

# Elements of Production

**Electrical Theory:**  
Interpret and apply  
electrical and electronic  
principles and  
theories. 5.1

- 1 Read and interpret wiring diagrams and symbols. 5.1.1

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- 2 Describe the features, benefits, and applications of electrical and electronic systems. 5.1.2

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- 3 Describe the relationship between electrical effects and electromagnetic effects. 5.1.3

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- 4 Explain methods of producing electrical current. 5.1.4

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- 5 Describe the differences between alternating current (AC) and direct current (DC). 5.1.5

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- 6 Compare and contrast conductors and insulators. 5.1.6

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- 7 Differentiate the relationships among voltage, current, resistance, and power in circuits and understand the basics of transformers. 5.1.7

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- 8 Measure the amperage of AC and DC electrical systems and system components. 5.1.8

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- 9 Calculate voltage, current, resistance, impedance, and power in circuits using Ohm's Law, Kirchhoff's Law, and Watt's Law. 5.1.9

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- 10 Describe the purpose of grounding and common methods used for grounding. 5.1.10

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- 11 Describe the uses of series, parallel, and series-parallel circuits. 5.1.11

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- 12 Use a digital multimeter to determine voltage, current, frequency, and phase. 5.1.12

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- 13 Identify and describe single-phase and three-phase power and the advantages of each. 5.1.13

**Structural Electrical  
Circuits:** Describe  
features of an electrical  
schematic that  
illustrates a wiring  
system and interpret

- 1 Describe over-current protective devices and their functions. 5.2.1

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- 2 Identify key information and follow manufacturer's recommendation to repair or replace motors per manufacturer specifications. 5.2.2

and install the design. 5.2

- 3 Map circuits and label the service panel directory to reflect devices installed on each circuit. 5.2.3
- 4 Calculate service requirements for an electrical installation and evaluate for safe capacity. 5.2.4
- 5 Identify types of cable, conduit, boxes, switches, outlets, and other common wiring devices. 5.2.5
- 6 Identify fasteners, anchors, and fire stop systems. 5.2.6
- 7 Select materials and lay out rough-in wiring runs according to specifications, drawings, and code requirements. 5.2.7
- 8 Select and install lighting technologies and systems. 5.2.8
- 9 Make conductor terminations and connect appliances to circuits. 5.2.9
- 10 Identify and apply basic troubleshooting with electrical systems and circuits. 5.2.10

Design and Estimate:  
Interpret basic site plan  
for a desired outcome or  
company  
specification. 5.3

- 1 Identify and interpret symbols, drawings, prints, and blueprints. 5.3.1
- 2 Apply proportional measurement and scale techniques. 5.3.2
- 3 Complete a site inventory and analysis, including physical conditions, code and utilities requirements, and the environmental impact. 5.3.3
- 4 Develop a program list, including intended use, budget, economics, customer wants and needs, and maintenance. 5.3.4
- 5 Identify and apply the principles of balance, proportion, scale, focal point, emphasis, rhythm, harmony, and unity to create a design. 5.3.5
- 6 Identify and apply the elements of line, function, form, texture, and color to create a design. 5.3.6
- 7 Identify and apply design, organizational, and spatial principles into a design. 5.3.7
- 8 Calculate the space requirements and compute various attributes, including length, angle measurement, surface area, and volume. 5.3.8
- 9 Identify construction documents, common scales, specifications, and materials used in construction or fabrication. 5.3.9
- 10 Identify material, input, and equipment needs based on availability to calculate costs in production or application. 5.3.10
- 11 Establish the sequential steps of construction and installation. 5.3.11

**Surveying and Mapping:  
Perform surveying  
procedures to construct  
a site plan. 5.4**

- 1 Identify civil drafting symbols and abbreviations. 5.4.1**
- 2 Interpret maps, topographic site plans, deeds, and aerial or satellite imagery for site planning. 5.4.2**
- 3 Perform site measurements. 5.4.3**
- 4 Integrate map and surveying data into geographic information system (GIS) or computer aided design (CAD) software. 5.4.4**
- 5 Identify topographical and existing features of areas, including property lines, benchmarks, utilities, streets, and setbacks, on survey maps, parcel maps, and plats. 5.4.5**

