Electronics Technology

8537 36 weeks / 280 hours

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Acknowledgments

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Course Description

Suggested Grade Level: 11 or 12
Prerequisites: 8547

Students will study advanced electronics technology skills required in today’s automated manufacturing environment. Electronics technology skills are universally in demand as society is increasingly dependent on electronics. Students will construct alternating current (AC) and analog circuits while exploring digital logic systems. This course leads to industry certification options to further validate student mastery of related skills.

Task Essentials List

- 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.

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<td>Comply with federal, state, and local safety legal requirements.</td>
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<td>Report personal injuries and environmental and equipment safety violations.</td>
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Working with Alternating Current (AC) Circuits
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<td>Describe alternating voltage and current.</td>
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<td>☑</td>
<td>Determine characteristics of inductance.</td>
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<td>Calculate inductive reactance.</td>
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<td>Determine the characteristics of capacitance.</td>
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<td>Explain the operation of resistor-inductor (RL) and resistor-capacitor (RC) networks.</td>
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<td>Determine current, voltage, and impedance in an RLC circuit.</td>
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<td>Determine resonant frequencies in RLC circuits.</td>
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**Working with Analog Circuits**

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<td>62</td>
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<td>Analyze amplifier circuits.</td>
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<td>Discuss the differences between analog and digital circuits.</td>
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<td>Analyze integrated circuits (IC).</td>
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**Understanding Digital Logic Systems**

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<td>Analyze digital integrated circuits.</td>
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<td>Convert numbers to digital numbering systems.</td>
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<td>69</td>
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<td>Interpret logic gate symbols, Boolean expressions, and truth tables.</td>
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<td>Describe microcontroller structure and architecture.</td>
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<td>Construct a logic probe or logic pulser.</td>
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<td>Troubleshoot a simple logic circuit.</td>
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<td>Construct encoder and decoder circuits.</td>
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<td>Describe timers.</td>
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<td>Define electrical relays.</td>
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<td>Describe sequential logic, register, and counter circuits.</td>
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<td>Build a digital clock.</td>
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<td>Construct arithmetic circuits.</td>
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<td>Describe digital memory circuits.</td>
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<td>Troubleshoot digital-to-analog and analog-to-digital converters.</td>
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**Examining Energy Sources**

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**Understanding Power Systems in Electronics**

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<td>84</td>
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<td>Differentiate between servo and non-servo electrical drive systems.</td>
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Legend: ☑ Essential  ○ Non-essential  ☉ Omitted

**Curriculum Framework**
Applying General Safety Standards (Core Safety)

Task Number 39

Comply with federal, state, and local safety legal requirements.

Definition

Compliance should include the Occupational Safety and Health Administration (OSHA), Virginia Occupational Safety and Health (VOSH) program, the U.S. Environmental Protection Agency (EPA) and

- identifying the Hazard Communication Standard (HCS)
- interpreting the information included on safety data sheets (SDS)
- describing the responsibilities of employers and employees under HCS.

Process/Skill Questions

- Where should hazardous materials be stored?
- What information can be found on an SDS?

Task Number 40

Maintain a safe working environment.

Definition

Maintenance should be ongoing and should include

- identifying potential hazards on a jobsite or in the lab
- taking measures to remedy hazards
- complying with school and instructor guidelines.

Potential hazards include

- unstable or improperly erected scaffolding
- electrical hazards
- jobsite debris
- improperly stored materials
- air quality hazards.

Process/Skill Questions

- What are some examples of jobsite hazards?
- Why is it important to adhere to safety standards on a jobsite?
- Why is safe storage of materials and tools important?
Task Number 41

Explain safe working practices around electrical hazards.

Definition

Explanation should include

- identifying equipment used to test electrical circuits
- describing safe working conditions
- demonstrating safe work habits.

Process/Skill Questions

- What is the definition of proximity work?
- What are acceptable working clearances, according to the National Electrical Code (NEC)?
- What are considered safe working conditions and habits?
- What is the unseen hazard with electrical work?

Task Number 42

Identify emergency first-aid procedures.

Definition

Identification should include standard first-aid procedures and school policies regarding accidents involving

- bodily fluids
- electrical injuries
- hydraulic injuries
- eye injuries
- falls
- burns.

