Telecommunications I

8650 36 weeks / 140 hours

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Acknowledgments

The components of this instructional framework were developed by the following technical panel and curriculum development team members:

Technical Panel

PJ Kamalei Haasenritter, Software Engineer I
Ray Knighton, Telecom Engineer, RCDD ITS and PM Infrastructure, MABB Network Operations Center, Chantilly

Curriculum Development Team

Allen Bierlair, Chesterfield Technical Center, Chesterfield County Public Schools
Tim McLeod, Spotsylvania Career and Technical Center, Spotsylvania County Public Schools
Lorna Gardner, Monroe Technology Center, Loudoun County Public Schools
Alton Jarvis, Rockbridge County High School, Rockbridge County Schools
Course Description

Suggested Grade Level: 10 or 11

Students will learn about the technological advances and competition now transforming the voice, video, and data communications industry. This course will introduce students to the basic concepts and structural elements of the industry, including an introduction to signal transmission, attenuation, distortion, and signal propagation over cables, fiber, and air. User-premises based telecommunications platforms, switching, wiring, and networking, as well as facilities that provide and support telecommunications systems, will be studied. Students will have the skills to become Certified Telecommunications Electronics Technicians, Certified Satellite Installers, and Certified Fiber Optics Technicians through Electronics Technicians Association, International (ETA).

As noted in Superintendent's Memo #058-17 (2-28-2017), this Career and Technical Education (CTE) course must maintain a maximum pupil-to-teacher ratio of 20 students to one teacher, due to safety regulations. The 2016-2018 biennial budget waiver of the teacher-to-pupil ratio staffing requirement does not apply.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (〇) are optional
- Tasks/competencies designated by minus icons (−) are omitted
- Tasks marked with an asterisk (*) are sensitive.

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<td>39</td>
<td>+</td>
<td>Demonstrate special safety procedures required for outside equipment.</td>
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<td>40</td>
<td>+</td>
<td>Demonstrate compliance with OSHA requirements for telecommunications (Standard 1910.268).</td>
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<td>41</td>
<td>+</td>
<td>List safety procedures for operating a service truck.</td>
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<td>42</td>
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<td>Document procedures for eye and skin safety.</td>
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<td>43</td>
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<td>Describe electrostatic discharge.</td>
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<td><strong>Understanding AC/DC Fundamentals</strong></td>
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<tr>
<td>44</td>
<td>+</td>
<td>Apply safe working practices around AC and DC circuits.</td>
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<td>Demonstrate proper use of electronics tools and equipment.</td>
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<td>Analyze series and parallel DC circuit characteristics.</td>
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<td>Examine different types of circuit control devices.</td>
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<td>Examine the use of capacitors and inductors in DC circuits.</td>
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<td>Assemble circuits on printed circuit boards.</td>
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<td>Analyze semiconductor properties, devices, and integrated circuits.</td>
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<td>Analyze amplifier circuits used in various electronics products.</td>
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<td>Examine basic logic gates, logic truth tables, and digital signals.</td>
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<td><strong>Integrating Computer Skills</strong></td>
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<td>57</td>
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<td>Explain how software and hybrid hardware/software solutions may provide alternative solutions to problems.</td>
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<td>Explain worldwide numbering systems.</td>
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<td>Explain computer telephony integration.</td>
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<td>Demonstrate proficiency with standard office software.</td>
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<td>Draw a basic building wiring plan, using a CADD program.</td>
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<td>Explain the different levels of the OSI and TCP/IP models.</td>
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<td>Demonstrate skills in file system navigation, accessing manuals, and editing files in various operating systems.</td>
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<td>65</td>
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<td>Research computer and Internet security problems.</td>
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<tr>
<td><strong>Exploring Analog Telephony and Transmission Service Providers</strong></td>
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<td>66</td>
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<td>Outline the history of the telephone.</td>
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<td>67</td>
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<td>Demonstrate the basics of a wired voice system.</td>
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<td>68</td>
<td>+</td>
<td>Define POTS, DID, OPX, tie-lines, and WATS lines.</td>
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<td>69</td>
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<td>Explain the function of a PBX.</td>
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<td>70</td>
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<td>Construct local loops of phone companies.</td>
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<td>Describe the functions of the central exchange.</td>
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<td>Differentiate among dedicated lines, metered, and switched services.</td>
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<td>Compare broadband DSL and ISDN.</td>
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<td>Explain the purposes of local exchange carriers (LECs).</td>
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<td>Explore the history of telephone companies.</td>
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<td>Explain the difference between LECs and ROCs (regional operating companies).</td>
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<td>Define <em>independent telephone company</em>.</td>
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<td>Explain network operations centers (NOCs).</td>
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<td>Define the terms <em>In-band</em> and <em>Common Channel Signaling (CCS)</em> and <em>Signaling System 7 (SS7)</em>.</td>
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<td>Describe a network control point (NCP).</td>
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<td>Explain the importance of digital subscriber lines.</td>
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<td>Demonstrate proficiency with the use of scientific calculators.</td>
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<td>Describe and use the electrical color code.</td>
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<td>Produce a repair estimate.</td>
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<td>87</td>
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<td>Explain costs of doing business in a repair or installation firm or department, using a profit and loss statement.</td>
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</table>