**Geographic Information  
Systems (GIS): Employ  
GIS computer  
applications to interpret  
data, maps, and land  
use. 5.5**

- 1 Interpret and evaluate the accuracy of digital imagery and aerial photography. 5.5.1**
- 2 Explain map projections and the use of scales. 5.5.2**
- 3 Describe GIS data structures (e.g., vector, grid, triangulated irregular network [TIN]). 5.5.3**
- 4 Explain digital elevation methods (e.g., digital elevation model [DEM], global positioning system [GPS]). 5.5.4**
- 5 Interpret spatial interpolation and two- and three-dimensional functional spatial analyses. 5.5.5**
- 6 Demonstrate ranging methods. 5.5.6**
- 7 Identify sources of errors in GIS and formulate corrections and solutions. 5.5.7**
- 8 Determine one's position on the earth using GPS. 5.5.8**
- 9 Integrate GPS data into GIS applications. 5.5.9**
- 10 Identify desired user outcomes and create suitable instruction sheets and check sheets. 5.5.10**
- 11 Assess soil compaction and analyze the correlation between soil compaction data and pixel value. 5.5.11**
- 12 Identify suitability of given area for agricultural applications. 5.5.12**
- 13 Analyze zonal statistics and perform raster manipulation. 5.5.13**
- 14 Interpret results to create crop reports, prescriptions, and application maps. 5.5.14**

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**15** Conduct a temporal analysis to prepare recommendations. 5.5.15

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**16** Use geospatial technology to develop soil sampling grids or identify sampling sites for testing characteristics such as nitrogen, phosphorus, or potassium content, pH, or micronutrients. 5.5.16

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**Construction: Follow architectural plans to construct and repair agricultural structures and hardscapes.** 5.6

**1** Compare and contrast the structural properties, grades, and types of construction materials. 5.6.1

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**2** Lay out, cut, smooth, shape, and bore construction materials. 5.6.2

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**3** Lay out, cut, and install decks and floors. 5.6.3

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**4** Lay out, cut, assemble, and brace framing components. 5.6.4

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**5** Lay out, cut, and install stairs and steps. 5.6.5

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**6** Lay out, cut, and install roof framing, roof trim accessories, and roofing materials. 5.6.6

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**7** Install exterior doors and window units with hardware. 5.6.7

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**8** Install exterior sheathing and siding with trim accessories. 5.6.8

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**9** Install and repair glass, rigid plastic panels, or film plastic. 5.6.9

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**10** Install and repair draft stops, weather stripping, thermal insulation, and vapor barriers. 5.6.10

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**11** Analyze a surface's condition and select and apply abrasives and fillers. 5.6.11

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**12** Contrast surface coatings and apply under appropriate environmental conditions. 5.6.12

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**13** Review and apply facility and fencing options in a production setting. 5.6.13

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**Brick, Block and Concrete: Follow a design layout to install a structure using bricks, pavers, blocks, stone, or concrete.** 5.7

**1** Describe the physical properties of bricks, pavers, mortar, blocks, and concrete. 5.7.1

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**2** Explain the chemical reactions within and between materials. 5.7.2

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**3** Describe air ratio and slump. 5.7.3

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**4** Perform layout and elevations using measurements to scale. 5.7.4

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**5** Mix, place, and finish bricks, pavers, blocks, stone, or concrete. 5.7.5

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**6** Install cut bricks, pavers, blocks, stone, or concrete with or without adhesives. 5.7.6

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- 7 Install footers, lintels, sills, poured walls, floors, and accessories per manufacturer's specifications. 5.7.7**

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  - 8 Install gravel and sand pads. 5.7.8**

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  - 9 Layout and construct forms and reinforce them using steel, wire, and other materials. 5.7.9**

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  - 10 Layout and install anchor bolts in concrete. 5.7.10**

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  - 11 Install joints in concrete (e.g. expansion, saw cut vs tooled joint). 5.7.11**

