IDE). 5.4.2

3 Compile or interpret a working program. 5.4.3

4 Define test cases. 5.4.4

5 Test the program using defined test cases. 5.4.5

6 Correct syntax and runtime errors. 5.4.6

7 Debug logic errors. 5.4.7

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5 **Programming Conventions: Develop programs using applications security practices.** 5.5

1 Develop programs using data validation techniques. 5.5.1

2 Develop programs that use reuse libraries. 5.5.2

3 Develop programs using operating system calls. 5.5.3

4 Develop programs that call other programs. 5.5.4

5 Use appropriate naming conventions and apply comments. 5.5.5

6 Format output (e.g., desktop, mobile, enterprise, reports, data files). 5.5.6

6 **Software Development Lifecycle: Apply the software development lifecycle (SDLC).** 5.6

1 Determine requirements specification documentation. 5.6.1

2 Identify constraints and system processing requirements. 5.6.2

3 Develop and adhere to timelines. 5.6.3

4 Identify a programming language, framework, and an integrated development environment (IDE). 5.6.4

5 Identify input and output (I/O) requirements. 5.6.5

6 Design system inputs, outputs, and processes. 5.6.6

7 Document a design using the appropriate tools (e.g., program flowchart, dataflow diagrams, Unified Modeling Language [UML]). 5.6.7

8 Create documentation (e.g., implementation plan, contingency plan, data dictionary, user help). 5.6.8

9 Review the design (e.g., peer walkthrough). 5.6.9

10 Present the system design to stakeholders. 5.6.10

11 Develop the application. 5.6.11

12 Compare and contrast software methodologies (e.g., agile, waterfall). 5.6.12

13 Perform code reviews (e.g., peer walkthrough, static analysis). 5.6.13

14 Ensure code quality by testing and debugging the application (e.g., system testing, user acceptance testing). 5.6.14

15 Train stakeholders. 5.6.15

16 Deploy the application. 5.6.16

17 Collect application feedback and maintain the application. 5.6.17

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7 **Configuration/Change Management: Describe configuration management activities.** 5.7

1 Explain version management and interface control. 5.7.1

2 Explain baseline and software lifecycle phases. 5.7.2

3 Analyze the impact of changes. 5.7.3

Web Development: Learners apply principles of design and technology, including programming standards and protocols, to create, test, host, and maintain web pages and websites with text, graphics, multimedia, scripting, linking, and data integration in a structure that is easy to navigate and accessible for all users via a variety of hardware and software platforms. 6

1 **Web pages: Create basic web pages.** 6.1

1 Describe the basic principles of Hypertext Markup Language (HTML) and its functional relationship with web browsers. 6.1.1

2 Plan a web page considering subject, devices, audience, layout, color, links, graphics, and Americans with Disabilities Act (ADA) requirements. 6.1.2

3 Format the text of a web page in a WYSIWYG (What You See Is What You Get) editor and in a text editor using HTML formatting tags (e.g., hyperlink, e-mail, table formatting, graphic attributes). 6.1.3

4 Use writing process techniques (i.e., drafting, revising, editing, proofreading) to check the web page for format and text accuracy. 6.1.4

5 Create and format ordered and unordered lists on a web page using HTML list formatting tags. 6.1.5

6 Create and format a table in a web page using HTML table formatting tags and attributes. 6.1.6

7 Integrate styles (e.g., inline or external Cascading Style Sheets [CSS]). 6.1.7

2 **Links and Multimedia: Add links to a web page and insert multimedia files.** 6.2

1 Create absolute links and relative links. 6.2.1

2 Write a Hypertext Markup Language (HTML) anchor that links to another section of the same web page. 6.2.2

3 Create hyperlinks that send e-mail messages and download files. 6.2.3

4 Insert image and wrap text around the image using Cascading Style Sheets (CSS). 6.2.4

5 Resize a graphic image in a web page using CSS. 6.2.5

6 Insert media files (e.g., audio, video,) into a web page using HTML tags. 6.2.6

7 Build a hover or mouseover effect to change the style of a link. 6.2.7

3 **Scripting: Integrate scripting into a web page.** 6.3

1 Select and apply scripting languages used in web development. 6.3.1

2 Insert client-side script into a web page. 6.3.2

3 Insert comments into client-side scripts. 6.3.3

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Web Forms: Integrate forms into a web page. 6.4

1 Design a data entry form from specifications that will accept a variety of user inputs (e.g., radio buttons, text entry fields, check boxes, drop-down menus). 6.4.1

2 Write the Hypertext Markup Language (HTML) code to add a form to a web page. 6.4.2

3 Write the HTML code to add text entry fields, radio buttons, check boxes, drop-down menus, and other user inputs to a form. 6.4.3