Legend: ✗ Essential  ○ Non-essential  ☐ Omitted

### Curriculum Framework

### Practicing Safety

**Task Number 39**

**Demonstrate special safety procedures required for outside equipment.**

**Definition**

Demonstration should include
• using protective barriers in public work areas
• using tools and personal protective equipment (PPE)
• using rubber insulation
• using climbing-lineman body belts, lanyards, and safety straps
• using ladders
• using and grounding portable power equipment.

Process/Skill Questions

• What are the implications of not understanding the proper use of outside safety equipment?
• What resources are available for locating information on personal protective equipment (PPE)?
• How is cooperation vital in performing safe outside telecommunications work?
• What causes most falls?

Task Number 40

Demonstrate compliance with OSHA requirements for telecommunications (Standard 1910.268).

Definition

Demonstration should include

• using lockout/tagout procedures
• controlling the flow of electricity in a safe work environment
• using personal protective equipment for telecommunications centers and field installations
• using other safety and health standards that apply to the work conditions and practices in such areas.

Process/Skill Questions

• What is the role of OSHA as it relates to telecommunications?
• Why is it important to wear or use protective equipment?
• Whose responsibility is it to wear and maintain personal protective equipment?

Task Number 41

List safety procedures for operating a service truck.

Definition
List should include a safety check-off sheet with a minimum requirement of

- valid state vehicle inspection
- functioning seatbelts
- no unauthorized riders
- no driving under the influence of alcohol or drugs.

Process/Skill Questions

- What consequences may result if a person does not follow directions when performing required safety procedures?
- What are the advantages and disadvantages of having safety procedures?
- How do you report safety violations?
- What type of training is required in order to operate a service truck?

Task Number 42

Document procedures for eye and skin safety.

Definition

Documentation should include identifying the location, actions, and types of eyewash stations and skin protection to be used.

Process/Skill Questions

- What is the importance of an eye wash station?
- What types of materials are most effective for skin protection?
- Why is it important to wear personal protective equipment?

Task Number 43

Describe electrostatic discharge.

Definition

Description should include

- defining the term electrostatic discharge (the sudden flow of electricity between two charged objects)
- identifying safe handling procedures when working on sensitive devices.

Process/Skill Questions
• What must be worn to prevent destruction of electronic equipment?
• What are the implications of not using proper electrostatic discharge (ESD) procedures?
• When does ESD occur?

Understanding AC/DC Fundamentals

Task Number 44

Apply safe working practices around AC and DC circuits.

Definition

Application should include

• demonstrating compliance with safety standards in accordance with the National Electrical Code (NEC), the Occupational Safety and Health Administration (OSHA), and instructor guidelines
• identifying equipment used to test electrical circuits
• identifying resources available for workplace safety information
• demonstrating the proper use of personal protective equipment (PPE).

Process/Skill Questions

• Why is it important to be familiar with NEC and OSHA regulations?
• What could happen if a technician ignores safety standards?
• What resources are available for workplace safety?

Task Number 45

Demonstrate proper use of electronics tools and equipment.

Definition

Demonstration should include:

• describing potential hazards of working with various hand tools, soldering tools, and lab equipment
• explaining the proper use of personal protective equipment when using tools
• using hand tools (e.g., screwdrivers, wire strippers, wire cutters, crimping tools, power drills)
• identifying various types of soldering and desoldering tools and materials
• measuring voltage, current, and resistance with analog and digital multimeters
• explaining how the internal resistance of analog and digital meters can cause a loading effect
• calibrating an oscilloscope
• connecting and operating a function generator
• measuring voltage peak to peak (Vpp), voltage peak (Vp), time period (T) and frequency (f) using a function generator and oscilloscope
• describing various other electronics lab equipment that may be used in specific technology settings.

