

# Industrial Technologies Service Specialist - (IND)

## Competency Requirements: CET Core and Specialties



Industrial technologies service specialists are expected to obtain knowledge of industrial electronics core concepts which are then applicable to all the various specialty areas of industry. Once the technician has acquired these skills, abilities and knowledge, they will have a good industrial/automation electronics basis and would be prepared for the additional specialty areas covering a broad range of additional automation technologies.

The IND Core journeyman level covers twelve different categories with five IND Specialty areas covering additional categories. The IND Core certification examination will cover **all 16** category areas, while the IND Specialty category examinations will cover those specific areas in depth.

Basic electronics content should have been previously acquired through the Associate CETa certification. The CETa is the pre-requisite foundation to journeyman level CET certification.

Industrial Technologies Service Specialists must be knowledgeable in the following technical areas:

### **CORE:**

#### **1.0 Safety**

- 1.1. List First Aid equipment and describe industrial first aid procedures including:
  - 1.1.1. shock mitigation
  - 1.1.2. cut and abrasion treatment
  - 1.1.3. blunt force treatment
- 1.2. Identify fire hazards and how to handle different classes of fires in the workplace
- 1.3. List basic rules associated with workplace safety including:
  - 1.3.1. identifying surrounding conditions and possible safety issues
  - 1.3.2. explaining the safe procedures while working in confined spaces
  - 1.3.3. explaining industrial electrical safety rules described in electrical codes (NEC<sup>®</sup>, CEC)
  - 1.3.4. explaining safe lifting procedures
  - 1.3.5. climbing and safety rules that OSHA and ANSI A14 dictates for workers at heights
  - 1.3.6. identifying potential environmental hazards in the workplace including:
    - 1.3.6.1. atmosphere monitoring including low explosive limits (LEL),
    - 1.3.6.2. flammability,
    - 1.3.6.3. HAZMAT reactions
  - 1.3.7. summarizing the use of material safety data sheets (MSDS)
- 1.4. Describe what types of Personal Protection Equipment (PPE) should be worn for work environments where there is danger of:
  - 1.4.1. Arc Flash and Arc Blast
  - 1.4.2. eye injury
  - 1.4.3. ear injury
  - 1.4.4. head injury
  - 1.4.5. lung injury
  - 1.4.6. other injuries and the required work apparel
- 1.5. Describe safety procedures required working with and around industrial equipment including:
  - 1.5.1. Lockout / Tag Out
  - 1.5.2. tools and machines
  - 1.5.3. products
  - 1.5.4. test equipment
- 1.6. Explain safe work procedures for fiber optics including:
  - 1.6.1. handling and disposal
  - 1.6.2. installation environment and electrical hazards
  - 1.6.3. light sources

- 1.7. List safety precautions for static sensitive electronics components and products
- 1.8. Describe the Robotic safety concerns including:
  - 1.8.1. intrinsic fail safe system
  - 1.8.2. hard guards
  - 1.8.3. perimeter guards
  - 1.8.4. safety mats
  - 1.8.5. E-Stop (emergency stop)

## 2.0 Industrial Mathematics

- 2.1. Explain and identify single load electrical power circuits including:
  - 2.1.1. output
  - 2.1.2. input
- 2.2. Explain electrical circuits formulas including:
  - 2.2.1. series
  - 2.2.2. parallel
  - 2.2.3. complex (series-parallel)
- 2.3. Describe formulas for power, resistance, voltage and current as they apply to equipment and/or systems such as conductors, terminations and loads that have various combinations of capacitance, resistance and inductance
- 2.4. Explain mechanical advantage including:
  - 2.4.1. pivot/lever law
  - 2.4.2. torque
  - 2.4.3. units of measure including:
    - 2.4.3.1. Newton-meters
    - 2.4.3.2. foot pounds
  - 2.4.4. identifying pulley ratios
    - 2.4.4.1. single
    - 2.4.4.2. dual
  - 2.4.5. explaining belt sizes, and tension specifications
  - 2.4.6. gear ratios
- 2.5. Explain fluid power and flow calculations
- 2.6. Explain how to convert between decimal, binary, octal and hexadecimal numbering systems
- 2.7. Explain how to express gain and loss using the decibel (dB) and suffixes in power and signal level calculations

## 3.0 Diagrams and Schematics

- 3.1. Read and identify flow chart symbols and their use for the following:
  - 3.1.1. process control
  - 3.1.2. troubleshooting
  - 3.1.3. processor programming
- 3.2. Distinguish schematic diagrams for:
  - 3.2.1. electrical
    - 3.2.1.1. component
    - 3.2.1.2. circuit function
  - 3.2.2. electronics
  - 3.2.3. fluid power
- 3.3. Identify and explain ladder diagrams for the following applications:
  - 3.3.1. PLC
  - 3.3.2. electrical
- 3.4. Recognize and read block diagrams for:
  - 3.4.1. electronics

