Telecommunications II

8651 36 weeks / 280 hours

Table of Contents

Acknowledgments ......................................................................................................................................... 1
Course Description........................................................................................................................................ 2
Task Essentials Table.................................................................................................................................... 3
Curriculum Framework ................................................................................................................................. 5
Examining Customer Relations .................................................................................................................... 5
Practicing Cabling and Splicing .................................................................................................................... 9
Working with Wireless Networks .................................................................................................................. 15
Working with Optical Wiring ....................................................................................................................... 16
Examining Digital Telephones ..................................................................................................................... 21
Exploring Satellite Telecommunication ....................................................................................................... 22
Examining Building and Office Wiring ......................................................................................................... 27
Developing Employability Skills .................................................................................................................. 28
SOL Correlation by Task ............................................................................................................................... 34
Entrepreneurship Infusion Units .................................................................................................................. 36
Appendix: Credentials, Course Sequences, and Career Cluster Information ................................................... 37

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
Copyright © 2014

Course Description

Suggested Grade Level: 11 or 12
Prerequisites: 8650

Students will learn about the technological and competitive advances now transforming the communications industry. This course will introduce students to the basic concepts and structural elements of voice, video, and data communications industry. Topics will include 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 Technicians, Satellite Technicians, 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 (◯) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

<table>
<thead>
<tr>
<th>Task Number</th>
<th>8651</th>
<th>Tasks/Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examining Customer Relations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>⊕</td>
<td>Explain how a customer service specialist may encounter problems with customers, fellow workers, or allied personnel.</td>
</tr>
<tr>
<td>40</td>
<td>⊕</td>
<td>Describe ways to resolve customer conflicts.</td>
</tr>
<tr>
<td>41</td>
<td>⊕</td>
<td>Explain outages and other weather or natural phenomena and ways to soothe customer complaints regarding them.</td>
</tr>
<tr>
<td>42</td>
<td>⊕</td>
<td>Analyze the costs to perform in-house and outside service work.</td>
</tr>
<tr>
<td>43</td>
<td>⊕</td>
<td>Demonstrate “customer orientation” procedures used with customers who may be unfamiliar with the equipment you have installed.</td>
</tr>
<tr>
<td>44</td>
<td>⊕</td>
<td>Contrast poor cabling and wire-dressing work with good-quality wiring and installation.</td>
</tr>
<tr>
<td>45</td>
<td>⊕</td>
<td>Describe ways the service technician can help his company by assisting the sales or marketing functions of the business.</td>
</tr>
<tr>
<td><strong>Practicing Cabling and Splicing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>⊕</td>
<td>Contrast unshielded twisted pair (UTP), shielded twisted pair (STP), and screened twisted pair (ScTP) cable.</td>
</tr>
<tr>
<td>47</td>
<td>⊕</td>
<td>Demonstrate ability to install RJ-45, RJ-11, F-type, and BNC connectors.</td>
</tr>
<tr>
<td>48</td>
<td>⊕</td>
<td>Construct a cable TV network capable of transferring data and voice services.</td>
</tr>
<tr>
<td>49</td>
<td>⊕</td>
<td>Differentiate among coaxial cables.</td>
</tr>
<tr>
<td>50</td>
<td>⊕</td>
<td>Compare signal transmission capabilities of coaxial cable, CAT-5 cable, and fiber cabling.</td>
</tr>
<tr>
<td>51</td>
<td>⊕</td>
<td>Explain signal losses associated with long cable runs.</td>
</tr>
<tr>
<td>52</td>
<td>⊕</td>
<td>Construct a grounding subsystem for a telecommunications system.</td>
</tr>
<tr>
<td>53</td>
<td>⊕</td>
<td>Describe usage of cables for special applications (e.g., plenum, aerial, direct burial).</td>
</tr>
<tr>
<td>54</td>
<td>⊕</td>
<td>Analyze the effects of common cable casualties.</td>
</tr>
<tr>
<td>55</td>
<td>⊕</td>
<td>Explain impedance and impedance-matching requirements.</td>
</tr>
<tr>
<td><strong>Working with Wireless Networks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>⊕</td>
<td>Explore home and commercial wireless networking solutions.</td>
</tr>
<tr>
<td>57</td>
<td>⊕</td>
<td>Construct a wireless network.</td>
</tr>
<tr>
<td><strong>Working with Optical Wiring</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>⊕</td>
<td>Execute the steps in handling and disposal of optical fiber.</td>
</tr>
<tr>
<td>59</td>
<td>⊕</td>
<td>Classify types of optical cables, including different parameters of each.</td>
</tr>
<tr>
<td>60</td>
<td>⊕</td>
<td>List the components used in the construction of fiber optic cable.</td>
</tr>
<tr>
<td>Task Number</td>
<td>Tasks/Competencies</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Identify components of fiber optic cable.</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Terminate different types of fiber cable (loose-tube, break-out, armored, etc.).</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Demonstrate splicing methods.</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Identify different types of fiber connectors.</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>Describe the effect of distance on copper and fiber service.</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Demonstrate the use of light meters and light sources.</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>Explain the electrical to optical conversion process.</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Research historical voice and data solutions.</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Describe the C and Ku frequency bands.</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Describe the function of a Low Noise Block Downconverter (LNBD).</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Explain the components of common satellite signals.</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Explain the functions of a common satellite receiver.</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Describe the focal point and the focal distance of a dish.</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Explain the function of fixed, diode-switching, and dual-feed feedhorns.</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Describe the installation, calibration and testing of different types of dishes.</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>Analyze distribution problems in the input and output feeds.</td>
<td></td>
</tr>
<tr>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Research wiring standards.</td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>Distinguish among the methods of pre-wiring and ways to wire existing structures.</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>83</td>
<td>Investigate careers in the information technology field.</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>Create a printed résumé, including a résumé format suitable for posting online.</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>Research certification and educational opportunities.</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>Compose a letter of application.</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>Complete an electronic application form.</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>Compose an interview follow-up letter.</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>Identify the steps to follow in resigning from a position.</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>Develop a portfolio containing representative samples of a student’s work and make an oral presentation.</td>
<td></td>
</tr>
<tr>
<td>Task Number</td>
<td>Tasks/Competencies</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>Identify potential employment barriers for nontraditional groups and ways to overcome the barriers.</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>Research opportunities for government or government contractor employment.</td>
<td></td>
</tr>
</tbody>
</table>