Process/Skill Questions

- What steps should be followed when an accident occurs?
- Why is knowing cardiopulmonary resuscitation (CPR) an important skill within the construction trades?
- Why is it important to be certified to administer first aid?
- What first aid must be performed if an open wound is in contact with hydraulic fluid?
- What are the different classifications (i.e., degrees) of electrical burns?

Task Number 43

Identify the types of fires and the methods used to extinguish them.
Definition

Identification should include the

- classifications of fires (A, B, C, and D)
- causes and prevention of fires
- types of extinguishers
- use (when possible) of a fire extinguisher, in accordance with government regulations and instructor guidelines.

Process/Skill Questions

- Why do fires have different classifications, and what are they?
- What is the fire triangle?
- Why should extinguishers be inspected, and how often should they be inspected?
- What are the classifications of extinguishers?

Task Number 44

Identify personal protective equipment (PPE) requirements.

Definition

Identification should include the procedures for properly inspecting, wearing, and removing

- eye protection
- respirator
- hard hat
- gloves
- safety harness
- hearing protection
- safety shoes.

Process/Skill Questions

- What are some dangerous effects of sun exposure, and how can these risks be diminished?
- Why is wearing jewelry prohibited in the lab or on the jobsite?

Task Number 45

Inspect course-specific hand and power tools to visually identify defects.

Definition

Inspection of hand and power tools should include
• identifying components of machinery (e.g., guards, blades, moving parts, start/stop switches)
• identifying standard safety procedures (i.e., lab practices and manufacturer recommendations)
• observing use of all lab machinery
• identifying tool defects.

Process/Skill Questions

• What are some of the basic power tools used in electronics?
• What are the actions to take before using power equipment?
• Why should a power tool always be grounded?

Task Number 46

Demonstrate lifting and carrying techniques.

Definition

Demonstration should include lifting and carrying materials and equipment while

• lifting with the legs
• keeping the back straight
• holding the load close to the body
• getting help, if necessary.

Process/Skill Questions

• What are common injuries associated with improper lifting techniques?
• How can injuries be prevented?
• How does proper positioning affect proper technique?

Task Number 47

Demonstrate safe laddering techniques.

Definition

Demonstration should include using appropriate conduct and safety procedures while

• using aluminum ladders (e.g., three-point contact)
• carrying ladders (e.g., two people at all times)
• erecting and setting ladders
• identifying types of ladders and the components and safety features of each (e.g., wall or straight, extension, roof, attic, special-purpose, solid-beam, wood/aluminum, wood/aluminum truss, fiberglass).

Process/Skill Questions

• Why are ladders rated for certain weights?
• Why is the apex (i.e., highest point) of a step ladder not considered a step?

**Task Number 48**

**Report personal injuries and environmental and equipment safety violations.**

**Definition**

Report should include

• identifying the violation
• documenting the date of the violation
• submitting the report to the instructor, supervisor, or local OSHA inspectors.

**Process/Skill Questions**

• What ethical considerations might be involved when reporting coworkers?
• Why is it important to follow reporting procedures?
• Why is it important to report an injury promptly, before leaving the jobsite?
• What are the key components of a safety violation report?

**Working with Alternating Current (AC) Circuits**

**Task Number 49**

**Analyze network theorems.**

**Definition**

Analysis should include

• industry-relevant theorems (e.g., Thevenin’s theorem, Norton’s theorem, superposition theorem)
• delta-to-wye conversions.

**Process/Skill Questions**

• How can a circuit analysis be simplified using Norton’s theorem? Thevenin’s theorem? Superposition theorem?
• When might delta-to-wye conversions be used?
• What theorem would be used to analyze a circuit with multiple voltage sources?

**Task Number 50**
Use an oscilloscope.

Definition

Use should include

- identifying and understanding the parts and functions of an oscilloscope
- manipulating the front-panel controls to adjust the circuits for proper operation, including
  - measuring alternating current (AC) and direct current (DC) voltages
  - gaining information about the shape, time period, and frequency of voltage waveforms
- maintaining the oscilloscope according to manufacturer specifications.