Process/Skill Questions

• What are the advantages of digital multimeters over analog multimeters?
• Why are multimeters and oscilloscopes essential tools for technicians?
• What consequences may result if an oscilloscope is not properly calibrated?

Task Number 46

Analyze series and parallel DC circuit characteristics.

Definition

Analysis should include

• comparing and contrasting the characteristics of both series and parallel circuits
• calculating current, voltage, and resistance in series and parallel circuits using Ohm's law
• assembling basic series and parallel circuits
• measuring resistance, voltage, and current in both series and parallel circuits
• troubleshooting series and parallel circuits.

Process/Skill Questions

• Why is it important to be able to distinguish between series and parallel circuits?
• How is total resistance calculated for a series circuit? For a parallel circuit?
• Why must a technician understand Ohm's law?

Task Number 47

Examine different types of circuit control devices.
Definition

Examination should include

- identifying electrical switches, relays, time-delay relays, and solenoids
- defining the abbreviations SPST, SPDT, DPST, DPDT, NO, and NC
- explaining the significance of voltage ratings, current ratings, and mechanical life ratings
- assembling circuits controlled by various types of switches
- describing the internal structure of relays and solenoids
- examining how electromagnets are employed in relays and solenoids
- assembling circuits that use relays and solenoids.

Process/Skill Questions

- What is the difference between a DPST switch and a DPDT switch?
- What is the difference between a switch, a relay, and a solenoid?
- Why is it important to understand voltage and current ratings when replacing control devices?

Task Number 48

Examine the use of capacitors and inductors in DC circuits.

Definition

Examination should include

- interpreting and drawing capacitor and inductor schematic symbols
- describing the internal construction, voltage ratings, and current ratings of capacitors and inductors
- explaining potential safety concerns with capacitors and inductors and applying safe work practices
- calculating charge time and discharge time of capacitors and inductors
- calculating total capacitance for capacitors in series and parallel
- calculating total inductance for inductors in series and parallel
- describing different methods of measuring capacitance and inductance.

Process/Skill Questions

- Why is it important for technicians to understand how to calculate total capacitance and inductance?
- How does resistance in a circuit affect the charge time of a capacitor or inductor?
- Why should a capacitor be discharged before working on a circuit?
Task Number 49

Analyze alternating voltage and current.

Definition

Analysis should include

- defining the terms *alternating current, time period, frequency, and amplitude*
- identifying potential safety hazards when working with alternating current
- measuring AC voltage using digital multimeters and oscilloscopes
- measuring frequency and amplitude of an AC signal using an oscilloscope and signal generator
- calculating instantaneous and average values and effective (RMS) voltage or current
- converting RMS, peak, and peak-to-peak AC voltage values
- calculating frequency and time period of an AC waveform.

Process/Skill Questions

- What is the relationship of time period to frequency in an AC circuit?
- Why is it important for a technician to know how to use an oscilloscope?
- What is the frequency of the AC voltage provided from a wall outlet?

Task Number 50

Examine the use of capacitors and inductors in AC circuits.

Definition

Examination should include

- differentiating between resistance, reactance, and impedance in AC circuits
- defining RC, RL, and RLC AC circuits
- calculating capacitive reactance \( (X_C) \) in an AC circuit
- calculating inductive reactance \( (X_L) \) in an AC circuit
- describing resonant frequency in reactive circuits
- calculating total impedance \( (Z_T) \) in an AC circuit
- assembling AC circuits using resistors, capacitors, and inductors
- measuring voltage peak-to-peak, voltage peak, and frequency in AC circuits using an oscilloscope and function generator.

Process/Skill Questions

- What causes inductive reactance to increase as frequency increases?
• What is the difference between resistance, reactance and impedance?
• Why is it important for a technician to understand how frequency affects capacitive and inductive reactance?

Task Number 51

Analyze electrical power.

Definition

Analysis should include

• defining the terms work, energy, and power
• calculating power using Watt’s law
• describing the principles of the maximum power transfer theorem
• measuring electrical power consumption in a circuit.

Process/Skill Questions

• What causes electrical devices to become warm when turned on?
• Why is it important to understand how much power a device requires?
• What is the difference between power and work?