4 Explain the concept of a form action. 6.4.4

5 Write the HTML code to add a working button (e.g., submit, reset) to a form. 6.4.5

6 Format a completed form using HTML and Cascading Style Sheets (CSS) (e.g., fieldset, tabindex). 6.4.6

7 Code scripting to interact with data sources (e.g., database, web services). 6.4.7

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5 Websites: Create and update a website. 6.5

1 Implement web programming standards and protocols (e.g., World Wide Web Consortium [W3C], Hypertext Markup Language [HTML] 5). 6.5.1

2 Plan a website's structure for navigation and usability. 6.5.2

3 Use standard web programming languages (e.g., markup, scripting languages) in website development. 6.5.3

4 Install and configure a content management system (CMS). 6.5.4

5 Select an integrated development environment (IDE). 6.5.5

6 Create and edit a web page template. 6.5.6

7 Create and attach Cascading Style Sheets (CSS). 6.5.7

8 Format website layout (e.g., targeted platforms, text formatting, background color, text, tables, lists, iframes). 6.5.8

9 Incorporate audio and video, forms, and links on a website. 6.5.9

10 Develop and execute usability tests on a completed website, checking for information accessibility, ease of use, and navigation. 6.5.10

11 Code a website for cross-platform and cross-browser compatibility and validation. 6.5.11

12 Publish the completed website to a web server. 6.5.12

13 Integrate responsive design into web development. 6.5.13

14 Incorporate Search Engine Optimization (SEO) into webpages. 6.5.14

Digital Media: Learners apply principles of digital media to produce interactive media; develop and produce mu ap typography into media;

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1 Interactive Media: Describe and explain interactive media and interactive media production. 7.1

1 Identify the types and uses of interactive media environments (e.g., web-based, kiosks, games, mobile devices, video, print). 7.1.1

Describe the components of interactive media. 7.1.2

Identify the major characteristics of interactive media presentations. 7.1.3

create 3D models and 2D and 3D animation; and create digital video, audio, and photographs. 7

4 Identify important historical developments and future trends in interactive media. 7.1.4

5 Identify the major interactive media genres. 7.1.5

6 Perform critical review of interactive media products in different genres. 7.1.6

7 Identify the intellectual property rights, responsibilities, and controls related to interactive media. 7.1.7

8 Analyze the social and cultural implications of interactive media. 7.1.8

9 Identify major applications for interactive media (e.g., sales and marketing, interactive advertising, education, corporate training, corporate communications, distance learning, news, entertainment). 7.1.9

10 Identify specific uses for interactive media in each potential market. 7.1.10

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2 Multimedia Tools: Develop navigational structures, scripts, storyboards, and flowcharts for multimedia applications. 7.2

1 Choose a navigational menu structure (e.g., rollovers, drop-downs, disjointed). 7.2.1

2 Construct and place navigational units. 7.2.2

3 Build in interactive elements. 7.2.3

4 Determine uses and needs for site maps, multimedia scripts, storyboards, and flowcharts. 7.2.4

5 Make preliminary sketches showing placement of images and text on screen. 7.2.5

6 Place buttons and navigational graphics. 7.2.6

7 Select colors based on color theory and psychology. 7.2.7

8 Describe music, video, and special effects to be used. 7.2.8

9 Provide a sample layout to stakeholders for review. 7.2.9

10 Select and create visual design elements appropriate for the intended audience and use. 7.2.10

11 Develop characters and narrative to support intended outcomes. 7.2.11

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3 Production: Produce interactive media. 7.3

1 Select the media elements to be used (e.g., sound, video, graphics, text, animation). 7.3.1

2 Generate text for multi-image presentations (e.g., title graphics, charts, graphs). 7.3.2

3 Incorporate graphics (e.g., digital, hand-drawn, photographic). 7.3.3

4 Incorporate computer animation. 7.3.4

5 Prepare and integrate photographic images and special effects with graphic images. 7.3.5

Incorporate video footage. 7.3.6

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7 Edit video footage. 7.3.7

8 Record and/or acquire sound tracks (e.g., narrative, voiceover, sound effects, music). 7.3.8

9 Integrate sound with visuals. 7.3.9

10 Produce, test, debug, and archive a final product. 7.3.10

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4 Graphics: Construct and manipulate digital graphics. 7.4

