Massachusetts Department of Elementary & Secondary Education
Office for College, Career and Technical Education

Vocational Technical Education Framework

Information Technology Services Occupational Cluster

Information Support Services & Networking

CIP Code 110401

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Massachusetts Department of Elementary and Secondary Education
Office for College, Career, and Technical Education
75 Pleasant Street, Malden, MA 02148-4906
781-338-3910
www.doe.mass.edu/ccte/cvte/

ISSN IRCs

Industry Recognized Credentials (IRCs)

An **Industry Recognized Credential** is verification of an individual's qualification or competence. An authoritative third party issues the credential. **IRCs** are valued in the labor market and are a validation of an individual's knowledge and skill. Industry-recognized credentials are accepted by multiple employers across an industry. They are often endorsed by recognized trade associations or organizations representing a significant part of an industry or sector. IRCs are identified as either **"Essential"** or **"Optional"**.

Essential Credential
Each program has at least one essential safety credential and one industry-specific credential that have been identified as valuable statewide within a field. These credentials should be reported as part of Student Information Management System (SIMS) reporting. All programs must ensure that adequate time and resources are available for students to be instructed in the standards necessary to be prepared for the credential assessment and provide opportunities for students to obtain these certifications.

Optional Credential
Programs may choose to differentiate and **expand** upon their program by offering additional credentials. These may highlight local/regional demand within a field. Optional Credentials should be reported in SIMS only after any achieved essential credentials.

Framework Specific Industry Recognized Credentials

Essential Safety Credential

Credential Name	Offered By
OSHA 10 General	OSHA
ISAFE (Internet/Computer Safety Certification)	ISAFE

Essential Industry Credentials

Select two:

Credential Name	Offered By
CompTIA IT Fundamentals (Previously STRATA)	Pearson VUE
TestOut PC Pro (A+)	TestOut
Certiport IT Specialist Networking	Pearson VUE
Certiport IT Specialist Device Configuration and Management	Pearson VUE

Optional Credentials

Credential Name	Offered By
AWS Fundamentals (Amazon Web Services)	Amazon Web Service
Azure Fundamentals (AZ900)	Azure
Certiport IC3--Internet and Computing Core Certification	Pearson VUE
Certiport IT Specialist Databases	Pearson VUE
Certiport IT Specialist HTML and CSS	Pearson VUE
Certiport IT Specialist HTML5 Application Development	Pearson VUE

Certiport IT Specialist Java	Pearson VUE
Certiport IT Specialist JavaScript	Pearson VUE
Certiport IT Specialist Network Security	Pearson VUE
Certiport IT Specialist Python	Pearson VUE
Certiport IT Specialist Software Development	Pearson VUE
Cisco Certified CyberOps Associate	CISCO
Cisco Certified Network Associate (CCNA)	CISCO
CompTIA A+	Pearson VUE
CompTIA CASP+	Pearson VUE
CompTIA Cloud+	Pearson VUE
CompTIA CySA+	Pearson VUE
CompTIA Linux+	Pearson VUE
CompTIA Network +	Pearson VUE
CompTIA PenTest+	Pearson VUE
CompTIA Security +	Pearson VUE
CompTIA Server+	Pearson VUE
CyberArk Level One Trustee	CyberArk
Google Cloud Computing Services	Google
Google IT Support Professional Certificate	Coursera
Project Lead the Way CSA	PLW
Project Lead the Way CSE	PLW
Project Lead the Way CSP	PLW
Project Lead the Way Cybersecurity	PLW
TestOut Client Pro	TestOut
TestOut CyberDefense Pro	TestOut
TestOut Ethical Hacker Pro	TestOut
TestOut Linux Pro	TestOut
TestOut Network Pro (Net+)	TestOut
TestOut Routing and Switching Pro	TestOut
TestOut Security Pro (Security+)	TestOut
TestOut Server Pro (Install & Storage, Networking, and Identity)	TestOut

Strand 2: Technical Knowledge and Skills

2.A	**Information Support Services Safety Knowledge**
	Equipment Needed – See Addendum A
2.A.01	**Demonstrate appropriate use of safety procedures and tools.**
2.A.01.01	Explain the dangers of Electrostatic Discharge (ESD).
2.A.01.02	List the tools to protect against ESD.
2.A.01.03	Demonstrate appropriate use of ESD safety tools.
2.A.01.04	Implement personal safety and Occupational Safety and Health Administration (OSHA) guidelines.
	Performance Example:
	Students will demonstrate the appropriate use of ESD safety tools (ex: wrist strap, anti-static bags, and proper workspace) following safe handling and storage methods for computer components according to current industry and OSHA standards.
2.A.02	**Describe environmental impacts and the purpose of environmental controls.**
2.A.02.01	Use Material Safety Data Sheet (SDS) and manufacturer's recommendations for handling, protection and disposal of components and materials.
2.A.02.02	Monitor temperature, humidity level awareness and proper ventilation.
2.A.02.03	Identify devices and procedures to protect against power surges, brownouts, blackouts.
2.A.02.04	Demonstrate protection from airborne particles, dust and debris.
	Performance Example:
	Given a hazardous chemical such as isopropyl alcohol, students will research and print out SDS documentation and identify proper safety controls for handling, and storing the chemical.
2.B	**Trends in the Information Technology in the Workplace and Society**
	Equipment Needed – See Addendum A
2.B.01	**Describe the evolution of technology.**
2.B.01.01	Illustrate the information technology (IT) timeline (evolution).
2.B.01.02	Describe the impact of technologies on society.
2.B.01.03	Identify technologies and describe their uses in the workplace and society.
	Performance Example:

	Students will create an electronic presentation/timeline that shows the evolution of technology advancements in the IT field and how it has impacted society today. Students will create a tri-fold presentation of industry related certifications and highlight three different career pathways in the IT field. Students will research IT credentialing options. Students will choose a certification that interests them; then create a pathway for achieving this goal to place in their portfolio. Students will write an essay on, "What would the world be like today if computers didn't exist?" How would they spend their time? What would the work look like in the areas of communication, economy, education, family life, community? After choosing any occupation other than the IT field, students will research the types of technologies that are used in that field (not just computers per se). Students will present their findings in creative ways e.g. a recruitment program for a college or business, a website, a "day in the life," a story or a play. Students will research a company's usage of RSS feeds, Facebook, Twitter, and other types of social media. Create an electronic presentation or podcast highlighting the importance of interactive media on the chosen company/business.
2.B.02	**Describe the varied career paths in information technology.**
	Equipment Needed – See Addendum A
2.B.02.01	Identify and list professional certifications.
2.B.02.02	Identify and describe the various IT career paths.
2.C	**Operational Procedures**
	Equipment Needed – See Addendum A
2.C.01	**Practice proper communication and professionalism.**
2.C.01.01	Use proper language – avoid jargon, acronyms, and slang when applicable.
2.C.01.02	Set and meet expectations/timeline and communicate status with the customer.
2.C.01.03	Deal appropriately with customers concerning attitude, cultural sensitivity, punctuality, difficult situations and confidential materials.
	Performance Example:
	Given a network helpdesk support scenario, students will demonstrate appropriate communication and professionalism in email communication with the customer.
2.C.02	**Describe fundamentals of dealing with prohibited content/activity.**
2.C.02.01	Outline steps of first response identification, reporting and data preservation.
2.C.02.02	Explain use of documentation/documentation changes.
2.C.02.03	Describe the chain of custody process with regards to managing evidence.
	Performance Example:
	Students will create an electronic flowchart for handling digital evidence.
2.C.03	**Best Practices**
2.C.03.01	Compare and contrast documentation methods.
2.C.03.02	Implement basic change management best practices.
2.C.03.03	Implement basic disaster prevention and recovery methods.
	Performance Example:

	Given a scenario, students will be able to evaluate different networking mapping and topology software to diagram a small business network. Using a local or cloud-based software, students will be able to implement and manage an inventory management and ticketing system for a small business and support a ticket from creation to completion.
2.C.04	**Technology Policies and Ethics**
2.C.04.01	Explain the process of different licensing processes.
2.C.04.02	Demonstrate ethical practices with customer information.
2.C.04.03	Adhere to regulated policies and procedures.
	Performance Example:
	Given a scenario of a security incident, students will be able to develop a plan including incident response, path of escalation and chain of custody.
2.C.05	**Communication and Professionalism**
2.C.05.01	Use proper language and avoid jargon, acronyms, and slang, when applicable.
2.C.05.02	Demonstrate how to deal with customers in different situations.
2.C.05.03	Set and meet expectations/timeline and communicate status with the customer.
2.C.05.04	Deal appropriately with customers' confidential and private materials.
	Performance Example:
	Given a remote support scenario, students will be able to effectively communicate with a disgruntled customer on a computer issue.
2.D	**Computer Hardware**
	Equipment Needed – See Addendum A
2.D.01	**Explain basic cable types, features, and their purposes.**
2.D.01.01	Identify network cable and connector types.
2.D.01.02	Identify video cable and connector types.
2.D.01.03	Identify peripheral cable and connector types.
2.D.01.04	Identify storage cable and connector types.
2.D.01.05	Identify multipurpose cable and connector types.
	Performance Example:
	Given a scenario, students will differentiate between different video cables and their intended purpose. Given a scenario, students will identify a multipurpose cable, manufacturer, properties and purpose.
2.D.02	**Identify and install Random Access Memory (RAM) types.**
2.D.02.01	Identify and select appropriate RAM types.
2.D.02.02	Describe and distinguish different RAM configuration properties.
2.D.02.03	Install and test various RAM types.
	Performance Example:
	Given a motherboard, students will create a drawing that accurately illustrates the motherboard and label and briefly describe all of the components. Given a scenario, students will troubleshoot and test system RAM configuration.
2.D.03	**Identify Storage Devices and Media.**

2.D.03.01	Identify and select, and install appropriate Storage Devices.
2.D.03.02	Describe and distinguish different storage device properties (speed, size, type).
2.D.03.03	Identify and select, and install appropriate removable media devices.
2.D.03.04	Describe hardware/software Redundant Array of Independent Disk (RAID) types.
	Performance Example:
	Given a scenario, install and configure appropriate storage devices, such as Optical, Solid State, Magnetic and Flash Drives. Given a scenario, students will install, configure and test a digital video disc-rewritable (DVD-RW) optical drive. Given a scenario, students will install and configure a primary and secondary Serial Advanced Technology Attachment (SATA) hard disk drive in a computer. Given a scenario, students will install an external hard disk drive and generate a data backup.
2.D.04	**Motherboards and Expansion Cards**
2.D.04.01	Differentiate between different motherboard form factors
2.D.04.02	Explore and examine Basic Input/Output Systems (BIOS) and/or Unified Extensible Firmware Interface (UEFI) settings and features
2.D.04.03	Identify motherboard connector types
2.D.04.04	Identify and configure motherboard firmware settings
2.D.04.05	Identify types of expansion cards and explain their purpose
2.D.04.06	Configure and install appropriate expansion cards
	Performance Example:
	Given a scenario, students will install and configure motherboards, Central Processing Units (CPU), and add-on cards. Given a scenario, students will install and configure an expansion card such as a video card, sound card or Network Interface Card (NIC).
2.D.05	**CPUs and Cooling**
2.D.05.01	Differentiate among various Central Processing Unit (CPU) types and corresponding cooling devices.
2.D.05.02	List types and features of CPUs and their socket types.
2.D.05.03	Choose appropriate CPU for various motherboards.
2.D.05.04	Identify different system and CPU cooling types
2.D.05.05	Identify different system and CPU cooling types
	Performance Example:
	Given a scenario, students will create a chart that shows the differences between Intel processors and their Advanced Micro Devices (AMD) equivalent. Given a scenario, students will install a CPU on a motherboard; apply thermal paste and appropriate coolers.
2.D.06	**Power Supplies**
2.D.06.01	Determine power supply characteristics and specifications for types of voltage and power.

2.D.06.02	Select and install the proper power supply.
	Performance Example:
	Given a scenario, students will identify the different connectors on a power supply and list examples of their usage. Given scenario, students will install and verify functionality of a power supply in a computer chassis; connect power cables to corresponding motherboard and internal components.
2.D.07	**Peripheral Devices**
2.D.07.01	Explain the purpose, use and properties of various input and output peripheral devices.
2.D.07.02	Install and configure peripheral device
	Performance Example:
	Given a scenario, students will select, install and configure a given peripheral device.
2.D.08	**Printers**
2.D.08.01	Summarize the associated imaging process for each type of printer.
2.D.08.02	Install and configure various printers with appropriate cables and printer drivers.
2.D.08.03	Summarize printer types, installation and maintenance.
2.D.08.04	Perform printer maintenance.
	Performance Example:
	Given a scenario, students will install and test an all-in-one printer/scanner/copier with specified data cable and install accurate device drivers and software needed for full functionality.
2.D.09	**Develop customer specification and needs.**
2.D.09.01	Evaluate customer needs.
2.D.09.02	Select appropriate components and software for a customer configuration (i.e., CAD workstation, audio/video editing pc, home server, gaming pc, thin client).
	Performance Example:
	Given a variety of user types (gamer, video production, musician, etc.), students will specify a computer configuration that would fulfill the user's requirements.
2.D.10	**Evaluate characteristics of display devices.**
2.D.10.01	Identify different types of display devices, their connection types and cables.
2.D.10.02	Define refresh rates, resolution, native resolution, brightness/lumens.
2.D.10.03	Explain the use of analog vs. digital, privacy/antiglare filters and multiple displays.
	Performance Example:
	Given a scenario, students will install and configure multiple displays on a given workstation. Given a scenario, students will use the Microsoft DirectX Diagnostic Tool to analyze graphic display attributes of a system.
2.E	**Operating Systems**
	Equipment Needed – See Addendum A
2.E.01	**Desktop Operating Systems and Types**
2.E.01.01	Explain the purpose of an operating system.