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  - 12 Select curing, coloring, and texturing additives or specialty finishes and apply to concrete for a specific purpose. 5.7.12**
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**Water Distribution Systems: Calculate the demand for specific water applications and design and install water supply and drainage components. 5.8**

- 1 Calculate water demand for specific applications. 5.8.1**

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- 2 Compare the types, applications, and operating principles of pumps and controls. 5.8.2**

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- 3 Locate water system entry points, walls, and chases. 5.8.3**

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- 4 Identify components of supply and drainage systems and describe their functions. 5.8.4**

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- 5 Describe how waste moves from a fixture through the drain system to the environment. 5.8.5**

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- 6 Describe factors that are considered when planning and installing a supply and drainage system. 5.8.6**

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- 7 Estimate and compute length, angle of measurement, area, surface area, and volume to calculate pipe legs and pipe sizes. 5.8.7**

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- 8 Calculate the slope required for drainage components. 5.8.8**

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- 9 Select supply and drainage components based on their application for a given purpose. 5.8.9**

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- 10 Explain the impact of modifying structural members to accommodate supply and drainage lines. 5.8.10**

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- 11 Join pipe, pipefittings, and valves of similar and dissimilar materials using solder, brazing, solvents, and mechanical means of joining. 5.8.11**

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- 12 Connect plumbing fixtures and appliances to a supply and drainage system. 5.8.12**

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- 13 Compare and contrast sources of contamination in water supplies and methods of filtering and disinfecting water. 5.8.13**

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**14 Prevent freezing and mechanical damage to pipes.** 5.8.14

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**15 Describe how water moves from the source through the water distribution system to the fixture.** 5.8.15

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**16 Test a water supply and drainage system for leaks and pressure using soap, inert gas, electronic sensors, and fluorescent dye.** 5.8.16

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**17 Maintain plumbing fixtures.** 5.8.17

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**18 Identify, describe, and install cross connection and backflow prevention devices.** 5.8.18

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**Physics and Metallurgy of Welding: Apply the physics and metallurgy of welding in joining materials.** 5.9

**1 Assess how the welding arc produces a weld.** 5.9.1

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**2 Identify the factors that affect the deposit of weld metal and melting (e.g. speed, metal type, travel speed, amps, voltage, angles of electrode).** 5.9.2

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**3 Describe the effects of arc length and shielding gases on the arc.** 5.9.3

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**4 Identify key variables that determine the type of metal transfers.** 5.9.4

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**5 Analyze the relationship between wire feed speed and welding current.** 5.9.5

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**6 Describe pulsed arc transfer mode.** 5.9.6

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**7 Compare and contrast the relationship of wire size to deposition rate and current ranges.** 5.9.7

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**8 Compare constant current and constant voltage power sources and how they relate to the self-regulation of arcs.** 5.9.8

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**9 Explain conditions when arc blow occurs and how to reduce arc blow.** 5.9.9

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**10 Identify and describe the changes during solidification.** 5.9.10

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**11 Identify and describe concepts of common crystal structures in metallic materials.** 5.9.11

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**12 Identify and describe the types of weld imperfections and indicate their effects on material properties.** 5.9.12

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**Joining and Cutting Ferrous and Non-Ferrous Materials with Heat: Join and cut ferrous and non-ferrous materials using heat in horizontal and vertical positions.** 5.10

**1 Classify, select, handle, and store electrodes and match them to the job requirements based on the desired level of penetration and heat range.** 5.10.1

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**2 Determine the correct welder type, wire diameter, and gas to be used in a specific welding situation.** 5.10.2

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- 3 Compare and contrast ferrous and non-ferrous material welding operating characteristics and performance.** 5.10.3

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  - 4 Identify and select the appropriate joint design, weld type, and welding position.** 5.10.4

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  - 5 Set up and adjust the welder according to the material being welded and influencing conditions.** 5.10.5

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  - 6 Store, handle, and install high pressure gas cylinders.** 5.10.6

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  - 7 Clean, prepare, align, and secure post-weld material.** 5.10.7

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  - 8 Compensate for the effects of expansion and contraction forces when joining ferrous and non-ferrous materials.** 5.10.8

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  - 9 Employ protective methods for surrounding equipment and materials during welding and cutting operations.** 5.10.9