Process/Skill Questions

- What elements are common to all oscilloscopes?
- How do oscilloscopes display voltages?
- What is the purpose of the calibrate control function?
- How is the oscilloscope used in the daily work of technicians?
- How are voltage and time measured?

Task Number 51

Describe alternating voltage and current.

Definition

Description should include

- defining
  - alternating current
  - cycle
  - alternation degrees
  - frequency
  - sine
  - cosine
  - tangent
  - hertz
  - peak
  - sine curve
  - amplitude
- measuring AC voltage, using a meter and an oscilloscope
- measuring the frequency and amplitude of an AC signal, using an oscilloscope and a signal generator
- calculating instantaneous and average values and effective (root mean square [RMS]) voltage or current
- performing RMS-to-peak, peak-to-peak, frequency-to-time, and time-to-frequency conversions
- measuring current and voltage in an AC resistive circuit.

Process/Skill Questions
• What does phase refer to in sinusoidal waveform?
• What are some symmetrical waveforms that are not sinusoidal?
• What are circumstances where AC is used instead of DC?

Task Number 52

Determine characteristics of inductance.

Definition

Determination should include

• defining
  o henry (H)
  o inductor
  o inductance
  o Lenz's law
  o phase relationships
• explaining physical properties of an inductor
• explaining electrical characteristics of an inductor
• constructing a simple inductive circuit and observing the results of a change in frequency or inductance
• demonstrating the use of a voltmeter, oscilloscope, and signal generator
• drawing the schematic symbol for an inductor.

Process/Skill Questions

• What is a practical application of inductance?
• What is the phase relationship in a purely inductive circuit?
• What are the physical properties of an inductor?

Task Number 53

Calculate inductive reactance.

Definition

Calculation should include

• explaining inductive reactance and phase relationships
• describing the relationship between inductive reactance and frequency
• interpreting the formula $XL = 2\pi fL$
• drawing the waveform of a purely inductive circuit to show the phase relationship of voltage and current.

Process/Skill Questions

• What is inversely proportional to inductance?
• What is directly proportional to inductive reactance?
• What is the difference between current and voltage in an inductor in a phase relationship?

Task Number 54

Determine the characteristics of capacitance.

Definition

Determination should include

- defining
  - capacitor
  - dielectric
  - dielectric constant
  - microfarad
  - nanofarad
  - picofarad
  - working voltage
- describing the construction of various capacitors
- drawing the schematic symbols for
  - fixed capacitors
  - variable capacitors
  - polarized electrolytic capacitors
- explaining the significance of the capacitor’s voltage rating and capacitance rating
- calculating parallel capacitance, using the formula \( C_T = C_1 + C_2 + C_3 \ldots C_N \)
- calculating series capacitance, using the appropriate formula
- explaining safety factors involved in handling capacitors.

Process/Skill Questions

- What are the characteristics of a good dielectric?
- What are two ways to increase capacitance?
- Why are most capacitors measured in microfarads and picofarads?

Task Number 55

Demonstrate capacitive reactance.

Definition

Demonstration should include

- explaining capacitive reactance
- stating Ohm’s law and explaining its application to capacitive reactance
- listing reactance factors
- interpreting the formula \( X_c = \frac{1}{2\pi fC} \)
• drawing the waveform of a purely capacitive circuit to show the phase relationship of voltage and current.

Process/Skill Questions

• What is the definition of capacitive reactance?
• What is the relationship between frequency and capacitive reactance?

Task Number 56

Explain transformer operations.

Definition

Explanation should include

• describing transformer construction
• sketching schematic diagrams of transformers
• stating the methods for identifying primary and secondary leads
• listing safety procedures when connecting equipment to power lines
• measuring primary and secondary voltage
• calculating turns ratio, voltage ratio, primary and secondary currents, and the efficiency of a transformer.

Process/Skill Questions

• How does a transformer work?
• What is the reason for the phase shift in transformers?
• What determines the input-output ratio?

Task Number 57

Explain the operation of resistor-inductor (RL) and resistor-capacitor (RC) networks.