Curriculum Framework

Examining Customer Relations

Task Number 39

Explain how a customer service specialist may encounter problems with customers, fellow workers, or allied personnel.

Definition

Explanation should include

- researching best practices for customer service personnel
- identifying ways to anticipate customer needs
- identifying and listing good communication practices
- demonstrating how to be friendly and courteous to customers and fellow workers.

Process/Skill Questions

- Why is it important to be familiar with common best practices for customer relations?
- What would happen if a service technician failed to maintain a professional attitude while assisting a customer?
- What resources are available for learning good customer and workplace relations practices?

Task Number 40
Describe ways to resolve customer conflicts.

Definition

Description should include

- explaining how to properly communicate with a customer
- explaining the importance of good speaking and listening skills
- demonstrating the importance of smiling, being friendly, making eye contact, and being courteous
- explaining the importance of solving the customer’s problems promptly
- explaining how to direct the customer to others if you are unable to resolve the problem.

Process/Skill Questions

- What are some ways that you can reassure the customer that you are listening?
- Why is it important to solve customer problems in a timely manner?
- What should you do if you are unable to solve a customer problem?

Task Number 41

Explain outages and other weather or natural phenomena and ways to soothe customer complaints regarding them.

Definition

Explanation includes:

- contrasting the different types of weather events that commonly cause power and communication outages
- understanding how natural phenomena cause problems with power and communication equipment and systems
- understanding the importance of good service and maintenance in helping to prevent outages
- describing the importance of providing customers with ways to communicate service problems
- describing the importance of keeping the customer informed about the status of the issue and the importance of assuring the customer that restoring service is very important to you.

Process/Skill Questions

- Why is it important to understand how weather affects power and communication systems?
• How might good periodic maintenance and service provide a line of defense against the effects of natural phenomena?
• Why must a technician be concerned about reassuring the customer that the problem is being handled?

**Task Number 42**

**Analyze the costs to perform in-house and outside service work.**

**Definition**

Analysis should include

- identifying procedures required for in-house and outside service calls
- explaining the significance of creating an itemized bill of materials needed for a particular service call
- describing the importance of the service charge covering the cost of materials and labor.

**Process/Skill Questions**

- What might result if a technician does not keep a good account of all materials needed for a service job?
- Why is it a good idea to consider materials charges and labor charges separately?
- What strategies may be effective in keeping track of parts and materials needed for a service call?

**Task Number 43**

**Demonstrate “customer orientation” procedures used with customers who may be unfamiliar with the equipment you have installed.**

**Definition**

Demonstration should include

- describing best practices for demonstrating the use of newly installed equipment to customers
- describing why it is important that the customer be familiar with the installed equipment before you leave
• explaining how customer misunderstanding about equipment may lead to future service calls
• explaining potential safety concerns that may arise if the customer is unfamiliar with the newly installed equipment.

Process/Skill Questions

• Why is it important for technicians to explain the operation of new equipment to the customer?
• How might a service call result from a customer being unfamiliar with the equipment?
• How could being unfamiliar with equipment be a safety hazard to the customer?

Task Number 44

Contrast poor cabling and wire-dressing work with good-quality wiring and installation.

Definition

Contrast of work should include

• defining good-quality wiring practices
• identifying poor wiring practices
• examining various conduit, raceway, harness, and strapping products that aid in good-quality wiring installations
• listing resources for good wiring practices such as the National Electrical Code
• identifying potential safety concerns surrounding poor cabling installations
• estimating the potential cost difference between good-quality and poor wiring installations.

Process/Skill Questions

• What is it important to always “dress up” your wiring installations?
• Why is it important for a technician to be familiar with the latest products made to help create quality wiring installations?
• What might be some potential safety concerns with poorly wired installations?

Task Number 45

Describe ways the service technician can help his company by assisting the sales or marketing functions of the business.
Definition

Description should include

- understanding the function of the sales and marketing departments of a business
- describing the importance of understanding your company’s business model, goals, and structure
- identifying how the service technician’s job may affect company sales.

Process/Skill Questions

- What is the function of the sales department of a company?
- Why is it important for a technician to understand the overall business model of the company?
- How might poor technical service affect overall company sales?