Task Number 52

Assemble circuits on printed circuit boards.

Definition

Assembly should include

• describing potential hazards of working with materials containing lead
• identifying soldering tools and materials
• identifying methods of soldering and desoldering
• distinguishing between the solder side and component side of a printed circuit board
• demonstrating an understanding of copper traces on a printed circuit board
• demonstrating how to place electrical components in a printed circuit board
• demonstrating how to solder electrical components and trim excess component leads
• distinguishing between good and bad soldering connections and identifying “cold solder joints” and “solder bridges.”

Process/Skill Questions

• What consequences may result from a poor solder connection?
- What is the difference between a “cold solder joint” and a “solder bridge”?
- Why is it important to wear safety glasses when soldering?

**Task Number 53**

**Analyze semiconductor properties, devices, and integrated circuits.**

**Definition**

Analysis should include

- examining the atomic structure of silicon and germanium
- explaining how N-type and P-type semiconductor materials are made
- examining the function of the PN junction diode
- comparing and contrasting different types of diodes (e.g., rectifier diodes, Zener diodes, light-emitting diodes [LEDs])
- assembling circuits that use various types of diodes
- examining the function of various types of transistors (e.g., bipolar junction transistors [BJT], field effect transistors [FETs], metal oxide semiconductor field effect transistors [MOSFETs])
- demonstrating how to check diodes and transistors using a digital multimeter
- assembling circuits that use various types of transistors
- examining the function of special purpose semiconductors (e.g., voltage regulators, photo-transistors, solid-state relays, silicon-controlled rectifiers, and triacs)
- defining integrated circuits
- demonstrating how to determine the pin numbers on an integrated circuit
- assembling circuits using various integrated circuits (e.g., timer ICs, comparators, flip-flops, op-amps counters).

**Process/Skill Questions**

- How does a rectifier diode only allow current to flow in one direction?
- Why is it important to understand how different types of semiconductor devices operate?
- Why are silicon and germanium such popular semiconductor materials?
- What is the advantage of integrated circuits over discrete semiconductor components?

**Task Number 54**

**Analyze amplifier circuits used in various electronics products.**

**Definition**
Analysis should include

- comparing and contrasting the operation of various transistor amplifiers
- assembling various types of transistor amplifiers
- applying a signal to a transistor amplifier and measuring voltage gain (Av) using an oscilloscope
- examining the operational amplifier (op-amp) integrated circuit
- assembling amplifier circuits using an operational amplifier
- comparing and contrasting the advantages and disadvantages of various types of amplifier classes including class A, B, AB, C, and D
- examining different methods and components used to couple amplifier stages including capacitors and transformers.

Process/Skill Questions

- Why is it important to know how to measure amplifier gain with an oscilloscope?
- What is the purpose of an amplifier circuit?
- What are some of the advantages of an operational amplifier over a transistor amplifier?

Task Number 55

Examine basic logic gates, logic truth tables, and digital signals.

Definition

Examination should include

- comparing and contrasting analog and digital signals
- defining the voltage levels for digital logic circuits
- describing the operation of OR, AND, inverter, NAND, NOR, XOR and XNOR logic gates
- recognizing the schematic symbol for each basic logic gate
- constructing truth tables for each of the basic logic gates
- assembling circuits with the basic logic gates and verifying their operation using truth tables
- troubleshooting logic circuits with a logic probe.

Process/Skill Questions

- Why is it important to know the truth table of each basic logic gate?
- What is the difference between an analog and a digital signal?
- What is the advantage of using a logic probe over a digital multimeter when troubleshooting basic logic circuits?
Task Number 56

Analyze the function of a basic telephone set.

Definition

Analysis should include

- disassembling a telephone set according to instructor guidelines
- identifying the parts of the telephone set (e.g., microphone, speaker [earpiece], keypad, ringer, hook switch)
- demonstrating an understanding of the function of each telephone section
- reassembling the telephone and verifying proper operation.

Process/Skill Questions

- Why is it important to understand the major sections of a basic telephone set?
- How have different sections of the telephone changed throughout history?
- What is the difference between a microphone and a speaker?

Integrating Computer Skills

Task Number 57

Explain how software and hybrid hardware/software solutions may provide alternative solutions to problems.