Definition

Explanation should include

• describing and applying the Pythagorean theorem
• describing the properties of RL and RC circuits
• explaining impedance and phase angle
• converting circuit diagrams into phase diagrams
• sketching diagrams of RL and RC series and parallel circuits and assigning values for
  o resistance
  o capacitance
  o inductance
  o frequency
• applied voltage
  • calculating
    o inductive reactance (XL)
    o capacitive reactance (XC)
    o impedance (Z)
    o voltage across resistor (ER)
    o voltage across inductor (EL)
    o voltage across capacitor (EC)
• drawing a phasor diagram for RL and RC circuits and calculating the time constant for both
• explaining power factor correction.

Process/Skill Questions

• What practical applications use RC and RL networks?
• What is impedance?
• How is the Pythagorean theorem applied in RL and RC circuits?

Task Number 58

Determine current, voltage, and impedance in an RLC circuit.

Definition

Determination should include

• identifying the components of RC and RL circuits
• calculating total impedance
• stating the effect of frequency changes on current, voltage, and impedance
• describing why total impedance is capacitive or reactive
• identifying the uses of RLC circuits.

Process/Skill Questions

• What is the phase shift across the resistor in an RLC circuit?
• What determines if an RLC circuit is capacitive or inductive?
• What are the circumstances in which total impedance is reactive in an RLC circuit?

Task Number 59

Determine resonant frequencies in RLC circuits.

Definition

Determination should include

• defining
  o RLC circuit
- high-Q parallel circuit
- resonance

- applying reactance formulas
- calculating resonant frequency
- stating the reasons why \( XL \) must equal \( XC \)
- explaining the functions of low-pass, high-pass, and band-stop filter circuits
- troubleshooting filter circuits.

**Process/Skill Questions**

- How is resonance different than any other state in an RLC circuit?
- What applied technology makes wide use of tuned resonant frequencies?
- Why must \( XL \) equal \( XC \)?

**Working with Analog Circuits**

**Task Number 60**

**Work with semiconductor devices.**

**Definition**

Working with semiconductor devices should include

- describing semiconductor construction
- determining semiconductor parameters
- constructing a circuit, using semiconductors
- analyzing the uses of special semiconductors
- troubleshooting semiconductor circuits.

**Process/Skill Questions**

- What is the difference between a majority and minority carrier?
- What type of materials is used in all semiconductors?
- What is the proper bias of a positive-negative-positive (PNP) and a negative-positive-negative (NPN) transistor?

**Task Number 61**

**Analyze power supplies.**

**Definition**

Analysis should include

- describing linear- and switched-mode power supply circuit requirements
• describing how to step-up or step-down AC voltage
• differentiating among rectifier configurations (e.g., half-wave, full-wave, bridge)
• determining proper filter requirements
• identifying power supply regulation
• constructing a regulated power supply
• troubleshooting a power supply.

Process/Skill Questions

• What are the requirements when building a power supply?
• How is AC converted to DC for use in electronic devices?
• What is the difference between a half-wave and a full-wave rectifier?

Task Number 62

Analyze amplifier circuits.

Definition

Analysis should include

• identifying types and applications of amplifiers
• identifying methods of biasing and coupling
• designing a basic audio amplifier
• constructing an amplifier circuit
• troubleshooting an amplifier.

Process/Skill Questions

• What are multistage amplifiers?
• What are the options for amplifier coupling?
• What is feedback? Why is it used?

Task Number 63

Discuss the differences between analog and digital circuits.

Definition

Discussion should include theories and methodologies.

Process/Skill Questions

• What analog circuits are used in everyday life?
• What does analog mean?
• What are examples of a digital circuit?
• Why might one choose to use an analog or digital circuit for a given application?
Task Number 64

Analyze integrated circuits (IC).

Definition

Analysis should include

- identifying package types
- identifying the pin numbers of IC packages
- classifying IC
- determining IC characteristics
- constructing circuits using IC.

Process/Skill Questions

- What analog circuits are used in everyday life?
- What does analog mean?
- What is an example of an analog IC?

Task Number 65

Analyze oscillator circuits.

Definition

Analysis should include

- identifying types of oscillator circuits
- designing a basic oscillator circuit
- constructing an oscillator circuit
- troubleshooting an oscillator circuit.