Practicing Cabling and Splicing

Task Number 46

Contrast unshielded twisted pair (UTP), shielded twisted pair (STP), and screened twisted pair (ScTP) cable.

Definition

Contrast should include

- identifying the components of cable construction
- describing the purpose of each component of cable construction
- identifying appropriate applications of each type of cable
- identifying the various environmental ratings of twisted pair cabling
- describing the appropriate applications for the common environmental rating of cabling.

Process/Skill Questions

- What are the components of twisted pair cables?
- Why are shields and screens used in some twisted pair cable applications?
- What is the difference between the common environmental ratings (e.g., CM, CMR, CMP) of cables?
• Where are these types of cables used?

Task Number 47

Demonstrate ability to install RJ-45, RJ-11, F-type, and BNC connectors.

Definition

Demonstration should include

• identifying various types of cable connectors
• identifying the appropriate tools used for cable termination
• identifying safety concerns associated with cable termination
• applying associated industry standards for cable termination
• using the appropriate test equipment to verify proper cable termination.

Process/Skill Questions

• What tools are required to terminate cables using RJ-45/RJ-11/F-type/BNC connectors?
• What industry standards apply to terminating cables with RJ-45/RJ-11/F-type/BNC connectors?
• What test equipment can be used to test cables terminated with RJ-45/RJ-11/F-type/BNC connectors?
• How do you test a cable terminated with RJ-45/RJ-11/F-type/BNC connectors to determine whether the installation is correct?
• In what cases would you use T568A and T568B termination?

Task Number 48

Construct a cable TV network capable of transferring data and voice services.

Definition

Construction should include

• identifying network needs
• designing the network
• selecting appropriate network components
• selecting necessary tools and test equipment
• identifying relevant safety precautions
• installing the necessary components and cables
• terminating installed cables
• connecting cables to network components
• testing the network to verify correct operation.

Process/Skill Questions

• What information is necessary to determine network design?
• Where would you locate component specifications to use in network design?
• What is the difference between passive and active network components?
• What topographies would be appropriate for network design?

Task Number 49

Differentiate among coaxial cables.

Definition

Differentiation should include

• standard grades of cable
• impedance of common grades of cable
• type and number of shields used in cable construction
• construction of cables used in special applications (aerial, direct-burial, plenum, etc.)
• identification of connectors used in common coaxial cable applications
• importance of coaxial cable geometry.

Process/Skill Questions

• What effect does impedance have on signal transmission in coaxial cables?
• How do you determine what type of connector to use in terminating coaxial cable?
• What are the implications of changing the geometry of coaxial cables during installation?
• What are the implications of not using the appropriate type of cable in special applications (aerial, direct-burial, plenum)?

Task Number 50

Compare signal transmission capabilities of coaxial cable, CAT-5 cable, and fiber cabling.
Definition

Comparison should include

- type of signal (voltage, modulated radio frequency, digital modulation, light pulses)
- signal propagation distance limitations
- signal attenuation
- crosstalk
- structured cable certification test
- certification standards.

Process/Skill Questions

- What are the factors that determine length limits for cables?
- What is the cause of signal attenuation on cables?
- What is the purpose of each of the tests performed in the cable certification process?

Task Number 51

Explain signal losses associated with long cable runs.

Definition

Explanation should include

- factors that contribute to signal loss
- resources for computing signal losses
- calculation of signal loss at specific cable installations
- test equipment necessary to measure signal loss.

Process/Skill Questions

- What are the main causes of signal loss in cables?
- How can you calculate the maximum distance over which a signal can be sent over a cable?
- What are the implications of excessive signal loss in cables?
- How would you measure the signal loss in a cable run?

Task Number 52
Construct a grounding subsystem for a telecommunications system.

Definition

Construction should include

- identification of standards and codes applicable to providing a system ground
- identification of wire, connectors, and components to be used in establishing system ground
- selection of tools needed to construct system ground
- installation of connectors used on grounding conductors
- interconnection of grounding conductors and components to form the grounding subsystem.

Process/Skill Questions

- What documents govern the installation of the grounding subsystem in a structured cable system?
- What is the importance of installing a proper grounding subsystem?
- Why does the National Electrical Code (NEC) dedicate an entire chapter to grounding?
- Where would you find guidance for component selection for a grounding subsystem?

Task Number 53

Describe usage of cables for special applications (e.g., plenum, aerial, direct burial).

Definition

Description should include

- identification of environments that require specially constructed cables
- construction of specialty cables
- differences between common cables and cables designed for special applications
- differences in installation and termination of cables for special applications.

Process/Skill Questions

- What types of environments might require specially constructed cables?
- What are the implications of not using the appropriate cable in the environments that require them?
- How are common cables different from those designed for special applications?
Task Number 54

Analyze the effects of common cable casualties.

Definition

Analysis should include

- discussion of common mistakes made during cable installation and termination
- identification of test equipment used for troubleshooting cable system casualties
- interpretation of data collected during the troubleshooting process.

Process/Skill Questions

- What test equipment is available for troubleshooting cable casualties?
- What are the common causes of casualties in cable installations?
- What are the basic steps of the process employed in troubleshooting cable system casualties?

Task Number 55

Explain impedance and impedance-matching requirements.