2.E.01.02	Identify compatibility concerns between operating systems (Windows/ Mac/ Linux).
2.E.01.03	Compare and contrast specifications and limitations for 32-bit vs 64-bit operating systems.
2.E.01.04	Compare and contrast operating systems versions and features.
2.E.01.05	Explain and identify licensing, end of life and update limitations.
	Performance Example:
	Given a scenario, students will compare the pros and cons to using a Graphical User Interface (GUI) vs a Command Line Interface (CLI) operating system. Given the scenario, students will select an operating system that would be suitable for the hardware given.
2.E.02	**Installation and Upgrades**
2.E.02.01	Explain and implement various boot methods (imaging, multi, recovery).
2.E.02.02	Explain types of installation (clean install, upgrade, restore, unattended, repair, imaging and remote, GUID Partition Table (GPT)/Master Boot Record (MBR).
2.E.02.03	Explain and implement file system formatting.
2.E.02.04	Explain and perform different types of partitioning methods (volumes, system recovery).
2.E.02.05	Implement post installation procedures (time/date, driver installation, updates, domain configuration, security, etc.).
	Performance Example:
	Given a scenario, students will be able to partition, install and carry out post installation procedures in setting up a system for a user.
2.E.03	**Command Line Tools**
2.E.03.01	Explain how command line tools are used for diagnostics.
2.E.03.02	Describe and implement file management command line tools.
2.E.03.03	Explain and implement system management command line tools.
2.E.03.04	Describe and implement network management command line tools.
	Performance Example:
	Given a scenario, use the appropriate command line tools for network, system and file management. Given a scenario, use the ping tool to test network connectivity to a computer. Given a scenario, use diskpart to identify partitions on a physical disk. Given a scenario, use robocopy to copy files to a disk.
2.E.04	**Operating System Features and Tools**
2.E.04.01	Demonstrate the use of built-in Operating System (OS) features and tools (admin, disk management, run line commands) and how to access them through appropriate paths.
2.E.04.02	Explore different utilities within the administrative tools.
2.E.04.03	Explore different utilities within the system utilities.
2.E.04.04	Explore different utilities within disk management.
2.E.04.05	Explore different control panel applets and settings.
	Performance Example:

	Given a scenario, students will be able to create a user manual/ outline for the settings menu in windows. Given a scenario, students will use task manager to monitor disk utilization. Given a scenario, students will configure appropriate RAID features such as mirroring or spanning.
2.F	**Installing Applications**
	Equipment Needed – See Addendum A
2.F.01	**Summarize application installation and configuration concepts**
2.F.01.01	Research and understand hardware and operating system requirements.
2.F.01.02	Demonstrate methods of installation and deployment.
2.F.01.03	Understand open-source vs license-based software.
2.F.01.04	Install, configure, and utilize local and network applications.
2.F.01.05	Uninstall applications.
	Performance Example:
	Given a scenario, students will install/uninstall, configure and utilize local, remote or portable applications.
2.G	**Mobile Devices**
	Equipment Needed – See Addendum A
2.G.01	**Laptop's hardware, software, and features**
2.G.01.01	Install and configure laptop hardware and components
2.G.01.02	Install components within the display of a laptop
2.G.01.03	Configure appropriate laptop setting and features
	Performance Example:
	Given a scenario, students will be able to research and replace a laptop OEM keyboard. Given a scenario, students will be able to replace a WiFi antenna connector. Given a scenario, configure the laptop power settings.
2.G.02	**Various Types of Other Mobile Devices**
2.G.02.01	Compare and contrast characteristics of various types of other mobile devices.
2.G.02.02	Connect and configure accessories and ports of other mobile devices.
2.G.02.03	Configure basic mobile device network connectivity and application support.
2.G.02.04	Use various methods to perform mobile device synchronization.
	Performance Example:
	Given a scenario, students will be able to compare an Apple device to an Android device and its features in relation to a customer's needs. Given a scenario, configure a wireless accessory to a computer system. Given a scenario, students will be able to configure a POP3 email account on a user's mobile device. Given a scenario, students will be able to back up a user device to a cloud platform.
2.H.	**Networking**

	Equipment Needed – See Addendum A
2.H.01	**Compare the layers of the Open Systems Interconnection (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP) models**
2.H.01.01	Define the purpose of networking models.
2.H.01.02	Identify, describe and apply the layers of the OSI and TCP/IP model
2.H.01.03	Classify the differences between Layer applications, devices, and protocols as they relate to the OSI and TCP/IP models
	Performance Example:
	Performance Example: Students will create an electronic presentation/chart comparing the layers of the OSI to the TCP/IP models. Performance Example: In a chart, students will determine if the given device sample, protocol, PDU or application belongs to the associated layer of the OSI model.
2.H.02	**Compare and contrast Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) ports, protocols, and their purposes.**
2.H.02.01	Identify common Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) default ports.
2.H.02.02	Define common network protocols and their use of TCP or UDP
	Performance Example:
	Students will research the most common TCP and UDP ports and their associated applications and prepare a report summarizing their findings.
2.H.03	**Compare and contrast common networking hardware device's function and features.**
2.H.03.01	Differentiate the functionality of routers, switches, access points, cloud-based network controller, firewall, network interface card, repeater, hub, Cable/Digital Subscriber Line (DSL) modem, bridge, patch panel, Power over Ethernet (PoE), and powerline-Ethernet.
	Performance Example:
	Given a scenario, students will create an interactive presentation, podcast or Vlog that demonstrates the functionality and differences among hubs, switches, bridges, routers, firewalls, access points and modems.
2.H.04	**Compare and contrast wireless networking standards and encryption types.**
2.H.04.01	Categorize the various wireless standards, in terms of speeds, distances and frequencies.
2.H.04.02	Describe various wireless encryption types.
	Performance Example:
	Given a scenario, students will create a presentation comparing the various wireless standards for speed, distance limitations and frequencies. Given a network scenario, students will decide the appropriate wireless encryption type to satisfy customer specifications.
2.H.05	**Install, configure, and deploy a secure Small Office/Home Office (SOHO) wireless/wired network using best practices.**