Process/Skill Questions

- What is the purpose of an oscillator circuit? How are they used?
- How is the frequency of an oscillator circuit determined?
- What are the different types of oscillator circuits?

Task Number 66

Identify modes of wireless communication.

Definition

Identification should include
• types of modulation
• radio frequency (RF) technology
• cell technology.

Process/Skill Questions

• What is modulation?
• What are the advantages and disadvantages of wireless communication?
• What government agency is responsible for the oversight of all broadcast frequencies?
• What are the differences between digital and analog communication?

Understanding Digital Logic Systems

Task Number 67

Analyze digital integrated circuits.

Definition

Analysis should include

• identifying package types
• identifying the pin numbers of IC packages
• identifying digital voltage levels
• identifying digital signals
• explaining the differences between transistor-transistor logic (TTL) and complementary metal oxide semiconductor (CMOS) circuits
• describing IC handling and soldering safety procedures.

Process/Skill Questions

• What digital circuits are used in everyday life?
• What is the difference between TTL and CMOS circuits?
• What voltage levels are used to represent digital signals?

Task Number 68

Convert numbers to digital numbering systems.

Definition

Conversion should include

• defining
  o binary
  o octal
hexadecimal
base numbers
encoder
decoder
bit
byte

- explaining the 2s complement method of converting decimal numbers
- converting decimal numbers to binary numbers
- converting decimal numbers to hexadecimal numbers
- converting binary numbers to hexadecimal and to decimal numbers
- explaining the function of an encoder and decoder
- adding, subtracting, multiplying, and dividing binary numbers.

Process/Skill Questions

- What device converts decimal numbers to binary numbers?
- Why should technicians learn the binary numbering system?
- What numbers are in the hexadecimal numbering system?

Task Number 69

Interpret logic gate symbols, Boolean expressions, and truth tables.

Definition

Interpretation should include

- drawing Boolean expressions, logic gate symbols, and truth tables for basic logic gates (e.g., AND, OR, NOT, NOR, NAND, XOR, XNOR)
- explaining how a NAND gate can be used to construct other gates
- explaining how a truth table is constructed
- designing a Karnaugh map from a truth table
- differentiating between positive and negative logic
- explaining the differences between TTL and CMOS circuits
- listing IC handling and soldering safety procedures
- using combinational logic simplification using Boolean algebra rules
- using sequential logic.

Process/Skill Questions

- Where did Boolean algebra get its name?
- What are the basic logic gates?
- How does the NOR gate differ from the NAND gate?

Task Number 70

Describe microcontroller structure and architecture.
Definition

Description should include the way microcontrollers are used in consumer and commercial applications.

Process/Skill Questions

- What is a microcontroller?
- What are some of the ways to program a microcontroller?
- What are the advantages and disadvantages of using a microcontroller over logic gates?

Task Number 71

Construct a logic probe or logic pulser.

Definition

Construction should include

- constructing a logic probe on a breadboard and performing an operational test
- constructing a logic pulser on a breadboard and performing an operational test
- explaining the use of logic probes and pulsers in troubleshooting digital circuits.

Process/Skill Questions

- Why should a technician learn to use a logic probe?
- What does a standard logic probe measure?
- What is the difference between a logic probe and a logic pulser?

Task Number 72

Troubleshoot a simple logic circuit.

Definition

Troubleshooting should include

- constructing a logic circuit from a Boolean expression
- performing a functional check of the circuit
- formulating a truth table based on the results of the functional test
- performing troubleshooting procedures to locate the faulty IC and the faulty gate circuit within that IC
- removing and replacing the faulty component and repeating the functional check.

Process/Skill Questions

- What indication on the logic probe means the IC has no power?
- What are the first steps in troubleshooting any logic circuit?
- How can a Boolean expression be used to explain the workings of a circuit?
Task Number 73

Construct encoder and decoder circuits.

Definition

Construction should include

- converting decimal numbers to Binary Coded Decimal (BCD) (including other binary encoding methods such as Gray code and ASCII code)
- wiring digital displays
- explaining the function of decoder/driver and drawing a pinout diagram
- troubleshooting an encoder and a decoder circuit drawing
- explaining the function of a multiplexer and a demultiplexer and drawing a pinout diagram for each
- troubleshooting a multiplexer and demultiplexer circuit drawing.