Definition

Explanation should include describing

- computer software and hardware that can be used to aid in productivity
- specialty applications software available for design, documentation, and estimation
- computer hardware and peripheral devices that can be used for design, documentation, and estimation.
Process/Skill Questions

- What software applications are available to aid in productivity?
- What specialty computer hardware is available to aid in productivity?
- What peripheral devices are available to aid in productivity?

Task Number 58

Explain worldwide numbering systems.

Definition

Explanation should include

- Internet protocol (IP) addressing, including
  - IPv4
  - IPv6
  - media access control (MAC)
- purpose of IP addressing
- purpose of MAC addressing
- how IP and MAC addresses are used in data communication.

Process/Skill Questions

- What is the purpose of Internet protocol addressing?
- How is IP addressing used in data communication?
- What is the purpose of MAC addressing?
- How is MAC addressing used in data communication?

Task Number 59

Explain computer telephony integration.

Definition

Explanation should include

- integration of telephone functions into computer applications with emphasis on call center application
- common terms used in computer telephony integration (CTI), including
  - screen popping
  - dialing
  - phone control
  - call transfer
o call routing
o voice recording.

Process/Skill Questions

- How is the computer used to facilitate call center management?
- What is the hierarchy for calls placed to a call center?
- How is computer telephony integration superior to non-integrated call centers?

Task Number 60

Demonstrate proficiency with standard office software.

Definition

Demonstration should include the following applications:

- word processing
- spreadsheet calculation and graph generation
- database construction and editing
- preparation of a graphical presentation

Process/Skill Questions

- Why is it important for all employees to be proficient in the common office productivity applications?
- When is it appropriate to use a database rather than a spreadsheet for managing data?
- What are some of the basic rules for creating a graphical presentation?

Task Number 61

Draw a basic building wiring plan, using a CADD program.

Definition

Drawing should include

- layers
- use of wiring symbols
- dimensioning
- annotation conventions.
Process/Skill Questions

- What information can be found on the various drawing layers used for cabling installation?
- Why does a cable installer need information beyond what is found on the “T” drawings?
- What is the difference between “design” drawings and “as-built” drawings?

Task Number 62

Describe Internet and network topologies and technologies.

Definition

Definition should include

- wide area network (WAN) technologies
- WAN topologies
- local area network (LAN) technologies
- LAN topologies.

Process/Skill Questions

- What are the common WAN and LAN technologies?
- What are the common WAN and LAN topologies?
- What are the benefits and limitations of the common LAN topologies?
- What are the benefits and limitations of the common WAN topologies?

Task Number 63

Explain the different levels of the OSI and TCP/IP models.

Definition

Explanation should include

- layers of the OSI model and the function of each
- layers of the TCP/IP model and the function of each.

Process/Skill Questions

- What is the function of each layer of the OSI model?
- What is the function of each layer of the TCP/IP model?
• How does the OSI model differ from the TCP/IP model?

**Task Number 64**

**Demonstrate skills in file system navigation, accessing manuals, and editing files in various operating systems.**

**Definition**

Demonstration should include

• describing similarities and differences in computer/server operating systems
• identifying command-line interface commands used in network configuration and troubleshooting
• obtaining network information using the command-line interface
• navigating the file system and transferring files over a network using the command-line interface.

**Process/Skill Questions**

• Why is it important to be able to conduct file transfer over a network using the command-line interface?
• What network information can be obtained using the command-line interface?
• What are the differences between the network component operating systems and workstation operating systems?

**Task Number 65**

**Research computer and Internet security problems.**

**Definition**

Research should include the following:

• Physical security threats
  - Social engineering
  - Equipment access vulnerability
• Data security threats
  - Hacking
Process/Skill Questions

- What are some of the common threats to data?
- How do unauthorized individuals get access to data that should be secure?
- Why should a security plan be an integral part of an acceptable use policy?

Exploring Analog Telephony and Transmission Service Providers

Task Number 66

Outline the history of the telephone.

Definition

Outline should include

- telephone prehistory
- invention of the telephone
- early telephone developments
- early commercial developments
- 20th and 21st century developments.

Process/Skill Questions

- What basic parts make up an analog telephone?
- What role did the analog telephone play in advancing human communication?
- How was crosstalk and hum from nearby AC eliminated?

Task Number 67

Demonstrate the basics of a wired voice system.

Definition
Demonstration should include how to connect a wired voice system.