2.H.05.01	Determine the hardware, software and infrastructure requirements for implementation.
2.H.05.02	Access and configure wireless/wired Integrated Services Router (ISR) for a basic SOHO network.
2.H.06	**Explain common network configuration concepts.**
2.H.06.01	Explain the purpose and properties of Internet Protocol (IP) addressing.
2.H.06.02	Differentiate the difference between multicast, unicast, and broadcast.
2.H.06.03	Configure IP address, subnet mask and default gateway on a network device.
2.H.06.04	Describe and prepare an IP addressing scheme using both Classful and a Classless Inter-domain Routing (CIDR)
2.H.06.05	Describe the differences between Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6)
2.H.06.06	Distinguish differences between IP Address types: static, dynamic using both Dynamic Host Configuration Protocol (DCHP) and Automatic Private IP Addressing (APIPA), public, private with use of Network Address Translation (NAT), and link-local addressing.
	Performance Example:
	Given a scenario, students will design an IP scheme for a network and identify the network, broadcast, and host address range for a network. Students will apply Classless Inter-Domain Routing (CIDR) and Variable-Length Subnet Masking (VLSM) rules to a large network. Students will subnet an IPv6 network.
2.H.07	**Summarize the properties and purposes of services provided by networked hosts. (Server)**
2.H.07.01	Identify Application Services
2.H.07.02	Understand File and Print Services
2.H.07.03	Understand Web Services
2.H.07.04	Understand Remote Access Services
2.H.07.05	Understand Server Virtualization
2.H.07.06	Understand various Internet Server Appliances (UTM, IDS, IPS)
	Performance Example:
	Given a scenario, students will configure a local computer for Dynamic Host Configuration Protocol (DHCP) for both wired and wireless adapter cards. Students will configure an Integrated Services Router (ISR) to be a DHCP server for 25 dynamic nodes (laptops, desktops) and create a reservation for 5 static nodes (printers/servers). Students will install a Domain Name System (DNS) service on a local server or virtual server. Using a WHOIS website, students will locate 10 different domains/websites and identify the DNS service. Students will record data related to the corresponding DNS service, records, and configuration. Students will record data related to the corresponding DNS service, records, and configuration.

2.H.08	**Compare and contrast Internet connection types, network types, topologies, and their features**
2.H.08.01	Differentiate among network types such as Local Area Network (LAN), Wide Area Network (WAN), Personal Area Network (PAN), Metropolitan Area Network (MAN), Wireless Local Area Network (WLAN), and Wireless Mesh Wireless Network (WMN).
2.H.08.02	Identify the Internet connection types such as cable, fiber, satellite, and cellular.
2.H.08.03	Describe Carrier-sense Multiple Access with Collision Detection (CSMA/CD) and Carrier-sense Multiple Access with Collision Avoidance (CSMA/CA).
2.H.08.04	Compare and contrast physical vs. logical topologies.
2.H.08.05	Describe ring, bus, star, extended star & mesh topologies.
2.H.08.06	Describe Peer-to-peer, Client-server, Hybrid, Point to point, Point to multipoint topologies.
2.H.08	**Performance Example:**
	Given a scenario, students will research current SOHO Internet service provider (ISP) options and compare student's home network contracts to current offerings. Using diagram software, students will diagram a network's physical and logical topology. While reading/reviewing a network diagram, students will determine how the network device handles a packet in a given scenario.
2.H.09	**Use appropriate networking tools.**
2.H.09.01	Understand and utilize the use of networking tools such as: crimper, cable stripper, multimeter, tone generator and probe, cable tester, punch down tool, WiFi analyzer
2.H.09.02	Install and terminate network cabling.
2.H.10	**Implement a Switched network**
2.H.10.01	Select the appropriate media, cables, ports, and connectors to connect switches to other network devices and hosts.
2.H.10.02	Explain the process of layer 2 encapsulation and Ethernet framing.
2.H.10.03	Explain how a switch builds its Media Access Control (MAC) address table and forwards frames.
2.H.10.04	Describe switch forward methods and port settings available on layer 2.
2.H.10.05	Access and utilize the switch command line interface (CLI) to set parameters and perform, save and verify initial switch configuration tasks such as SVI, passwords, and remote access management.
2.H.10.06	Verify network status and switch operation using CLI utilities.
2.H.10.07	Implement and verify security for a switch (port security, deactivate ports)
	Performance Example:
	Identify, prescribe, and resolve common switched network media issues, configuration issues, auto-negotiation, and switch hardware failures.
2.H.11	**Implement a routed network.**
2.H.11.01	Describe routing concepts (including: packet forwarding, router lookup process).
2.H.11.02	Describe the operation of routers (including: router bootup process, POST, router components).
2.H.11.04	Configure, verify, and troubleshoot Routing protocols.

2.H.11.05	Access and utilize the router command line interface (CLI) to set item such as advanced global parameters and ACL's.
2.H.11.06	Connect, configure, and verify operation status of router/layer 3 interfaces using both IPv4 and IPv6 addressing.
2.H.11.07	Enable NAT for a small network with a single ISP and verify operation using CLI and ping.
2.H.11.08	Configure, verify and troubleshoot Dynamic Host Configuration Protocol (DHCP) and Domain Name System (DNS) operation on a router.
2.H.11.09	Perform and verify routing configuration tasks for static routes.
2.H.11.10	Verify network status and router operation using CLI utilities.
2.H.11.11	Manage router operating system configuration files (including save, edit, upgrade, restore)
2.H.11.12	Implement password and physical security for a network router
2.H.12	**Implement and verify Wide Area Network (WAN) links**
2.H.12.01	Describe different methods for connecting to a WAN
2.H.12.02	Configure and verify a basic WAN serial connection
	Performance Example:
	Given a scenario, students will terminate and test Unshielded Twisted Pair (UTP) cables for straight -through and cross over configurations. Students will run UTP cable for a basic network data drop, terminate cable at the wall (RJ45 female) and patch panel termination points.
2.I	**Security**
	Equipment Needed – See Addendum A
2.I.01	**Summarize the importance of physical and logical security measures.**
2.I.01.01	Explain user education and the principle of least privilege.
2.I.01.02	Analyze physical security techniques.
2.I.01.03	Analyze logical security techniques.
	Performance Example:
	Given a scenario, students will install and test physical security measures on devices, including but not limited to biometric and hardware locks, badge card readers, USB and server locks. Students will install, configure and test logical security measures on devices, including but not limited to user authentication, ports, and anti-malware.
2.I.02	**Compare and contrast wireless security protocols and authentication methods.**
2.I.02.01	Analyze wireless security protocols, encryption and authentication methods.
	Performance Example:
	Given a scenario, students will research and configure the most current protocol, encryption and authentication methods including WPA-2, Multifactor Authentication and RADIUS.
2.I.03	**Compare and contrast social engineering, threats, and vulnerabilities.**
2.I.03.01	Differentiate between malware, rootkits, phishing, shoulder surfing, spyware and viruses.