Definition

Explanation should include

- understanding of balanced and unbalanced transmission lines
- the effects of mismatched impedance between components in a cable system
- the making of impedance measurements
- the design of impedance-matching devices

Process/Skill Questions

- What are the implications of having components in a system with mismatched impedance?
- How do impedance-matching devices function?
- How do you resolve the problem of mismatched impedance between components?
Working with Wireless Networks

Task Number 56

Explore home and commercial wireless networking solutions.

Definition

Exploration should include

- identification of standards employed in wireless network design
- identification of components used in creating wireless networks
- evaluation of wireless network component requirements, features, and capabilities
- the capabilities and limitations of wireless networks
- issues related to security of wireless networks
- identification of common wireless network security protocols.

Process/Skill Questions

- Why do we employ standards in creating wireless networks?
- What is the advantage of using Power over Ethernet (PoE)?
- Why is security an important consideration in creating wireless networks?
- What are the commonly used wireless security protocols?
- What are the main limitations to wireless network components?

Task Number 57

Construct a wireless network.

Definition

Construction should include

- defining network requirements
- designing the network
- selecting appropriate components to meet network requirements
- installing wireless network components
• configuring wireless network components.

Process/Skill Questions

• What factors must be taken into account when selecting the active components for a wireless network?
• What are the implications of inadequate security on a wireless network?
• What are the appropriate steps to take in testing the operation and security when installing a wireless network?
• What are some of the settings that should be changed from the factory default settings when configuring wireless network components?

Working with Optical Wiring

Task Number 58

Execute the steps in handling and disposal of optical fiber.

Definition

Execution should include following safety procedures for handling and disposal of fiber.

Process/Skill Questions

• What resources are available for disposing of optical fiber?
• Why must you never open the sharps container?
• What should you always do after handling fiber and before touching your face or eating?
• Where should you place used applicator tips?

Task Number 59

Classify types of optical cables, including different parameters of each.

Definition

Classification should include

• multimode 62.5/125
• multimode 50/125
• single mode 9/125
• identifying the best cable to use in a given situation.

Process/Skill Questions

• What is the difference between multimode and single mode?
• What is the part of the cable in which the optical signal travels?

Task Number 60

List the components used in the construction of fiber optic cable.

Definition

List should include connectors, adapters, splice enclosures, and outlets.

Process/Skill Questions

• When testing a splice, what is the maximum allowable attenuation by standard?
• What does the term MAC mean?
• Which fiber optic splicing method does not require glue, is cost effective, and can be reopened?

Task Number 61

Identify components of fiber optic cable.

Definition

Identification should include stripping the cable to expose and name the core, cladding, and buffer components of fiber optic cable.

Process/Skill Questions

• What was invented along with pure glass in the development of fiber optic communications?
• What mode of fiber optic cabling is described if only one ray of light is allowed to propagate down the fiber?
• What term describes the way a light beam moves through a fiber?

---

**Task Number 62**

**Terminate different types of fiber cable (loose-tube, breakout, armored, etc.).**

**Definition**

Termination requires the demonstration of a variety of elements including

- workstation preparation
- assembling necessary tools and consumables
- following safety procedures.

**Process/Skill Questions**

- What consequences would result if a cable were not terminated properly?
- What safety measures must be considered when terminating all types of fiber?
- When should you test the fiber optic cable for continuity?

**Task Number 63**

**Demonstrate splicing methods.**

**Definition**

Demonstration includes following manufacturer’s guidelines in the use of splice trays and the following methods:

- Adhesive
- Anaerobic
- Chemical bonding
- Fusion
- Hot melt
- Mechanical fiber

**Process/Skill Questions**

- What three safety items may be used when building a fiber optic cable?
- What are the steps to apply epoxy to connect a fiber connector?
How is following a checklist beneficial to successfully developing fiber optic cables?

Task Number 64

Identify different types of fiber connectors.

Definition

Identification should include

- single tip (ST), which uses a bayonet coupling
- snap connector (SC), used in single- and multimode telecommunications and data systems
- FC, which is mainly used with single-mode telecommunications systems in Europe and Asia.

Process/Skill Questions

- What consequences may result from not using the proper type of connector to a buffered cable?
- When determining what type of connector to use, what factors must you consider?
- How do you properly terminate an SC connector to a patch cord?

Task Number 65

Describe the effect of distance on copper and fiber service.

Definition

Description should include the advantages and disadvantages of each, and how distance influences selection.

Process/Skill Questions

- When retrofitting a building, what distances must be considered to determine use of fiber or copper?
- What safety issues must considered when installing copper vs. fiber?
- How do you convince your customer that one is better than the other for the situation?
Task Number 66

Demonstrate the use of light meters and light sources.

Definition

Demonstration should follow manufacturer’s specifications and ensure optimal effectiveness of fiber cabling.

Process/Skill Questions

- What are intrinsic and extrinsic attenuations in optical systems?
- What is the difference between modal and chromatic dispersion?
- What type of dispersions results from light traveling at different angles?

Task Number 67

Explain the electrical to optical conversion process.

Definition

Explanation should include the identification of the four characteristics of light: speed, wavelength and frequency, movement, and amplitude.

Process/Skill Questions

- What is the difference between reflection and refraction?
- How does light bend when it travels through different materials?
- How fast does light move in fiber optic technology? At what wavelength?

Task Number 68

Explain synchronous optical network (SONET) and dense wavelength division multiplexing (DWDM).