Process/Skill Questions

- What steps are required to convert BCD to decimal on paper?
- What are the types of digital displays?
- What is the difference between a multiplexer and a demultiplexer?

Task Number 74

Describe timers.

Definition

Description should include the importance of timers to electric circuits. Description may also include timing circuits that use a 555 chip, such as Astable, Monostable, and Bistable.

Process/Skill Questions

- Why are timers important to electric circuits?

Task Number 75

Define electrical relays.

Definition

Definition should include the concept that electrical relays are electrical switches that open and close under the control of other electrical circuits. Electronic relays are able to control an output circuit of higher power than the input circuit. Therefore, power relays can be considered to be, in a broad sense, a form of an electrical amplifier.

Process/Skill Questions
What does it mean that power relays can be considered an electrical amplifier?
Why are electrical relays important?

Task Number 76

Describe sequential logic, register, and counter circuits.

Definition

Description should include

- defining
  - *sequential*
  - *latch*
  - *pulse*
  - *synchronous*
  - *asynchronous*
  - *positive edge-triggering*
  - *disabled*
  - *enabled*
  - *toggling*
- generating a digital clock pulse using a crystal
- explaining how a latch is used to store information
- drawing a frequency divider circuit
- describing the operation of a binary counter
- explaining the differences between a serial-load and parallel-load shift register
- using an oscilloscope to see the digital clock pulses after they go through a counter or frequency divider
- building a digital clock using gates, dividers, counters.

Process/Skill Questions

- What is the difference between asynchronous and synchronous circuits?
- How is a latch used to store information?
- What is meant by *edge-triggering*?
- How are crystals used to produce a precise clock pulse in a digital circuit?

Task Number 77

Build a digital clock.

Definition

Building should incorporate the use of

- *gates*
counters  
clock pulse  
registers  
binary-to-decimal decoders.

**Process/Skill Questions**

- What is a *register*?
- What is a *binary-to-decimal decoder*?

**Task Number 78**

**Construct arithmetic circuits.**

**Definition**

Construction should include building and troubleshooting a full-adder circuit.

**Process/Skill Questions**

- Which logic gates are used to construct an adder?
- How does a full-adder circuit work?
- How is an adder circuit made to subtract?

**Task Number 79**

**Describe digital memory circuits.**

**Definition**

Description should include

- defining
  - *RAM*
  - *ROM*
  - *EPROM*
  - *PROM*
  - *scratch-pad*
  - *sequential access*
  - *static*
  - *volatile*
  - *nonvolatile*
  - *ECL*
- describing the difference between sequential and random access
- listing steps in troubleshooting ROM and RAM.

**Process/Skill Questions**
What is the difference between RAM and ROM memory?
What does CMOS stand for? What is its function?
What type of memory is volatile memory?

**Task Number 80**

**Troubleshoot digital-to-analog and analog-to-digital converters.**

**Definition**

Troubleshooting should include

- explaining the special interface encoders and decoders used between analog and digital devices
- describing how operational amplifiers are used in digital to analog (D/A) converters and comparators
- listing and explaining the characteristics of common specifications used for A/D conversion, such as type of output resolution, conversion time, accuracy, power supply voltage and input/output voltage levels
- building a circuit, using an A/D converter chip.

**Process/Skill Questions**

- What is the difference between DAC and ADC?
- Why do digital or analog signals need to be converted?
- What is the name of a digital piece of electronic equipment that contains an A/D converter?

**Examining Energy Sources**

**Task Number 81**

**Identify alternative power systems.**

**Definition**

Identification should include

- wind
- solar
- hydropower
- geothermal.

**Process/Skill Questions**

- What are the factors that determine which alternative power system should be used?
- Which power system did Nikola Tesla champion?
- Which city first used hydroelectric power?
Task Number 82

Explain the operation of a generator.

Definition

Explanation should include

- identifying internal components
- identifying the methods of mechanical power (prime mover)
- determining A/C and D/C characteristics
- diagramming a spinning magnet inside a coil.

Process/Skill Questions

- What are the primary components used in the construction of a generator?
- What is meant by the frequency of a generator?
- What factors determine the power output of a generator?