2.I.03.02	Analyze common threats, vulnerabilities and social engineering techniques.
2.I.03.03	Examine mitigation techniques.
	Performance Example:
	Given a scenario, students will detect, remove, and prevent malware using appropriate tools and methods. Students will research an exploited network. Students will research the most common security threats. Students will create an electronic presentation summarizing the security threats and highlighting the preventative measures that could be taken on the given device.
2.I.04	**Implement security best practices to secure a workstation.**
2.I.04.01	Compare and contrast the differences of basic Microsoft Windows OS security settings such as Users and groups, file and folder permissions.
2.I.04.02	Compare and contrast the differences of basic Linux OS / Mac OS security settings such as Users and groups, file and folder permissions.
2.I.04.03	Examine Password Best Practices, Account management, Basic Active Directory functions, Patch/update management and Data encryption
	Performance Example:
	Given a scenario, on a small peer to peer network, students will create and test shared folders allowing for some and all users to view, edit and save. Students will secure a workstation by disabling guest and unknown accounts. Students will run a password analyzer program against a list of student created passwords to determine strength in accordance of best practices. Students will configure users and groups in Windows OS
2.I.05	**Implement methods for securing Mobile devices.**
2.I.05.01	Define and describe pass code locks, remote wipes, locator applications, remote backup applications, failed login attempts restrictions.
2.I.05.02	Distinguish among appropriate antivirus applications, available OS updates and patches, authentication and encryption.
	Performance Example:
	Given a scenario, students will secure and use a mobile device according to organizational policies. Students will then select appropriate authentication methods to harden the mobile device. Students will evaluate local policies such as acceptable use or BYOD.
2.I.06	**Describe appropriate data destruction/disposal methods.**
2.I.06.01	Explain hard drive sanitation methods and physical destruction.
	Performance Example:
	Given a scenario, students will implement appropriate data destruction and disposal methods including physical destruction and recycling or repurposing best practices.
2.I.07	**Configure security on SOHO wireless and wired networks.**
2.I.07.01	Configure options for MAC filtering, port forwarding/triggering, Service Set Identifier (SSID) broadcast, and wireless encryption
2.I.07.02	Enable/disable services such as firewall, DHCP, Perimeter Network/Demilitarized Zone (DMZ), NAT, & WiFi Protected Setup (WPS).
2.I.07.03	Disable unused ports and update firmware

	Performance Example:
	Given a scenario, students will configure an ISR per a given client scenario using industry best practices such as enabling MAC filtering, port forwarding and wireless encryption. Students will configure a firewall setting on a wired/wireless system according to client specifications.
2.J	**Virtualization and Cloud Computing**
	Equipment Needed – See Addendum A
2.J.01	**Compare and contrast Cloud Computing concepts**
2.J.01.01	Explore common cloud models
2.J.01.02	Compare and contrast Shared resources (Internal vs. External), Rapid elasticity, On-demand, Resource pooling, Measured Service, and Metered Services
2.J.01.03	Evaluate and use Off-site email applications, Cloud-Based file storage services, and Virtual application streaming/cloud-based applications.
	Performance Example:
	Given a scenario, students will . . .
2.J.02	**Set up and configure client-side virtualization.**
2.J.02.01	Identify and describe the purpose and different types of virtual machines.
2.J.02.02	Configure client-side virtualization to include Resource, Emulator, Security, and Network requirements.
2.J.02.03	**Explain the use of Hypervisor**
2.J.02.04	**Install a Virtual Solution such as desktop, server or switches.**
	Performance Example:
	Given a scenario, students will configure client-side virtualization to include Resource, Emulator, Security, and Network requirements.
2.K	**Troubleshooting**
	Equipment Needed – See Addendum A
2.K.01	**Use the best practice methodology to resolve problems.**
2.K.01.01	Identify the problem.
2.K.01.02	Establish a theory of probable cause (question the obvious).
2.K.01.03	Test the theory to determine cause.
2.K.01.04	Establish a plan of action to resolve the problem and implement the solution.
2.K.01.05	Verify full system functionality and, if applicable, implement preventive measures.
2.K.01.06	Document findings, actions, and outcomes.
	Performance Example:
	Given a scenario, students will demonstrate the proper use of the six (6) step troubleshooting methodology.
2.K.02	**Hardware Troubleshooting**
2.K.02.01	Troubleshoot problems related to motherboards, RAM, CPUs, and power.
2.K.02.02	Troubleshoot hard drives and RAID arrays.
2.K.02.03	Troubleshoot video, projector, and display issues.

2.K.02.04	Troubleshoot common mobile device issues while adhering to the appropriate procedures.
2.K.02.05	Troubleshoot printers.
	Performance Example:
	Given a scenario, students will determine a variety of hardware problems, repair or replace the components and test the solutions.
2.K.03	**Networking Troubleshooting**
2.K.03.01	Troubleshoot common wired and wireless network problems.
2.K.03.02	Identify and Correct Layer 2 and Layer 3 Addressing Issues.
2.K.03.03	Demonstrate common troubleshooting command line tools (Ping, Tracert/traceroute, Dig, Ipconfig/Nslookup, Address Resolution Protocol (ARP), Nbtstat, and Netstat).
2.K.03.04	Install software and hardware tools, protocol analyzer, throughput testers, and connectivity software.
	Performance Example:
	Given a scenario, students will use problem solving strategies and diagnostic tools to identify network problems. Given a scenario, students will download a free packet sniffer software package; install sniffer on a basic LAN; generate traffic to capture packets; and open and view captured packets.
2.K.04	**Software Troubleshooting**
2.K.04.01	Troubleshoot Operating System problems such as failure to boot, updates and patches, and OS Repair.
2.K.04.02	Troubleshoot and resolve PC security issues.
2.K.04.03	Use best practice procedures for malware removal.
2.K.04.04	Troubleshoot mobile OS, application, and application security issues.
2.K.04	**Performance Example:**
	Given a scenario, students will solve a variety of software problems using appropriate diagnostic utilities, apply appropriate repair techniques, and test the solutions.
2.L	**Programming Concepts**
	Equipment Needed – See Addendum A
2.L.01	**Compare and contrast programming language categories.**
	Describe what a computer program is and how it runs.
2.L.01.01	Differentiate Interpreted (Scripting languages, Scripted languages, Markup languages); Compiled programming languages; Query languages; Assembly language.
2.L.01.02	Identify Script file types (.bat, .ps1, .vbs, .sh, .py, .js); Environment variables; Comment syntax; Basic script constructs (Basic loops, Variables); Basic data types (Integers, Strings)
2.L.02	**Use programming organizational techniques and interpret logic.**
2.L.02.01	Develop Organizational techniques (Pseudocode concepts, Flow-chart concepts, Sequence); Logic components (Branching, Looping)