Definition

Explanation should include
• defining the term **SONET** (synchronous optical network)—a technology standard that defines optical signals and a synchronous frame structure for multiplexed digital traffic
• defining the term **DWDM** (dense wavelength division multiplexing)—a technique for increasing the bandwidth of optical network communication by putting data from different sources together on an optical fiber, but at different wavelengths
• understanding the factors involved in the use of each.

**Process/Skill Questions**

• What OSI layer would best describe where SONET resides?
• What are the implications of using SONET vs. DWDM?
• What format employs multiple light wavelengths to transmit signals over a single optical fiber?

---

**Examining Digital Telephones**

---

**Task Number 69**

**Research historical voice and data solutions.**

**Definition**

Research should include

• defining voice solutions and when they were first implemented
• defining data solutions and when they were first implemented
• determining which solution is best for a particular situation.

**Process/Skill Questions**

• Who first implemented voice and data solutions?
• How did voice and data evolve over time?
• What problems could arise from outdated voice and data solutions?

**Task Number 70**
Compare the advantages of bundled and unbundled telephone services from the perspective of providers and customers.

Definition

Comparison should include

- types of services offered
- benefits to the customer
- benefits to the providers.

Process/Skill Questions

- What are major advantages of bundled and unbundled telephone systems?
- Why are telephone providers choosing to bundle their service?
- What are the benefits of a customer choosing to bundle telephone services as opposed to keeping them separated?

Exploring Satellite Telecommunication

Task Number 71

Describe the C and Ku frequency bands.

Definition

Description should include

- explanation of the electromagnetic spectrum and the major “bands”
- comparison of the bands, including frequency and wavelength
- correlation of frequency/wavelength to size and type of equipment used to communicate within each band.

Process/Skill Questions

- What are the main frequency bands used for public satellite communications?
- What is the difference in the equipment used with each satellite frequency band compared to the others?
- In what type of orbit are telecommunications satellites found?
• Why are telecommunications satellites in this type of orbit?

**Task Number 72**

**Describe the function of a Low Noise Block Downconverter (LNBD).**

**Definition**

Description should include

- the components that make up the LNBD, including low-noise amplifier, frequency mixer, local oscillator, and IF amplifier
- the function of each component that makes up the LNBD
- the location of and physical description of the LNBD
- the role of polarization in the transmission of satellite signals.

**Process/Skill Questions**

- What components make up an LNBD?
- What is the function of each component of the LNBD?
- Why is the LNBD located behind the antenna feedhorn?
- What is the difference between horizontal/vertical polarization and circular polarization?
- How is polarization used in telecommunications satellite communication?

**Task Number 73**

**Explain the components of common satellite signals.**

**Definition**

Explanation should include

- NTSC, PAL, or SECAM television broadcast standards
- quadrature phase-shift keying (QPSK) for digitized television signal or multiplex of signals
- digital television using open standards such as MPEG and DVB-S or ISDB-S
- conditional access using encryption/scrambling methods
- direct broadcast via satellite, television receive-only, and direct-to-home television.

**Process/Skill Questions**
- What are the differences between NTSC, PAL, and SECAM?
- Why is QPSK used with digital signal distribution rather than NTSC, PAL, or SECAM?
- What is the difference between open standards and conditional access?

---

**Task Number 74**

**Explain the functions of a common satellite receiver.**

**Definition**

Explanation should include

- satellite receiver processes the signal from the satellite dish and broadcasts it to the output device or devices
- signal compression/decompression including MPEG standards
- encoding including intraframe, predicted frame, and bidirectional frame
- encryption and decryption of secure signals.

**Process/Skill Questions**

- What functions are performed by the satellite receiver?
- Why is signal compression used in satellite communications?
- What is encoding and how is it used?
- Why are some satellite signals encrypted?

---

**Task Number 75**

**Describe the focal point and the focal distance of a dish.**

**Definition**

Description should include

- the terms associated with parabolic reflectors, including *diameter*, *vertical height*, *focal length*, and *focal point*
- the mathematical relationship between the dish characterization quantities \( F = D^2 / 16H \) and \( F / D = 1 / [ 4 \tan(\Theta/2) ] \)
- the importance of the reflected signal being a collimated beam.

**Process/Skill Questions**
• Why are parabolic reflectors used for satellite communications?
• What measures are necessary to calculate the focal point of a parabolic reflector?
• What is the meaning of collimated radiation?
• Why is it desirable to have a collimated beam of radiation from a satellite antenna?

**Task Number 76**

**Explain the function of fixed, diode-switching, and dual-feed feedhorns.**

**Definition**

Explanation should include

• describing linear and circular polarization
• describing fixed polarization orientation
• identifying pin diodes used for switching between horizontal and vertical polarization
• circular polarization (clockwise and counterclockwise)
• converting from circular to linear polarization
• distinguishing between diode switching and dual feed
• diagramming diode switching and dual feed.

**Process/Skill Questions**

• What is the difference between circular and linear polarization?
• How is polarization changed on an antenna?
• Why can two different signals be transmitted on the same channel/frequency?
• How is circular polarization converted to linear polarization? Linear to circular?