Understanding Power Systems in Electronics

Task Number 83

Identify basic industrial components.

Definition

Identification should include

- disconnect
- fuse
- power supply
- programmable logic controllers (PLC)
- relay
- safety relay
- sensors.

Process/Skill Questions

- What are basic industrial components?
- Why are sensors important?

Task Number 84

Differentiate between servo and non-servo electrical drive systems.
Definition

Differentiation should include

- comparing the two drive systems
- comparing the advantages and disadvantages of applications
- selecting the appropriate servo for the application.

Process/Skill Questions

- What are the similarities and differences of a servo and non-servo electrical drive system?
- Which drive system is assumed to be more accurate? Why?
- Which drive system is the easiest to maintain? Why?

Task Number 85

Describe motor control systems.

Definition

Description should include

- identifying the circuits used in a motor control system (e.g., H-bridge)
- determining the wiring method for a simple motor control circuit
- explaining the differences between an automated and non-automated control system
- demonstrating use of a PLC
- examining the efficiency of automated and non-automated control systems.

Process/Skill Questions

- Why do motors need to be controlled?
- What is an example of an application for a non-automated control system?
- What is an example of an application for an automated control system?

SOL Correlation by Task

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>English:</th>
<th>History and Social Science:</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Comply with federal, state, and local safety legal requirements.</td>
<td>11.5, 12.5</td>
<td>GOVT.7, GOVT.8, GOVT.9, GOVT.14, GOVT.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Science: CH.1</td>
</tr>
<tr>
<td>40</td>
<td>Maintain a safe working environment.</td>
<td>11.5, 12.5</td>
<td>WHII.8</td>
</tr>
<tr>
<td>41</td>
<td>Explain safe working practices around electrical hazards.</td>
<td>11.5, 12.5</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| 42 | Identify emergency first-aid procedures. | History and Social Science: WHII.8  
     |   | English: 11.5, 12.5 |
| 43 | Identify the types of fires and the methods used to extinguish them. | History and Social Science: WHII.8  
     |   | English: 11.5, 12.5 |
| 44 | Identify personal protective equipment (PPE) requirements. | English: 11.5, 12.5 |
| 45 | Inspect course-specific hand and power tools to visually identify defects. |   |
| 46 | Demonstrate lifting and carrying techniques. |   |
| 47 | Demonstrate safe laddering techniques. |   |
| 48 | Report personal injuries and environmental and equipment safety violations. | English: 11.1, 11.6, 11.7, 12.1, 12.6, 12.7 |
| 49 | Analyze network theorems. | English: 11.5, 12.5  
     |   | Mathematics: AII.3, AII.5, AII.10, MA.11 |
| 50 | Use an oscilloscope. | English: 11.5, 12.5  
     |   | Science: PH.11 |
| 51 | Describe alternating voltage and current. | English: 11.3, 11.5, 12.3, 12.5  
     |   | Mathematics: T.3, T.4, AII.3  
     |   | Science: PH.11 |
| 52 | Determine characteristics of inductance. | English: 11.3, 11.5, 12.3, 12.5 |
| 53 | Calculate inductive reactance. | English: 11.5, 12.5  
     |   | Mathematics: T.3, AII.3, AII.5, AII.10 |
| 54 | Determine the characteristics of capacitance. | English: 11.3, 11.5, 12.3, 12.5  
     |   | Mathematics: AII.3 |
| 55 | Demonstrate capacitive reactance. | English: 11.5, 12.5  
     |   | Mathematics: T.3, AII.3 |
| 56 | Explain transformer operations. | English: 11.5, 11.6, 12.5, 12.6  
     |   | Mathematics: T.6, AII.3 |
| 57 | Explain the operation of resistor-inductor (RL) and resistor-capacitor (RC) networks. | English: 11.5, 12.5  
     |   | Mathematics: G.8, T.2, T.3, AII.3, MA.8 |
| 58 | Determine current, voltage, and impedance in an RLC circuit. | English: 11.5, 12.5  
<pre><code> |   | Mathematics: AII.3 |
 |   | Mathematics: AII.3 |
</code></pre>
<p>| 60 | Work with semiconductor devices. | English: 11.5, 12.5 |
| 61 | Analyze power supplies. | English: 11.5, 12.5 |</p>
<table>
<thead>
<tr>
<th></th>
<th>Task</th>
<th>Language(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>Analyze amplifier circuits.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>63</td>
<td>Discuss the differences between analog and digital circuits.</td>
<td>English: 11.1, 12.1</td>
</tr>
<tr>
<td>64</td>
<td>Analyze integrated circuits (IC).</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>65</td>