2.L.03	**Explain the purpose and use of programming concepts.**
2.L.03.01	Demonstrate Identifiers (Variables, Constants); Containers (Arrays, Vectors); Functions; Objects (Properties, Attributes, Methods)
2.L.04	**Explain database concepts and the purpose of a database.**
2.L.04.01	Describe the usage of database (Create, Import/input, Query, Report); Flat file vs. database (Multiple concurrent users, Scalability, Speed, Variety of data); Records; Storage (Data persistence)
2.L.05	**Compare and contrast various database structures.**
2.L.05.01	Distinguish between structured vs. semi-structured vs. non-structured; Relational databases (Schema, Tables, Rows/records, Fields/columns, Primary key, Foreign key, Constraints); Non-relational databases (Key/value databases, Document databases)
2.L.06	**Summarize methods used to interface with databases.**
2.L.06.01	Use Relational methods (Data manipulation - Select, Insert, Delete, Update, Data definition - Create, Alter, Drop, Permissions); Database access methods (Direct/manual access, Programmatic access, User interface/utility access, Query/report builders); Export/import (Database dump, Backup)
	Performance Example:
	Given a scenario, students will design a simple program for a specific application. Given a scenario, students will create, test functionality, debug and document a simple computer program. Given a scenario, students will create a custom database from a given set of guidelines.
2.M	**Web Page Development**
	Equipment Needed – See Addendum A
2.M.01	**Explain the fundamentals of web page development**
2.M.01.01	Describe the methods of creating web sites.
2.M.01.02	Apply structural requirements (information architecture) for development of a web site
2.M.01.03	Create a web site, using web site design software or programming language.
2.M.01.04	Apply web site design features.
2.M.01.05	Create hyperlinks.
2.M.01.06	Proofread, edit and test a web site.
2.M.01.07	Explain and demonstrate publishing, updating, and maintaining a web site.
2.M.01.08	Describe methods for achieving web site recognition.
2.M.01.09	Critique a web site according to accepted web site design principles.
	Performance Example:
	Given a scenario, students will create a webpage, upload the webpage to a File Transfer Protocol (FTP) server and administer changes to the webpage via an FTP client.
***2.N**	**Cyber-Security** – All items are Advanced Plus (A+)
	Equipment Needed – See Addendum A

2.N.01	**Personal Security**
2.N.01.01	Evaluate whether a particular cyber behavior is acceptable in a social context.
2.N.01.02	Consider the impact of personal cyber behavior on others
2.N.01.03	Design the correct level of protection by implementing the appropriate safeguards
2.N.01.04	Recognize that a digital presence affects future success, both personally and professionally.
2.N.01.05	Identify personal data sharing that places people at risk and evaluate risky personal data-sharing practices
2.N.01.06	Identify various Threat Actors and their roles
2.N.02	**System Security**
2.N.02.01	Weigh the outcomes of various types of computer "hacking", including black, white, and gray
2.N.02.02	Analyze the evidence of an attack.
2.N.03	**Applied Cyber Security**
2.N.03.01	Use digital forensics investigative techniques to solve a cybercrime.
2.N.03.02	Describe the potential legal ramifications of cybercrimes.
2.N.03.03	Define what constitutes a cybercrime
2.N.03.04	Respond to a detected cybersecurity event
2.N.03.05	Identify the sectors of society that are at risk to cybersecurity breaches.
2.N.03.06	Utilize virtualization for threat investigation
2.N.03.07	Research Incident Response Frameworks: Cyber Kill Chain, Diamond Model, Chain of Custody, and National Institute of Standards and Technology (NIST)
2.N.03.08	Research and apply standards – Policies, NIST, Regulations for data management
2.N.03.09	Utilize Alert & Monitoring tools – Event Viewer, Protocol/Port Analyzers (Wireshark, Simple Network Management Protocol (SNMP)), and NetFlow
2.N.03.10	Investigate, evaluate, and respond to alerts such as logs and PCAPs
2.N.03.11	Differentiate symmetric/asymmetric cryptography algorithms for Integrity, Authenticity, Confidentiality (Public Key Infrastructure (PKI)/digital certificates/hashes/Authentication, Authorization, Accounting (AAA)
***2.O**	**Server Management** – All items are Advanced Plus (A+)
	Equipment Needed – See Addendum A
2.O.01	**Install and manage servers**
2.O.01.01	Manage device drivers, including but not limited to, installation; removal; disabling; update/upgrade; rollback; troubleshooting; Plug & Play; interrupts; driver signing
2.O.01.02	Manage services, including but not limited to, what services are; which state a service can be in; startup types; recovery options; delayed startup; Run As settings for a service; stopping or pausing a service; service accounts, dependencies.
2.O.01.03	Perform various server installations including, but not limited to, choosing correct OS version; partitioning; F8 options; server core vs. full; interactive install; unattended install; automated install using WDS; upgrade vs. clean install; firmware updates including BIOS
2.O.02	**Implement server roles.**

2.0.02.01	Prepare various types of application servers including, but not limited to, mail servers; database servers; collaboration servers; monitoring servers; threat management.
2.0.02.02	Configure web services including, but not limited to, Internet Information Services (IIS), World Wide Web (WWW), FTP, separate worker processes, adding components, sites, ports, SSL and certificates.
2.0.02.03	Utilize remote access including, but not limited to, remote assistance, remote administration tools, remote desktop services, licensing, remote desktop gateway, Virtual Private Network (VPN), application virtualization, multiple ports.
2.0.02.04	Configure file and print services including, but not limited to, printer pools; web printing; web management; driver deployment; file, folder, and share permissions vs. rights; auditing; print job management.
2.0.02.05	Create server virtualization modes; Virtual Hard Disk (VHDs); virtual memory; virtual networks; snapshots and saved states; physical to virtual; virtual to physical.
2.0.03	**Manage active directory.**
2.0.03.01	Create accounts and groups
2.0.03.02	Structure organizational units and containers.
2.0.03.03	Describe active directory infrastructure including but not limited to domain controllers, forests, operation master roles, domain vs. workgroup, child domains, trusts, functional levels, namespace, sites, and replication.
2.0.03.04	Identify storage technologies.
2.0.04	**Manage active directory.**
2.0.04.01	Classify RAID (RAID 0, RAID 1, RAID 5, RAID 10 and combinations; hardware and software RAID).
2.0.04.02	Structure organizational units and containers.
2.0.04.03	Identify disk types (Advanced Technology Attachment (ATA); basic disk; dynamic disk; mount points; file systems; mounting a virtual hard disk; distributed file systems; optical disks).
2.0.05	**Manage server performance.**
2.0.05.01	Distinguish among major server hardware components.
2.0.05.02	Explain performance monitoring (methodology; procedures; effect of network, CPU memory and disk; creating a baseline; using performance and resource monitor in task manager).
2.0.05.03	Explain logs and alerts.
2.0.06	**Perform server maintenance.**
2.0.06.01	Identify the steps in the server startup process.
2.0.06.02	Explain the value of business continuity (i.e., backup and restore, disaster recovery and data redundancy).
2.0.06.03	Manage server patch management

Strand 3: Embedded Academics

Embedded Academics Grades 9 –14 for Chapter 74 Vocational Technical Education Programs

Due to the thoughtful planning that went into the revisions of the English Language Arts & Literacy (2017), Mathematics (2017), Science and Technology Engineering (2016), and Digital Literacy Frameworks (2016), the current Vocational Technical Education Frameworks can move forward with a new level of embedded academics that are more content focused and more meaningful to students as they attain transferrable skills. Core content area experts carefully developed the literacy standards and academic practices in the aforementioned Massachusetts Frameworks documents which are highlighted. The Standards for Literacy in Content Areas, the Standards for Mathematical Practice, the High School Science & Engineering Practices, and the Digital Literacy & Computer Science Practices complement but do not take the place of the grade-level or course-level content standards in any of the discipline-specific Vocational Technical Education Frameworks.