**Task Number 77**

**Describe the installation, calibration and testing of different types of dishes.**

**Definition**

Description should include

• discussion of geosynchronous orbit
• measurement of elevation
• measurement of azimuth
• measurement of received signal strength.
Process/Skill Questions

- What are the characteristics of geospatial orbits?
- Why do television satellites fly in geospatial orbits?
- How do you determine where to position a satellite dish to receive the best signal from a satellite?
- What devices can be used for measuring received signal strength?

Task Number 78

Analyze distribution problems in the input and output feeds.

Definition

Analysis should include

- effect of obstructions on received signal strength
- effect of discontinuity on signal transmission
- causes of discontinuity in transmission lines
- effect of polarization on received signal strength.

Process/Skill Questions

- What are the most common situations that interfere with signal reception and transmission?
- What is the cause of the most common discontinuity in coaxial cables?
- How do you determine whether there is a discontinuity in a coaxial cable?
- How does the signal propagate through a coaxial waveguide?

Task Number 79

Compare different types of antennas for distribution of satellite feeds.

Definition

Comparison should include

- types of wireless distribution systems available, including
- UHF
- LoftBox
- SCART
- EIA multiport

- advantages and disadvantages of each system
- installation process of each system.

**Process/Skill Questions**

- What types of systems are available for television distribution from a satellite receiver throughout a home?
- How would you explain the differences in distribution systems to a client?
- How do the various systems compare from an installation standpoint?

---

**Examining Building and Office Wiring**

**Task Number 80**

**Research wiring standards.**

**Definition**

Research should include standards developed by the Occupational Safety and Health Administration and the Telecommunications Industry Association, as well as local building codes.

**Process/Skill Questions**

- Why are there standards?
- Who can modify the standards?
- Why are there local building codes?

**Task Number 81**

**Distinguish among the methods of pre-wiring and ways to wire existing structures.**

**Definition**
Distinction should include the application and general rules related to the following:

- entry, attic, and crawlspace precautions
- fishing walls
- routing wiring through false ceilings

**Process/Skill Questions**

- How do you prevent damage to wiring during installation?
- What type of wiring should be used in false ceilings?
- What type of wiring should be used in walls?

---

**Task Number 82**

**Explain the National Electrical Code (NEC) or other safety rules pertaining to structural wiring.**

**Definition**

Explanation should include the purpose, scope, and intent of Article 90–Introduction and Chapter 8: Communications.

**Process/Skill Questions**

- Who is responsible for enforcing the National Electrical Code?
- Who must comply with the NEC?
- What other safety rules govern structural wiring?

---

**Developing Employability Skills**

---

**Task Number 83**

**Investigate careers in the information technology field.**

**Definition**

Investigation includes using the Internet, magazines, books, and other resources to research characteristics, skills, benefits, and occupations found in industrial maintenance.
Process/Skill Questions

- What personal characteristics are best suited for work in the information technology field?
- What are some local employers of information technology workers?
- What are some benefits of a job in the information technology field?

Task Number 84

Create a printed résumé, including a résumé format suitable for posting online.

Definition

Creation of the résumé should include

- educational background
- work history
- honors and awards
- membership in club and/or community activities, leadership positions held, and community service.

Students should identify the reasons for keeping a résumé current to reflect experience and education credentials even if they are not currently involved in a job search.

Process/Skill Questions

- What are the basic purposes of a résumé?
- Should a résumé contain the applicant's photograph? Age? Ethnic origin? Gender? Why or why not?
- What are the benefits and pitfalls of submitting an electronic résumé?
- How can a person best present his or her skills and experience to fit a particular career area or job?

Task Number 85

Research certification and educational opportunities.

Definition

Research should include:
• exploring resources such as the Virginia Employment Commission and Virginia VIEW
• examining instructor-provided resources such as newspapers, trade journals, and online sources
• examining industry certification opportunities provided by certification organizations such as the National Occupational Competency Testing Institute (NOCTI) and the Electronics Technicians Association, International (ETA International)
• exploring educational opportunities using resources such as the Virginia Community College System.

Process/Skill Questions

• What resources are helpful in finding employment in the telecommunications field?
• What opportunities are provided by organizations such as NOCTI and ETA International?
• Why is it important to research sources of educational, employment, and certification information?

Task Number 86

Compose a letter of application.

Definition

Composition should include

• use of proper letter format
• reference to enclosed résumé, highlighting qualifications and relevant background
• request for an interview
• special attention to grammar and content.

Process/Skill Questions

• Why is a letter of application important?
• What is the proper format for a letter of application?

Task Number 87

Complete an electronic application form.

Definition

Application form should reflect attention to the following concerns:
• parts of an employment application (e.g., name, address, Social Security number, education, work experiences, job title, references, other qualifications)
• references (ask permission before using)

The electronic application form should include complete, accurate, and effectively organized information. It should follow additional criteria specifically related to electronic transmittal of such information (e.g., attention to security concerns, inclusion of key words to enhance interest in the application).

Process/Skill Questions

• Why is it important to ask a person's permission before using his or her name as a reference?
• How can you prepare to complete an online application?
• Why is honesty important when completing a job application? What could happen if a job applicant is not honest?
• Why should you dress professionally when visiting a company to obtain an application?
• What can a job application tell an employer about an applicant?

Task Number 88

Compose an interview follow-up letter.

Definition

Composition should include

• appropriate business letter format
• expression of appreciation for the interview as a business courtesy
• reminder of the applicant's qualifications
• confirmation of the applicant's interest in the job
• request for further action, perhaps a second interview or meeting.