1 Identify the purpose and intended audience of graphics. 7.4.1

2 Select color, shape, size, and texture of objects. 7.4.2

3 Create or acquire graphics. 7.4.3

4 Manipulate and layer objects. 7.4.4

5 Differentiate between vector and raster graphics. 7.4.5

6 Select an appropriate graphic file format and resolution. 7.4.6

7 Optimize and export graphics files for intended use. 7.4.7

8 Select graphic software applications. 7.4.8

9 Manipulate graphic objects. 7.4.9

10 Compress and decompress graphic files. 7.4.10

11 Describe and select color profiles (e.g., Red Green Blue [RGB], Cyan Magenta Yellow Key [CMYK], Pantone). 7.4.11

---

5 Typography: Integrate typography in media. 7.5

1 Identify typographic measurements (e.g., picas, points, pixels, ems). 7.5.1

2 Mix families of type within a project. 7.5.2

3 Select appropriate kerning, leading, tracking, and other related formatting. 7.5.3

4 Identify appropriate typefaces (e.g., serif, sans serif, Web Safe, screen, print). 7.5.4

5 Prepare a type style guide. 7.5.5

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6 Animation: Create 2D and 3D and virtual animation. 7.6

1 Develop a plan and storyboard for an animation. 7.6.1

2 Import 2D, 3D, and virtual assets. 7.6.2

3 Create key frames and apply tweens and paths. 7.6.3

4 Create special effects and virtual navigation. 7.6.4

5 Create 2D, 3D, and virtual environments. 7.6.5

6 Render and export animations. 7.6.6

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7 Video: Create a video production. 7.7

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Identify equipment and other production needs (e.g. drone, stop action, Digital Single Lens Reflex (DSLR), and 360 cameras). 7.7.1

2 Analyze the script and storyboard to develop a production schedule. 7.7.2

3 Set up audio, lighting, and scenery for the shoot. 7.7.3

4 Select a video recording format and shoot the video. 7.7.4

5 Select a linear or nonlinear editing system and edit the video. 7.7.5

6 Add transitions (e.g., dissolves, wipes, cuts), titles, special effects, and digital effects. 7.7.6

7 Add a sound track, narration, and/or voiceover. 7.7.7

8 Export video to the desired medium. 7.7.8

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8 Audio: Create an audio production. 7.8

1 Evaluate performance needs and technical resources. 7.8.1

2 Identify sound requirements based on script analysis. 7.8.2

3 Design score appropriate to production and post-production needs. 7.8.3

4 Determine microphone and speaker placement. 7.8.4

6 Set up and operate audio-for-video recording devices. 7.8.6

5 Select and incorporate Foley mechanical and electrical sound effects. 7.8.5

7 Set up and operate a time code system for audio/video synchronization. 7.8.7

8 Perform audio mixing. 7.8.8

9 Operate a sound mixing board during production. 7.8.9

---

9 Photographs: Create photographs. 7.9

1 Select and set up lighting needed (e.g., electronic flash units, reflectors, bounce, spot, daylight). 7.9.1

2 Select a digital file format or film format and camera. 7.9.2

3 Select and attach lenses (e.g., wide-angle, telephoto, zoom) and filters (e.g., color-compensating, polarizing, special effects). 7.9.3

4 Determine composition, formal qualities, scale, and use of space. 7.9.4

5 Use International Standards Organization (ISO), shutter speed, aperture, and white balance settings to shoot manual photographs. 7.9.5

6 Edit photographs (e.g., color corrections, cropping, enhancements). 7.9.6

Databases: Learners apply principles of designing, creating, and maintaining databases, including data storage, retrieval, modeling, manipulation, and for ac

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1 Data Modeling: Develop a data model to describe an application's data. 8.1

1 Develop specifications for a database in consultation with the client. 8.1.1

2 Identify the real-world entities (e.g., customers, purchases) to put in a table and the attributes of the entities (e.g., customer names and addresses, purchase dates and amounts). 8.1.2

Identify the relationships between database entities. 8.1.3

and administration; and database hardware and software issues. 8

4 Determine the data types (e.g., text, numbers) and domains (e.g., number greater than zero, text string of two letters) of attributes. 8.1.4

5 Determine whether attributes allow for a null value. 8.1.5

6 Determine unique identifiers (i.e., keys) of entities. 8.1.6

7 Normalize the data model as appropriate for the application. 8.1.7

8 Generate data modeling documentation (e.g., entity-relationship, workflow, Unified Modeling Language [UML]). 8.1.8

9 Verify that the data model matches specifications. 8.1.9

---

2 Design and Creation: Design and create databases. 8.2

1 Design and create database tables and relationships. 8.2.1

2 Create database columns and specify properties (e.g., name, type, domain). 8.2.2

3 Name tables and fields in conformance with naming conventions. 8.2.3

4 Define indexes as appropriate for the application. 8.2.4

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3 Data Entry and Access: Enter and access data in databases. 8.3