Mathematics, science, technology, reading, writing, speaking, and listening skills and standards focus on understanding and practicing discipline-specific literacy, math, STE, and communication skills, using resources and characteristics of specific Vocational Technical Education programs. The philosophy of the embedded academics is not to have vocational teachers become traditional content teachers of English, science, and mathematics but is intended to reinforce the concept that it

is the responsibility of all teachers to embed rich academic experiences in Vocational Technical Education. This will ensure that students recognize the transferrable skills that are essential for success in 21st century careers and in college. In rigorous Vocational Technical Education, students have hands-on and real-world experiences which develop relevant connections both from academic areas to Vocational Technical areas and vice versa.

The performance examples included in Strand Three are models developed using the portrait from the English Language Arts & Literacy (2017) of Students Who Are Ready for College, Careers, and Civic Participation. The examples illustrate how individual vocational teachers may use academic practices and literacy standards from the Massachusetts Frameworks listed above to seamlessly embed and explicitly teach relevant academics through Vocational Technical Education.

Vocational Technical Education of the past and of the 21st century naturally embed the elements of the portrait of Students Who are Ready for College, Careers, and Civic Participation through the hands-on and real-world experiences that students engage in throughout their tenure as Vocational Technical students. The following guidelines and practices that are collated in this document for easy reference are directly from the English Language Arts & Literacy (2017), Mathematics (2017), Science & Technology Engineering (2016), and Digital Literacy Frameworks (2016).

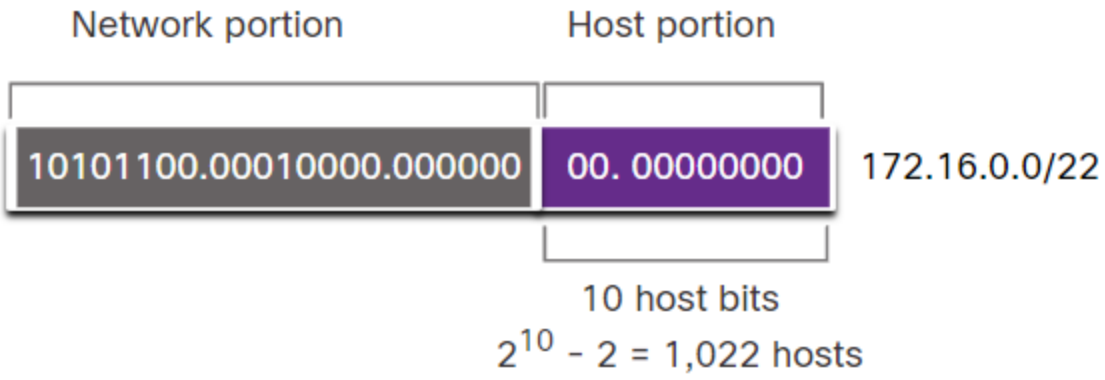
Embedded Academic Performance Examples

ISS Networking Performance Task 1

In your new role as a Junior Network Administrator you are asked to design a new IPv4 addressing scheme for your company's network. Corporate headquarters has been allocated a public network address space of 172.16.0.0 /22 (10 host bits) by its ISP. As shown in the figure, this will provide 1,022 host addresses.

Network Portion **Host Portion**
172.16.0.0 /22 **10101100.00010000.00000000.00000000**

10 host bits means: 2 to the 10th power - 2 = 1,022 hosts



Your boss has shown you both a physical and logical topology of the newly planned network. The new network needs to accommodate a minimum of 10 subnets for the corporate office, a DMZ, and several small branch offices. This means that the organization requires at least 10 subnets from the company's 172.16.0.0.0/22 public address space. The largest subnet requires 40 host addresses. Please create a chart of your proposed new network address scheme for your company's network that includes each of the 10 subnets along with the host ranges and broadcast addresses for each.

Embedded Math:
Kathy to add

Embedded Science & Engineering:
Kathy to add

Embedded Reading in Science & Technical Subjects:
Kathy to add

Embedded Writing in Content Areas:
Kathy to add

Embedded Digital Literacy:
Kathy to add
DLCS 1,3,4,7

Embedded Speaking & Listening in Content Areas:
Kathy to add

Career & Technical Standards:
[2.H.06.01] Explain the purpose and properties of IP Addressing.
[2.H.06.02] Differentiate the difference between multicast, unicast, and broadcast.
[2.H.06.03] Configure IP address, Subnet Mask and Default Gateway on a network device.
[2.H.06.04] Describe and prepare a Classful and a Classless Subnetting Addressing scheme (CIDR)

ISS Networking Performance Task #2

You are an employee of a consulting firm called Computer Solutions. Your firm's responsibilities include ON-SITE inspections for the planning phase of a network installation, including determining:

- What type of network would best suit each particular customer (e.g., peer-to peer or client/server)
- If the customer needs a LAN and/or a WAN
- What type of network topology will best suit the customer
- Which cabling media will meet the customer's needs now and in the near future
- Brands of hardware and software needed by the customer and translating that information into the number of servers, workstations, and licenses that will serve your customer's business network and wholly support their business.

Your responsibility is to design a fully switched / routed network. While a complete professional project would require sales to detail the necessary costs involved, this is not part of your role. For sales to price your network solution, your drawings will consist of the physical layout, drawings of the logical topology layout, network operating systems, application software, TCP/IP architecture, servers, switches, routers (network infrastructure), and all workstations and printers (user devices). Be sure to include productivity software, client operating systems, specific software for the various departments such as anti-virus software, and uninterruptible power supplies. Make sure there are sufficient numbers and types of servers, server racks, cabling, connections, switches, and routers. Your design should allow for a 10% growth in the number of employees on the network (Keep this in mind when researching switches—ensure there are enough ports!).

Embedded Math:
Kathy to add

Embedded Science & Engineering:
Kathy to add

Embedded Reading in Science & Technical Subjects:
Kathy to add

Embedded Writing in Content Areas:
Kathy to add

Embedded Digital Literacy:
Kathy to add

Embedded Speaking & Listening in Content Areas:
Kathy to add

Career & Technical Standards:
[2.C.01] Practice proper communication and professionalism.
[2.D.09] Develop customer specification and needs.
[2.F.01.01] Research and understand hardware and operating system requirements.
[2.F.01.04] Install, configure and utilize local and network applications.
[2.H.05] Install, configure, and deploy a secure SOHO wireless/wired network using best practices.

[2.H.06.03] Configure IP address, Subnet Mask and Default Gateway on a network device.
[2.H.07] Summarize the properties and purposes of server services provided to networked hosts.
[2.H.08.04] Compare and contrast physical vs. logical topologies.
[2.H.09.02] Install and terminate network cabling.
[2.H.10] Implement a Switched network
[2.H.11] Implement a routed network.