Process/Skill Questions

• What’s the importance of a follow-up letter?
• When should you send a follow-up letter?
• Should it be an email or typed or handwritten note?
• To whom should this correspondence be sent?
• What should be included in the letter?

Task Number 89
Identify the steps to follow in resigning from a position.

Definition

Identification of steps should include

- providing an example of an oral or written resignation from the job
- demonstrating the provision of ample time to find a replacement, typically two weeks
- conveying an offer to train the replacement.

Process/Skill Questions

- Who would receive a letter of resignation?
- Why is it necessary to give at least two weeks' notice when leaving a job?
- When would it be appropriate to resign by another type of communication?

Task Number 90

Develop a portfolio containing representative samples of a student’s work and make an oral presentation.

Definition

Portfolio should include a résumé and a combination of electronic and non-electronic documents representative of the student’s qualifications. Selected documents should reflect the student’s knowledge, skills, and abilities.

Process/Skill Questions

- What types of skills should be reflected in a portfolio?
- What types of information would belong in a telecommunications applicant’s portfolio?
- What are other ways to promote your skills and abilities?

Task Number 91

Identify potential employment barriers for nontraditional groups and ways to overcome the barriers.

Definition
Identification of employment barriers should include

- gender
- ethnicity
- age
- discrimination in hiring or promoting.

Ways to overcome the barriers should include

- scholarships
- job training programs
- mentorships
- minority assistance programs.

**Process/Skill Questions**

- What regulations and laws exist to reduce discrimination in the workplace?
- How would you answer interview questions regarding gender or age?
- What federal and state agencies regulate workplace hiring practices?

**Task Number 92**

**Research opportunities for government or government contractor employment.**

**Definition**

Research should include

- correlating skills and knowledge with job requirements
- exploring available jobs using a variety of resources
- understanding the effects of social media on employment
- identifying any additional requirements or certifications for the job (e.g., security clearance)
- selecting a target job.

**Process/Skill Questions**

- What types of resources would you use to find work as a government contractor?
- What is a security clearance?
- What effect does social media have on getting a job? On keeping a job?
## SOL Correlation by Task