**Process/Skill Questions**

- How is proper placement of all components in a wired voice system vital in performing voice transmission?
- What is the nomenclature for the wire used in wired voice systems?
- How does a wired voice system work?

**Task Number 68**

**Define** *POTS, DID, OPX, tie-lines, and WATS lines.*

**Definition**

Definition should include the following abbreviations and terms:

- *POTS* (plain old telephone service)—a voice-grade telephone service based on analog signal transmission
- *DID* (direct inward dialing)—allows an individual extension on a private branch exchange (PBX) to be reached directly via its own standard outside number, determining the appropriate situations to use each service
- *OPX* (off-premise extension)—an extension telephone at a location distant from its servicing PBX
- *tie-line*—a telephone line that directly connects two or more PBXs
- *WATS* (wide area telephone service)—flat-rate long-distance service offering for customer dial-type telecommunications

**Process/Skill Questions**

- What was the voice-grade telephone service based on analog signal transmission that was common before the advent of advanced forms of telephony?
- When would you use OPX?
- How does WATS work?

**Task Number 69**

**Explain the function of a PBX.**

**Definition**

Explanation should include
• a definition of the term PBX (private branch exchange)—a telephone exchange that serves a particular business or office
• the basic function of the PBX—to connect the internal telephones at a business and to connect the business to a public switched network
• identification of the different types of PBX systems.

Process/Skill Questions

• How does PBX work?
• How does PBX usage apply to your everyday activities?
• What causes problems with the PBX?

Task Number 70

Construct local loops of phone companies.

Definition

Construction should include

• identifying the components needed
• assembling the components
• troubleshooting the connection.

Process/Skill Questions

• How is the handset earpiece coupled into the circuit?
• What causes the audible dial tone heard in the receiver?
• What resources are available for locating information on local loops of phone companies?

Task Number 71

Describe the functions of the central exchange.

Definition

Description should include the location and its purpose as a collecting point for local subscriber lines.

Process/Skill Questions

• What does an exchange consist of?
• What consequences may result if the central telephone exchange loses power?
• What is the purpose of having several exchanges located in one building?
**Task Number 72**

**Differentiate among dedicated lines, metered, and switched services.**

**Definition**

Differentiation should include

- describing each service
- explaining the appropriate use for each service
- describing the strengths and weaknesses of each service.

**Process/Skill Questions**

- When is the best time to use each of the above services?
- What is a switched service?
- What are the strengths of each service?

**Task Number 73**

**Compare broadband DSL and ISDN.**

**Definition**

Comparison should include

- definition of the term *DSL* (digital subscriber line)—technology that provides Internet access by transmitting digital data over a local telephone network
- definition of the term *ISDN* (integrated services digital network)—technology that allows simultaneous voice and data transfer over a local telephone network
- the similarities and differences of the services
- the speed of each service.

**Process/Skill Questions**

- Why can DSL be used on a basic telephone line?
- What is a major market application for ISDN?
- What term would be used to describe a broad range of technologies that provide a higher data rate access to the Internet?

**Task Number 74**
Explain the purposes of local exchange carriers (LECs).

Definition

Explanation should state that LECs manage local telephone lines and switches, provide services within their business area, and handle incoming and outgoing long-distance calls.

Process/Skill Questions

- What are the two broad categories of a wireline telephone company?
- How are the two categories of wireline different?
- How did the implications of the 1984 divestiture of then-regulated monopoly carrier American Telephone and Telegraph affect telephony?

Task Number 75

Explore the history of telephone companies.

Definition

Exploration should include major milestones since the telephone company’s inception.

Process/Skill Questions

- Who made the first telephone communication and said, “Mr. Watson--come here--I want to see you”?
- Who invented an automatic telephone?
- What major event took place in 1893 and 1894 to cause the breakup of Bell’s monopolistic behavior?

Task Number 76

Explain the difference between LECs and ROCs (regional operating companies).

Definition

Explanation should include
• the reason for the creation of regional operating companies
• the function of ROCs.

Process/Skill Questions

• What is the purpose of regional operating companies?
• How do LECs relate to regional operating companies?
• How do ROCs apply to everyday life?

Task Number 77

Define independent telephone company.

Definition

Definition should state that an independent telephone company was a company outside the Bell System, organized by AT&T and operated in many rural areas.

Process/Skill Questions

• What is a Class 5 telephone switch?
• How did independent telephone companies operate?

Task Number 78

Explain network operations centers (NOCs).