ISS Networking Performance Task #3

Your school is starting a new program, where students run a help desk in the school where teachers and staff can get technical support. The ninth and tenth grade students are level-one tech support technicians, and the 11th and 12th grade students are upper level tech support. Students will be assisting teachers and staff with different tech needs. When school is in session this is done in person for set hours during the school day. Students practice interacting with teachers and fellow students with tech problems. The more experienced 10th and 11th grade students will help train the 9th graders. Using clarifying questions students will help the customer describe the problem. Shifting from open ended to closed questions to narrow help define the problem clearly. Students will ultimately take customers through the six-step process.

Students may access documentation from prior problems that are similar. This knowledge base has been created and updated to reflect tech support encountered. Student will ask teacher or older peers for support as they learn. The student will solve the problem and verify that the problem is solved. The student will document the problem and the solution. This documentation may be used to generate a Frequently Asked Questions (FAQ). These experiences build a constant pool of tech support students. Students will utilize ticketing software to document the problem from start to resolution. This help desk provides direct tech support experience for the students. When students interview for co-op positions they can refer to specific examples of their experience. The help desk can be utilized by students also but it is usually done by appointments due to scheduling.

Embedded Math:
Kathy to add

Embedded Science & Engineering:
Kathy to add

Embedded Reading in Science & Technical Subjects:
Kathy to add

Embedded Writing in Content Areas:
Kathy to add

Embedded Digital Literacy:
Kathy to add

Embedded Speaking & Listening in Content Areas:
Kathy to add

Career & Technical Standards:

[2.C.01.01] Use proper language – avoid jargon, acronyms, and slang when applicable
[2.C.01.02] Set and meet expectations/timeline and communicate status with the customer.
[2.K.01.01] Identify the problem.
[2.K.01.02] Establish a theory of probable cause (question the obvious)
[2.K.01.03] Test the theory to determine cause.
[2.K.01.04] Establish a plan of action to resolve the problem and implement the solution.
[2.K.01.05] Verify full system functionality and, if applicable, implement preventive measures.
[2.K.01.06] Document findings, actions, and outcomes.
[2.K.04.01] Troubleshoot OS problems such as failure to boot, updates and patches, and OS Repair.
[2.K.04.02] Troubleshoot and resolve PC security issues.
[2.K.04.03] Use best practice procedures for malware removal.
[2.K.04.04] Troubleshoot mobile OS, application, and application security issues.

Appendices

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education or the Massachusetts Association of Vocational Administrators.

Appendix – ISSN Equipment

Each ISSN student will need a modern, high-end workstation with recommended minimum RAM and processing to support multiple virtual machines. Students will need Internet access and various USB flash drives for moving files between computers in the lab. Lab space will be needed

for hardware assembly and must include a space to work with an electrostatic discharge (ESD) mat with a ground cord, an electrostatic discharge (ESD) wrist strap and cord, and safety glasses.

Classroom licenses for appropriate certification learning platforms to support ISSN curriculum frameworks and IRC certification(s) are recommended (examples include Cisco, Google Training, TestOut, CompTIA, or GMetrix).

Additionally, the following PC assembly hardware, software, tools, equipment, accessories, and technology resources are needed for every two students in the program.

- 1 PCI, PCIe, or AGP-compatible motherboard
- 1 PC Case with 300W power supply
- 4 GB RAM (64-bit) (2 X 2GB suggested), some labs will require one module of RAM to be uninstalled or the simulation of a faulty module for troubleshooting purposes.
- 1 Intel or AMD CPU, 1 gigahertz (GHz) or faster with support for PAE, NX, and SSE2
- 1 CPU heat sink and cooling fan
- 60 GB hard drive (minimum); 80 GB or more (recommended), the system must support a full install of Windows 10 and two partitions of the same size
- 1 DVD-ROM (minimum), DVDR, or BD/BDR (optional)
- 1 Ethernet Card (If the motherboard does not have an Ethernet port)
- 1 Wireless network adapters (compatible with the wireless router)
- 1 PCI, PCIe, or AGP (recommended) video card. DirectX 9 graphics device with WDDM 1.0 driver
- Cables to connect HDD/CD (Quantities vary)
- 1 Keyboard
- 1 Mouse
- 1 Super VGA (1024 X 768) or higher-resolution video monitor
- Various operating systems to install such as the most recent Windows and Linux distributions
- Various anti-virus software
- At least 1 Internet connection for Internet searches and driver downloads
- Phillips screwdriver
- Flathead screwdriver
- Hex Socket Drivers (various sizes)
- Lint-free cloth
- Electronics cleaning solution
- Flashlight
- Thermal compound
- Multimeter
- Compressed air service canister (optional due to globally varying classroom health and safety laws)
- Power supply tester
- Wire cutters
- RJ-45 Crimpers
- Punch Down Tool
- Cable strippers
- RJ-45 Connectors and Jacks

- Modular cable tester
- Network Loop back plugs (optional)
- Smartphones and tablets are desirable for use with the labs in the Mobile Devices standards
- 1 printer or integrated printer/scanner/copier for the class to share

Networking equipment and software will be needed to share within the program. The following equipment are minimum requirements and recommended for every three students in the program.

- 2 - Cisco ISR 4221 (2GE, 2NIM, 8G FLASH, 4G DRAM, IPB) ordered with IOS-XE Image with Payload Encryption (ISR4221/K9).
- 2 - Catalyst 1000 24port GE, 4x1G SFP (C1000-24T-4G-L)
- 1 - Wireless router (generic brand) with WPA2 support
- Ethernet cables
- Console Cable 6ft with USB Type A and mini-USB Type B
- Console Cable 6ft with RJ45 and DB9F
- 1 - 4ft Open Frame 19 Inch 22U 2-Post Network Server Relay Rack with Rolling Casters
- 2 - 2 Port Serial WAN Interface card (NIM-2T)
- 2 - V.35 Cable, DTE Male to Smart Serial, 10 Feet
- 2 - V.35 Cable, DCE Female to Smart Serial, 10 Feet
- An extra PCs to run an application server (MS Windows Server or Windows 10 or later)
- 2 extra Desktop PCs acting as clients (MS Windows 10 or later) that include 2 Wired/Wireless LAN Adapters for the client PCs -- Ethernet cables and Serial Cables as required
- Tera Term or Putty terminal emulation software and source SSH client software for lab PCs
- Oracle VirtualBox or VMWare Workstation Player (latest version)
- Wireshark (latest version)
- Open-source server software: For various services and protocols, such as Telnet, SSH, HTTP, DHCP, FTP, Trivial File Transfer Protocol (TFTP), etc.
- Windows Server (latest version)
- Kali Linux (latest version)
- Packet Tracer (latest version)

DESE Statewide Articulation Agreements

ARTICULATION AGREEMENTS

Between

Massachusetts Community Colleges

And

Massachusetts Chapter 74 State-Approved

for more information, click

http://www.masscc.org/partnerships-initiatives/voc-schools-articulation-agreements

Student Organizations

- SkillsUSA www.maskillsusa.org