1 Insert, update, and delete records. 8.3.1

2 Enter and bulk import data into databases and transfer data between databases. 8.3.2

3 Write Structured Query Language (SQL) scripts and stored procedures. 8.3.3

4 Retrieve, filter, sort, and parse data. 8.3.4

5 Commit and roll back transactions. 8.3.5

6 Generate and print forms, reports, and results of queries (e.g., calculated fields, functions). 8.3.6

---

4 Database Management: Manage databases. 8.4

1 House database files in an environment appropriate to anticipated user demand. 8.4.1

2 Control user access to data. 8.4.2

3 Log access to the database by user and type of transaction. 8.4.3

4 Backup, verify, and recover data. 8.4.4

Cybersecurity: Learners apply principles of Cybersecurity to secure and defend information technology systems, selection and implementation of me se

1 Cybersecurity: Examine and employ principles of Cybersecurity. 9.1

1 Identify the goals, objectives and purposes of cybersecurity. 9.1.1

2 Describe the concepts of malware attack vectors. 9.1.2

3 Maintain data security using data labeling, handling and, disposal as prescribed by policy and law. 9.1.3

Mitigate threats by remaining abreast of industry information. 9.1.4

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digital assets, mange threats, deploy countermeasures, and establish strategies to protect business information using risk and incident management. 9

5 Identify types of controls (e.g., Deterrent, Preventive, Detective, Compensating, Technical, and Administrative). 9.1.5

6 Manage physical and digital assets. 9.1.6

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2 Access Control and Asset Security: Apply identification (ID), authorization, and physical asset security. 9.2

1 Perform authorization control (e.g., least privilege, separation of duties, mandatory access, discretionary access, rule-based access control, role-based access control, time of day restrictions, location distractions). 9.2.1

2 Implement authentication techniques (e.g., Tokens, Common access card, Smart card, Multifactor authentication, Single sign-on, Biometrics, Personal identification verification card, Username, Federation, Transitive trust/authentication). 9.2.2

3 Use authentication factors (e.g., Something you are, Something you have, Something you know). 9.2.3

4 Mitigate security implications of third party connectivity and access. 9.2.4

5 Implement Data Loss Prevention (DLP). 9.2.5

6 Implement perimeter security (e.g., Fencing, Proximity readers, Access list, Proper lighting, Mantraps, Video Surveillance, Signs, Guards, Barricades, Biometrics, Protected distribution (cabling), Alarms, Motion detection). 9.2.6

7 Inventory devices. 9.2.7

---

3 Application Development Security: Develop and maintain application security. 9.3

1 Identify application vulnerabilities (e.g., Cross-site scripting, SQL injection, LDAP injection, XML injection, Directory traversal/command injection, Buffer overflow, Integer overflow, Zero-day, Cookies and attachments, Locally Shared Objects (LSOs), Flash cookies, Malicious add-ons, Session hijacking, Header manipulation, Arbitrary code execution/remote code execution). 9.3.1

2 Mitigate application attacks (e.g., SANS, OWASP). 9.3.2

3 Implement secure coding concepts (e.g., Error and exception handling, Input validation, Cross-site scripting prevention, Cross-site Request Forgery, (XSRF) prevention, OWASP). 9.3.3

4 Implement secure application configuration (e.g., Application hardening, Application patch management). 9.3.4

5 Discover and mitigate common database vulnerabilities and attacks. 9.3.5

6 Differentiate between Server-side vs. client-side validation. 9.3.6

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4 Setup a Secure Network: Setup and maintain network security. 9.4

1 Setup and maintain secure roles and system management techniques (e.g., password, group, and user privilege policies and monitoring). 9.4.1

Secure use of network Protocols (e.g., IPSec, SNMP, SSH, DNS, TLS, SSL, TCP/IP, FTPS, HTTPS, SCP, ICMP). 9.4.2

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3 Apply principles of IPv4 and IPv6 securely. 9.4.3

4 Apply wireless security configurations (e.g., Disable SSID broadcast, TKIP, CCMP, Antenna placement, Power level controls). 9.4.4

5 Manage PKI and certificates (Transport encryption, Non-repudiation, Hashing, Key escrow, Steganography, Digital signatures). 9.4.5

6 Use of algorithms/protocols with transport encryption (e.g., SSL, TLS, IPSec, SSH, HTTPS). 9.4.6

7 Install and configure network devices (firewalls, switches, load balancers, proxies, web security gateways, VPN concentrators). 9.4.7