Definition

Explanation should state that NOCs are responsible for monitoring power failures, communication alarms, and various other performance issues that affect networks.

Process/Skill Questions

• Why are NOCs essential in a network?
• What performance issues affect networks?
• How does a NOC monitor power failures?

Task Number 79

Define the terms In-band and Common Channel Signaling (CCS) and Signaling System 7 (SS7).
Definition

Definition should include the following:

- *Common Channel Signaling*—a signaling method in which one channel is reserved solely for network management; also referred to as out-of-band signaling.
- *Signaling System 7*—telephony signaling protocols used to set up public switched telephone network (PSTN).

Process/Skill Questions

- How does CCS function?
- What is the purpose of SS7?

Task Number 80

Describe a network control point (NCP).

Definition

Description should include

- defining the term *network control point* (a node in the signaling network used to store customer and routing information)
- how network control points are used in the SS7 structure.

Process/Skill Questions

- How does an NCP function?
- How does an NCP control the progression of a call?

Task Number 81

Explain the importance of digital subscriber lines.

Definition

Explanation should state that DSL allows digital signals to be transferred over telephone lines that are already in place.

Process/Skill Questions

- How does DSL work?
• What are the implications of being able to transfer digital information over analog lines?
• What resources are available for locating information on DSL?

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**Task Number 82**

**Explore digital solutions to telephony (VoIP and cellular services).**

**Definition**

Exploration should include

• the quality of telephone systems for computer networks
• cellular uplink and downlink.

**Process/Skill Questions**

• What are some features you would expect of a traditional PBX provided with NBX?
• What types of calls may be placed through the access to the PSTN via the NBX?
• How are uplinks and downlinks distinguished in a cellular system?

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**Applying Mathematics**

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**Task Number 83**

**Apply mathematics skills using electronics formulas.**

**Definition**

Application should include solving for unknown variables using

• Ohm’s law to calculate voltage, resistance, or current
• capacitive reactance \( X_C = \frac{1}{2\pi fC} \)
• inductive reactance \( X_L = \pi fL \).

**Process/Skill Questions**
• How much current is contained in a circuit if the total applied voltage is 12 volts and the resistance is 1,000 ohms?
• Why is it important for you to be able to use electronic formulas to solve for unknown values?
• Why does the capacitive reactance of a circuit increase when the circuit’s frequency decreases?
• What is the relationship of frequency to reactance in an inductive reactive circuit?

Task Number 84

Demonstrate proficiency with the use of scientific calculators.

Definition

Demonstration should include how to use the function keys and scientific notation, make and multiply fractions, store recall, and clear memory.

Process/Skill Questions

• What are the implications of not knowing how to properly use a scientific calculator?
• How do you create a fraction with your scientific calculator?
• What could cause an incorrect recall of stored data?

Task Number 85

Describe and use the electrical color code.

Definition

Description should include the standard color code for telecom cable, major and minor colors, basic electrical color-coding, and various mnemonics used to remember the color codes.

Process/Skill Questions

• What is the mnemonic used to recall the major/minor color groups of electrical telecommunication wiring?
• What resources are available for locating information on basic electrical color-coding?
• What are the implications of not knowing the standard telecom color codes?

Task Number 86
Produce a repair estimate.

**Definition**

Production of an estimate should include itemized consumables and man-hours to complete a task or tasks and be based on profitability concepts.

**Process/Skill Questions**

- What are the advantages of understanding the profitability concepts involved in a basic estimate?
- What role does communication play in presenting the estimate?
- How does the profitability concept apply to everyday life?

**Task Number 87**

**Explain costs of doing business in a repair or installation firm or department, using a profit and loss statement.**

**Definition**

Explanation should include

- defining profit and loss (a financial statement that summarizes the revenues, costs, and expenses incurred during a specific period of time – usually a fiscal quarter or year)
- creating a working form to model an understanding of repair or install costs
- understanding the effect of taxation on outcome.

**Process/Skill Questions**

- What is a profit and loss statement?
- What resources are available for locating information on items that may be found on a profit and loss statement?
- What are some possible profits that may result from operations?