<td>Analyze oscillator circuits.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>66</td>
<td>Identify modes of wireless communication.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>67</td>
<td>Analyze digital integrated circuits.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>68</td>
<td>Convert numbers to digital numbering systems.</td>
<td>English: 11.3, 11.5, 12.3, 12.5</td>
</tr>
<tr>
<td>69</td>
<td>Interpret logic gate symbols, Boolean expressions, and truth tables.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mathematics: COM.15</td>
</tr>
<tr>
<td>70</td>
<td>Describe microcontroller structure and architecture.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>71</td>
<td>Construct a logic probe or logic pulser.</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Troubleshoot a simple logic circuit.</td>
<td>Mathematics: COM.15</td>
</tr>
<tr>
<td>73</td>
<td>Construct encoder and decoder circuits.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>74</td>
<td>Describe timers.</td>
<td>English: 11.3, 11.5, 12.3, 12.5</td>
</tr>
<tr>
<td>75</td>
<td>Define <em>electrical relays</em>.</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Describe sequential logic, register, and counter circuits.</td>
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<td>77</td>
<td>Build a digital clock.</td>
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<td>78</td>
<td>Construct arithmetic circuits.</td>
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<tr>
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<td>Troubleshoot digital-to-analog and analog-to-digital converters.</td>
<td>English: 11.5, 12.5</td>
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<td>81</td>
<td>Identify alternative power systems.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
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<td></td>
<td>Science: ES.6</td>
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<tr>
<td>82</td>
<td>Explain the operation of a generator.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Science: PH.11</td>
</tr>
<tr>
<td>83</td>
<td>Identify basic industrial components.</td>
<td>English: 11.5, 12.5</td>
</tr>
<tr>
<td>84</td>
<td>Differentiate between servo and non-servo electrical drive systems.</td>
<td>English: 11.5, 12.5</td>
</tr>
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<td>85</td>
<td>Describe motor control systems.</td>
<td>English: 11.5, 12.5</td>
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</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.” Teachers can find the infusion/unit in the course listing.
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Associate Certified Electronics Technician (CETa) Examination
- Certified Satellite Installer (CSI) Examination
- College and Work Readiness Assessment (CWRA+)
- Computer Service Technician (CST) Examination
- Customer Service Examination
- Customer Service Specialist (CSS) Examination
- Electronics Application/Electronics Technology Examination
- Electronics Assessment
- Electronics Module: AC (EM2) Examination
- Electronics Module: Analog (EM3) Examination
- Electronics Module: Comprehensive Basic (EM5) Examination
- Electronics Module: DC Basics (EM1) Examination
- Electronics Technology Assessment
- Industrial Electricity Assessment
- Industrial Electronics Assessment
- Mechatronic Systems Certification Examinations
- Mobile Electronics Certified Professional (MECP) Basic Installation Technician Examination
- National Career Readiness Certificate Assessment
- Professional Communications Certification Examination
- Student Electronics Technician (SET) 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.

- Electronics/Industrial Robotics Technology (8547/36 weeks, 140 hours)

Career Cluster: Arts, Audio/Video Technology and Communications

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
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<tbody>
<tr>
<td>Audio and Video Technology and Film</td>
<td>Audio and Video Equipment Technician&lt;br&gt;AUDIO-VIDEO Designer, Engineer&lt;br&gt;Sound Engineering Technician</td>
</tr>
</tbody>
</table>

Career Cluster: Science, Technology, Engineering and Mathematics

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<th>Occupations</th>
</tr>
</thead>
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<td>Engineering and Technology</td>
<td>Electrical Engineer&lt;br&gt;Electrical Engineering Technician&lt;br&gt;Electronics Engineering Technician</td>
</tr>
</tbody>
</table>