<table>
<thead>
<tr>
<th>Task</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain how a customer service specialist may encounter problems</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>with customers, fellow workers, or allied personnel.</td>
<td></td>
</tr>
<tr>
<td>Describe ways to resolve customer conflicts.</td>
<td></td>
</tr>
<tr>
<td>Explain outages and other weather or natural phenomena and ways to</td>
<td></td>
</tr>
<tr>
<td>soothe customer complaints regarding them.</td>
<td></td>
</tr>
<tr>
<td>Analyze the costs to perform in-house and outside service work.</td>
<td>History and Social Science: GOVT.1, GOVT.15</td>
</tr>
<tr>
<td>Demonstrate “customer orientation” procedures used with customers</td>
<td></td>
</tr>
<tr>
<td>who may be unfamiliar with the equipment you have installed.</td>
<td></td>
</tr>
<tr>
<td>Contrast poor cabling and wire-dressing work with good-quality wiring and installation.</td>
<td></td>
</tr>
<tr>
<td>Describe ways the service technician can help his company by assisting the sales or marketing functions of the business.</td>
<td></td>
</tr>
<tr>
<td>Contrast unshielded twisted pair (UTP), shielded twisted pair (STP), and screened twisted pair (ScTP) cable.</td>
<td></td>
</tr>
<tr>
<td>Demonstrate ability to install RJ-45, RJ-11, F-type, and BNC connectors.</td>
<td></td>
</tr>
<tr>
<td>Construct a cable TV network capable of transferring data and voice services.</td>
<td></td>
</tr>
<tr>
<td>Differentiate among coaxial cables.</td>
<td></td>
</tr>
<tr>
<td>Compare signal transmission capabilities of coaxial cable, CAT-5 cable, and fiber cabling.</td>
<td></td>
</tr>
<tr>
<td>Explain signal losses associated with long cable runs.</td>
<td></td>
</tr>
<tr>
<td>Construct a grounding subsystem for a telecommunications system.</td>
<td></td>
</tr>
<tr>
<td>Describe usage of cables for special applications (e.g., plenum, aerial, direct burial).</td>
<td></td>
</tr>
<tr>
<td>Analyze the effects of common cable casualties.</td>
<td>Science: PH.2</td>
</tr>
<tr>
<td>Explain impedance and impedance-matching requirements.</td>
<td></td>
</tr>
<tr>
<td>Explore home and commercial wireless networking solutions.</td>
<td></td>
</tr>
<tr>
<td>Construct a wireless network.</td>
<td></td>
</tr>
<tr>
<td>Execute the steps in handling and disposal of optical fiber.</td>
<td></td>
</tr>
<tr>
<td>Classify types of optical cables, including different parameters of each.</td>
<td></td>
</tr>
<tr>
<td>List the components used in the construction of fiber optic cable.</td>
<td></td>
</tr>
<tr>
<td>Identify components of fiber optic cable.</td>
<td></td>
</tr>
<tr>
<td>Terminate different types of fiber cable (loose-tube, break-out, armored, etc.).</td>
<td></td>
</tr>
<tr>
<td>Demonstrate splicing methods.</td>
<td></td>
</tr>
<tr>
<td>Identify different types of fiber connectors.</td>
<td></td>
</tr>
<tr>
<td>Describe the effect of distance on copper and fiber service.</td>
<td></td>
</tr>
<tr>
<td>Demonstrate the use of light meters and light sources.</td>
<td></td>
</tr>
<tr>
<td>Explain the electrical to optical conversion process.</td>
<td>Science: PH.8, PH.9</td>
</tr>
<tr>
<td>Task</td>
<td>Course Codes</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Explain synchronous optical network (SONET) and dense wavelength</td>
<td>English: 11.8, 12.8</td>
</tr>
<tr>
<td>division multiplexing (DWDM).</td>
<td></td>
</tr>
<tr>
<td>Research historical voice and data solutions.</td>
<td></td>
</tr>
<tr>
<td>Compare the advantages of bundled and unbundled telephone services</td>
<td></td>
</tr>
<tr>
<td>from the perspective of providers and customers.</td>
<td></td>
</tr>
<tr>
<td>Describe the C and Ku frequency bands.</td>
<td>Science: PH.9</td>
</tr>
<tr>
<td>Describe the function of a Low Noise Block Downconverter (LNBD).</td>
<td></td>
</tr>
<tr>
<td>Explain the components of common satellite signals.</td>
<td></td>
</tr>
<tr>
<td>Explain the functions of a common satellite receiver.</td>
<td></td>
</tr>
<tr>
<td>Describe the focal point and the focal distance of a dish.</td>
<td>Science: PH.8, PH.9</td>
</tr>
<tr>
<td>Explain the function of fixed, diode-switching, and dual-feed</td>
<td>Science: PH.8, PH.9</td>
</tr>
<tr>
<td>feedhorns.</td>
<td></td>
</tr>
<tr>
<td>Describe the installation, calibration and testing of different</td>
<td></td>
</tr>
<tr>
<td>types of dishes.</td>
<td></td>
</tr>
<tr>
<td>Analyze distribution problems in the input and output feeds.</td>
<td></td>
</tr>
<tr>
<td>Compare different types of antennas for distribution of satellite</td>
<td></td>
</tr>
<tr>
<td>feeds.</td>
<td></td>
</tr>
<tr>
<td>Research wiring standards.</td>
<td>English: 11.8, 12.8</td>
</tr>
<tr>
<td>Distinguish among the methods of pre-wiring and ways to wire</td>
<td></td>
</tr>
<tr>
<td>existing structures.</td>
<td></td>
</tr>
<tr>
<td>Explain the National Electrical Code (NEC) or other safety rules</td>
<td></td>
</tr>
<tr>
<td>pertaining to structural wiring.</td>
<td></td>
</tr>
<tr>
<td>Investigate careers in the information technology field.</td>
<td>English: 11.8, 12.8</td>
</tr>
<tr>
<td>History and Social Science: GOVT.1</td>
<td></td>
</tr>
<tr>
<td>Create a printed résumé, including a résumé format suitable for</td>
<td>English: 11.6, 11.7,</td>
</tr>
<tr>
<td>posting online.</td>
<td>12.6, 12.7</td>
</tr>
<tr>
<td>Research certification and educational opportunities.</td>
<td>English: 11.8, 12.8</td>
</tr>
<tr>
<td>History and Social Science: GOVT.1</td>
<td></td>
</tr>
<tr>
<td>Compose a letter of application.</td>
<td>English: 11.6, 11.7,</td>
</tr>
<tr>
<td>12.6, 12.7</td>
<td></td>
</tr>
<tr>
<td>Complete an electronic application form.</td>
<td>English: 11.6, 11.7,</td>
</tr>
<tr>
<td>12.6, 12.7</td>
<td></td>
</tr>
<tr>
<td>Compose an interview follow-up letter.</td>
<td>English: 11.5, 11.7,</td>
</tr>
<tr>
<td>12.7</td>
<td></td>
</tr>
<tr>
<td>Identify the steps to follow in resigning from a position.</td>
<td></td>
</tr>
<tr>
<td>Develop a portfolio containing representative samples of a student’s</td>
<td></td>
</tr>
<tr>
<td>work and make an oral presentation.</td>
<td>English: 11.1, 11.6,</td>
</tr>
<tr>
<td>11.7, 12.6, 12.7</td>
<td></td>
</tr>
<tr>
<td>Identify potential employment barriers for nontraditional groups</td>
<td>History and Social</td>
</tr>
<tr>
<td>and ways to overcome the barriers.</td>
<td>Science: VUS.14</td>
</tr>
<tr>
<td>Research opportunities for government or government contractor</td>
<td>English: 11.8, 12.8</td>
</tr>
<tr>
<td>employment.</td>
<td></td>
</tr>
</tbody>
</table>
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
- Electronics Module: Digital (EM4) 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 I (8650/36 weeks, 140 hours)

Career Cluster: Arts, Audio/Video Technology and Communications

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio and Video Technology and Film</td>
<td>Audio-Video Designer, Engineer</td>
</tr>
<tr>
<td>Performing Arts</td>
<td>Sound Engineering Technician</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Computer Programmer</td>
</tr>
<tr>
<td></td>
<td>Network Systems and Data Communication Analyst</td>
</tr>
<tr>
<td></td>
<td>Telecommunications Equipment Installer, Repairer</td>
</tr>
</tbody>
</table>