**SOL Correlation by Task**

<table>
<thead>
<tr>
<th>Demonstrate special safety procedures required for outside equipment.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate compliance with OSHA requirements for telecommunications (Standard 1910.268).</td>
<td>History and Social Science: GOVT.9, GOVT.15</td>
</tr>
<tr>
<td>List safety procedures for operating a service truck.</td>
<td></td>
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<tr>
<td>Document procedures for eye and skin safety.</td>
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<tr>
<td>Task</td>
<td>Subject</td>
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<tr>
<td>---------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
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<tr>
<td>Describe electrostatic discharge.</td>
<td>English: 10.5, 11.5</td>
</tr>
<tr>
<td>Apply safe working practices around AC and DC circuits.</td>
<td></td>
</tr>
<tr>
<td>Demonstrate proper use of electronics tools and equipment.</td>
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</tr>
<tr>
<td>Analyze series and parallel DC circuit characteristics.</td>
<td>Science: PH.2, PH.11</td>
</tr>
<tr>
<td>Examine different types of circuit control devices.</td>
<td>Science: PH.1, PH.11</td>
</tr>
<tr>
<td>Examine the use of capacitors and inductors in DC circuits.</td>
<td>Science: PH.1, PH.11</td>
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<tr>
<td>Analyze alternating voltage and current.</td>
<td>Science: PH.1, PH.2, PH.11</td>
</tr>
<tr>
<td>Examine the use of capacitors and inductors in AC circuits.</td>
<td>Science: PH.1, PH.11</td>
</tr>
<tr>
<td>Analyze electrical power.</td>
<td>Science: PH.1, PH.2, PH.11</td>
</tr>
<tr>
<td>Assemble circuits on printed circuit boards.</td>
<td>Science: PH.12</td>
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<tr>
<td>Analyze semiconductor properties, devices, and integrated circuits.</td>
<td>Science: PH.1, PH.2, PH.11</td>
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<tr>
<td>Analyze amplifier circuits used in various electronics products.</td>
<td>Science: PH.1, PH.2, PH.11</td>
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<tr>
<td>Examine basic logic gates, logic truth tables, and digital signals.</td>
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<tr>
<td>Analyze the function of a basic telephone set.</td>
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<tr>
<td>Explain how software and hybrid hardware/software solutions may provide alternative solutions to problems.</td>
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<td>Explain worldwide numbering systems.</td>
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<tr>
<td>Explain computer telephony integration.</td>
<td>English: 10.5, 11.5</td>
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<td>Demonstrate proficiency with standard office software.</td>
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<td>Draw a basic building wiring plan, using a CADD program.</td>
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<td>Describe Internet and network topologies and technologies.</td>
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<td>Explain the different levels of the OSI and TCP/IP models.</td>
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<td>Demonstrate skills in file system navigation, accessing manuals, and editing files in various operating systems.</td>
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<tr>
<td>Research computer and Internet security problems.</td>
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<td>Outline the history of the telephone.</td>
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<td>History and Social Science: VUS.1, VUS.10, VUS.14</td>
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<tr>
<td>Demonstrate the basics of a wired voice system.</td>
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<td>Define <em>POTS, DID, OPX, tie-lines</em>, and <em>WATS</em> lines.</td>
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**Entrepreneurship Infusion Units**

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Associate Certified Electronics Technician (CETa) Examination
- Certified Alarm Security Technician (CAST) Examination
- Certified Satellite Installer (CSI) Examination
- College and Work Readiness Assessment (CWRA+)
- Customer Service Examination
- Customer Service Specialist (CSS) Examination
- Data Cabling Installer (DCI) Examination
- Electronics Module: AC (EM2) Examination
- Electronics Module: Analog (EM3) Examination
- Electronics Module: Comprehensive Basic (EM5) Examination
- Electronics Module: DC Basics (EM1) Examination
- Fiber Optics Installer (FOI) Examination
- General Communications Technician - Level 1 (GCT1) Examination
- National Career Readiness Certificate Assessment
- Network Cabling Specialist Certification Examinations
- Professional Communications Certification Examination
- Telecommunications Electronics Technician (TCM) Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.

- Telecommunications II (8651/36 weeks, 280 hours)

Career Cluster: Arts, Audio/Video Technology and Communications

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<tr>
<td></td>
<td>Sound Engineering Technician</td>
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<tr>
<td>Performing Arts</td>
<td>Video, Film Editor</td>
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<tr>
<td>Telecommunications</td>
<td>Computer Programmer</td>
</tr>
<tr>
<td></td>
<td>Network Systems and Data Communication Analyst</td>
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<tr>
<td></td>
<td>Telecommunications Equipment Installer, Repairer</td>
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