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  - 10 Perform continuous, stitch, tack, plug, and butt welds with and without backing and fillet welds.** 5.10.10

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  - 11 Cut ferrous and non-ferrous materials using oxy fuel and plasma equipment based on the various applications.** 5.10.11
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**Fabricating with Cold Ferrous and Non-Ferrous Materials: Repair ferrous and non-ferrous material structures and equipment through cutting, shaping, forming, and joining stock.** 5.11

- 1 Evaluate ferrous and non-ferrous structures and equipment and plan the method of repair.** 5.11.1

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  - 2 Lay out and cut ferrous and non-ferrous material.** 5.11.2

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  - 3 Shape stock through bending, cutting, drilling, and filing.** 5.11.3

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  - 4 Form and assemble metal through cutting and bending.** 5.11.4

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  - 5 Edge metal through wiring, turning, beading, and crimping.** 5.11.5

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  - 6 Identify various methods of fastening ferrous and non-ferrous material.** 5.11.6

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  - 7 Fasten ferrous and non-ferrous material using a range of hardware.** 5.11.7

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  - 8 Process ferrous and non-ferrous material through tapping, threading, torquing, and smoothing.** 5.11.8

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  - 9 Analyze the surface condition and select and apply abrasives and fillers for ferrous and non-ferrous material.** 5.11.9

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  - 10 Contrast surface coatings and apply them under appropriate environmental conditions.** 5.11.10
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**Precision Agriculture:**  
Analyze data from precision agriculture platforms and prepare recommendations. 5.12

- 1 Identify a list of agricultural enterprises that can benefit from precision agriculture. 5.12.1**

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- 2 Identify and explain precision agriculture platforms and differentiate uses and benefits for specific platforms. 5.12.2**

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- 3 List specific precision agriculture techniques for pesticide application, yield mapping, soil analysis, tillage and planting operations, animal feed and water systems, temperature-controlled housing, and specific machine functions. 5.12.3**

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- 4 Explain steps involved in procuring required equipment based on the desired outcome to meet a production goal. 5.12.4**

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- 5 Demonstrate proficiency using a multi-meter on precision components to determine reading from manufacture's specifications. 5.12.5**

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- 6 Determine the correct course of action based on preliminary troubleshooting findings. 5.12.6**

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- 7 Analyze each component in relation to the system and determine the suitability of a given component for different agriculture applications. 5.12.7**

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- 8 Apply precision agriculture information to specifically reduce the negative environmental impacts of production practices. 5.12.8**

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- 9 Explain how programable logic control (PLC) works and determine equipment malfunctions related to plc failure. 5.12.9**

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- 10 Interpret results and prepare recommendations to present findings to stakeholders. 5.12.10**

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- 11 Determine precision system based on cost and recommendation for an operation. 5.12.11**

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- 12 Explain and figure variable rate for production goal. 5.12.12**

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- 13 Identify and troubleshoot problems that arise with computer/network/hardware and software compatibility problems. 5.12.13**

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- 14 Calibrate, repair, and maintain electronic equipment per manufacturer's specifications. 5.12.14**

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- 15 Identify and describe functions of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming. 5.12.15**

**Electronic Systems:**  
Learners apply principles of electronics related to electronic

- 1 Describe static (open circuit) and dynamic (closed circuit) testing principles. 5.13.1**

theory, alternating and direct current, electronic components, electronic circuits, digital electronics, and power supply. 5.13

- 2 Measure the source voltage and perform voltage drop and current draw tests in electronic circuits. 5.13.2
- 3 Identify and describe the principles of capacitance and inductance. 5.13.3
- 4 Identify and describe the functions of non-suppressed, suppressed, and bistable relays. 5.13.4
- 5 Inspect and test switches, connectors, relays, solenoid, and wires of electronic circuits. 5.13.5
- 6 Identify, manufacture, and repair or replace terminal connectors per OEM specifications. 5.13.6
- 7 Perform solder repair of electrical wiring. 5.13.7
- 8 Locate shorts, grounds, opens, and resistance problems in electronic circuits. 5.13.8
- 9 Inspect, test, and reset or replace or reset fusible links, circuit breakers, and fuses per OEM specifications. 5.13.9