8 Install and configure network security devices. (Protocol analyzers, Spam filter, UTM security appliances, URL filter, Content inspection, Malware inspection). 9.4.8

9 Implement port security. 9.4.9

10 Monitor and manage network Unified Threat Management. 9.4.10

11 Mitigate network threats (e.g., Flood guards, Loop protection, Implicit deny, Network separation, Log analysis, Unified threat management, peripheral and removable media). 9.4.11

12 Apply the principles of secure Network Design (e.g., DMZ, Subnetting, NAT/PAT, Remote access, Telephony, Virtualization). 9.4.12

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5 Threat Management: Mitigate common threats. 9.5

1 Describe, locate, and mitigate security threats (e.g., Adware, Viruses, Spyware, Trojan, Rootkits, Logic bomb, Botnets, Ransomware, Polymorphic malware). 9.5.1

2 Describe and discover vulnerabilities to and mitigate network attacks. (e.g., Man-inthe-middle, DDoS, DoS, Replay, Smurf attack, Spoofing, Spam, Phishing, Spim, Spit and other attacks). 9.5.2

3 Configure defenses for Password attacks (e.g., Brute Force, Dictionary attacks, Hybrid, Birthday attacks, Rainbow tables). 9.5.3

4 Describe, appraise for, and mitigate Social Engineering attacks (e.g., Shoulder surfing, Dumpster diving, Tailgating, Impersonation, Hoaxes, Phishing, Spear Phishing, Whaling, Vishing, Principles, URL hijacking, Watering Hole). 9.5.4

5 Perform penetration testing. 9.5.5

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6 Cybersecurity Law: Adhere to Cybersecurity laws. 9.6

1 Adhere to licensing and intellectual property laws (e.g., copyright, trademark, digital rights management). 9.6.1

2 Adhere to regulatory and industry standards (e.g., PCIDSS, PADSS). 9.6.2

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7 Digital Forensics: Capture and analyze information using digital tools. 9.7

1 Recognize digital reconnaissance techniques (e.g., packet capture, OS fingerprinting, topology discovery, DNS harvesting). 9.7.1

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Use tools and procedures for digital reconnaissance (e.g., host scanning, network mapping, NMAP, packet analyzer, vulnerability scanner). 9.7.2

3 Analyze reconnaissance results (data correlation, data analytics, point-in-time, data logs, packet captures). 9.7.3

4 Collect digital evidence according to established policies and protocols (e.g., system image, packet captures). 9.7.4

5 Maintain chain of custody on evidence. 9.7.5

6 Generate file hash. 9.7.6

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8 Countermeasures: Use countermeasures to monitor systems and reduce risk. 9.8

1 Design and implement network segmentation. 9.8.1

2 Differentiate between detection controls and prevention controls (e.g., IDS vs. IPS, Camera vs. guard). 9.8.2

3 Use discovery tools and utilities to identify threats (e.g., Protocol analyzer, Vulnerability scanner, Honeypots, Honeynets, Port scanner). 9.8.3

4 Create, edit and use roles and system management tools. 9.8.4

5 Implement endpoint security. 9.8.5

6 Implement Access Control Lists (ACL). 9.8.6

7 Deploy a server hardening plan. 9.8.7

8 Implement a Network Access Control (NAC) plan. 9.8.8

9 Interpret alarms and alert trends. 9.8.9

10 Apply Incident response procedures (e.g., Preparation, Incident identification, Escalation and notification, Mitigation steps, Lessons learned, Reporting, Recovery procedures, First responder, Incident isolation, Quarantine, Device removal, Data breach). 9.8.10

11 Differentiate between types of Penetration testing (e.g., Black box, White box, Gray box). 9.8.11

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9 Disaster Recovery and Business Continuity: Apply fundamentals of disaster recovery and business continuity. 9.9

1 Describe the concepts of Risk Management (e.g., Business continuity concepts, Business impact analysis, Identification of critical systems and components, Removing single points of failure). 9.9.1

2 Describe the concepts of Risk assessment (e.g., Disaster recovery plan, IT contingency planning - Succession planning, Redundancy). 9.9.2

3 Describe and plan Fault tolerance (e.g., Hardware, RAID, Clustering, Load balancing, Disaster recovery concepts, Backup plans/policies, Backup execution/frequency). 9.9.3

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10 Risk Management: Apply concepts of risk management. 9.10

1 Enforce concepts related to threat vectors and probability/threat likelihood. 9.10.1

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2 Identify concepts of risk calculation (Likelihood, ALE, Impact, SLE, ARO, MTTR, MTTF, MTBF). 9.10.2

3 Implement Governance, risk management and Compliance Management processes (risk mitigation, govern compliance). 9.10.3