Motors and Programmable Logic Controllers: Learners will apply the principles of installing motors, variable-frequency drives (VFD) and power wiring; as well as program, install, and monitor digital computers used for automation of electronic mechanical processes to perform tasks. 5.14

- 1 Identify types and components of single phase and three phase motors. 5.14.1
- 2 Interpret motor nameplate information and motor specifications. 5.14.2
- 3 Calculate motor loads. 5.14.3
- 4 Determine motor rotation needed for the installed load and explain the process for reversing rotation (i.e. three phase and single phase). 5.14.4
- 5 Interpret schematics and control diagrams for building a motor circuit. 5.14.5
- 6 Wire single phase and three phase circuits and install motor control devices (e.g. contactors, starters, variable-frequency drive (VFD), and motor speed controls). 5.14.6
- 7 Explain the starting sequence of motor components within a given circuit. 5.14.7
- 8 Troubleshoot and repair motor starting systems to verify operation according to schematics and control diagrams. 5.14.8
- 9 Describe the use of Programmable Logic Circuits (PLC) in manufacturing automation. 5.14.9
- 10 Identify Programmable Logic Controller (PLC) components. 5.14.10
- 11 Design a motor control program using manual and automatic modes. 5.14.11

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**12 Monitor and troubleshoot a network and hardwired system with a Programmable Logic Controller (PLC).** 5.14.12

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**13 Monitor and troubleshoot Programmable Logic Controller (PLC) operation.** 5.14.13

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**14 Install and maintain Programmable Logic Controllers (PLCs).** 5.14.14

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**Animal Behavior: Apply management practices to assure animal welfare considering species-specific behaviors, human safety, social influences, public perception, and regulations associated with animal welfare.** 5.15

**1 Understand social influences, public perception, and regulations that are associated with animal welfare.** 5.15.1

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**2 Describe the adaptations and special senses (e.g., sight, hearing, smell, touch) of animals and how they contribute to animal behavior.** 5.15.2

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**3 Identify and describe the innate behavioral patterns of animals.** 5.15.3

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**4 Describe social relationships involved in behavioral adjustment and adaptation (e.g., animal-to-animal and human-to-animal interaction).** 5.15.4

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**5 Interpret an animal's intent based on its vocalization, body posture, and chemical means of communication.** 5.15.5

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**6 Recognize behavior abnormalities and recommend corrective action.** 5.15.6

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**7 Humanely handle, restrain, and move animals.** 5.15.7

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**8 Identify and describe the life expectancy and productive use of animals.** 5.15.8

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**9 Identify and describe the impacts of animal welfare and handling on meat quality and food safety.** 5.15.9

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**10 Compare and contrast proper and improper handling, equipment uses, and strategies that impact food quality.** 5.15.10

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**11 Identify methods to minimize animal stress and safety (physiology, psychological, and nutritional).** 5.15.11

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**12 Examine an animal to evaluate its general condition.** 5.15.12

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**Biosecurity: Connect the sources and causes of contamination and develop protocols to implement biosecurity procedures.** 5.16

**1 Investigate sources and origins of agents that can contaminate processed and unprocessed food products.** 5.16.1

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**2 Identify activities and biological agents that contribute to the risk of acquiring or preventing a specific disease.** 5.16.2

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**3 Identify sources of biological and chemical tampering points.** 5.16.3

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**4 Assess a facility's biosecurity, classify the level of risk, and recommend improvements.** 5.16.4

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- 5 Implement biosecurity procedures to prevent cross-site contamination (e.g., proper use and disposal of personal protective equipment [PPE] from site to site, vehicle cleaning between farm and processing site). 5.16.5**
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- 6 Screen and test animals and plant products for infectious agents or contamination. 5.16.6**
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- 7 Select bio-containment practices (e.g., quarantine, eradicate, showering into facilities) to manage pests and diseases. 5.16.7**
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- 8 Manage the biosecurity of raw materials and finished products during transportation (e.g., security seals, chain of custody). 5.16.8**