- 3.4.2. digital logic
- 3.4.3. microprocessors
- 3.4.4. use in troubleshooting techniques
- 3.4.5. test points
- 3.5. Identify pictorial diagrams for:
  - 3.5.1. parts placement
  - 3.5.2. assembly
  - 3.5.3. system placement
- 3.6. Explain Piping & Instrument diagrams (P&ID) and how they correlate to electrical wiring, relay logic, ladder logic and schematic diagrams

#### 4.0 Electrical Components

- 4.1. Explain uses of different light producing (emitting) devices
- 4.2. Identify NEMA<sup>®</sup> (National Electrical Manufacturers Association) plug and receptacle outlet patterns
  - 4.2.1. Describe physical requirements/best practices in installation of NEMA enclosures
- 4.3. Describe resistive component device types and their use including:
  - 4.3.1. differences between fixed and variable
  - 4.3.2. differences between traditional carbon versus metal film
  - 4.3.3. potentiometers and rheostats
  - 4.3.4. thermistors
  - 4.3.5. light dependent resistors (photocells)
  - 4.3.6. metal oxide varistor (MOV)
- 4.4. Explain the correlation of resistive components to actual devices and equipment where they are utilized, especially in regards to industrial electrical/electronic signaling devices and/or instrumentation
- 4.5. Describe capacitive components/ types and how they are used
- 4.6. Explain the correlation of capacitive components to actual devices and equipment where they are utilized, especially in regards to industrial electrical/electronic signaling devices and/or instrumentation
- 4.7. Identify transducer types and how they are used including:
  - 4.7.1. thermal transducers and sensors
  - 4.7.2. pressure sensors
    - 4.7.2.1. load cell transducer
  - 4.7.3. strain gauge
  - 4.7.4. linear variable differential transformer (LVDT)
  - 4.7.5. chemical transducers and sensors
    - 4.7.5.1. turbidity
    - 4.7.5.2. pH
  - 4.7.6. acoustic transducers and sensors including:
    - 4.7.6.1. ultrasonic
  - 4.7.7. magnetic sensors
  - 4.7.8. proximity sensors including:
    - 4.7.8.1. radar and sonar
  - 4.7.9. optical sensors including camera and video and photodiode sensors
  - 4.7.10. infrared sensors
  - 4.7.11. Explain how ohms law correlates to these devices and the components contained within them
- 4.8. Describe the use of iso-couplers
- 4.9. Describe the use of optical isolators
- 4.10. Recognize operational amplifier system level applications and characteristics of:

- 4.10.1. low noise
- 4.10.2. high input impedance
- 4.10.3. low output impedance
- 4.10.4. very high gain
- 4.10.5. sensors including difference detection
- 4.10.6. signal reduction/cancellation
- 4.10.7. Explain the circuit function application for amplifiers
- 4.11. Explain requirements for distribution system line amplifiers
- 4.12. Describe integrated circuit and semiconductor use in systems including:
  - 4.12.1. differences/tolerances of supply voltages for CMOS versus TTL
  - 4.12.2. designs using combinational logic:
    - 4.12.2.1. decoders to activate an output action
  - 4.12.3. Multiplexer/data selector
  - 4.12.4. Demultiplexer/data distributor

## 5.0 Electro-Mechanical Devices

- 5.1. Describe switch types and their uses (SPST, SPDT, DPDT, etc.)
  - 5.1.1. Explain the difference between a “pole” and the “throw of a switch”
  - 5.1.2. Explain how switches can be sensors and control devices
- 5.2. Explain the use of timers for the following purposes:
  - 5.2.1. general purpose
  - 5.2.2. delay
  - 5.2.3. interval
  - 5.2.4. programmable
  - 5.2.5. elapsed
  - 5.2.6. 555 Timer
- 5.3. Recognize counters used for:
  - 5.3.1. products
  - 5.3.2. cycles
- 5.4. Explain thermal and magnetic differences among:
  - 5.4.1. circuit breakers
  - 5.4.2. Cut-Outs
  - 5.4.3. overloads
- 5.5. Identify the structure and use of the following relays:
  - 5.5.1. stepping
  - 5.5.2. latching
  - 5.5.3. motor starter – contactor
  - 5.5.4. solid state
- 5.6. Define the component features of the following sounding (aural alert) devices:
  - 5.6.1. speaker
  - 5.6.2. buzzer
  - 5.6.3. bell
- 5.7. Describe the use of solenoids as:
  - 5.7.1. actuators for loading and sizing
  - 5.7.2. control valves
  - 5.7.3. clamps
  - 5.7.4. drivers

## 6.0 Wiring and Codes

- 6.1. Describe copper wire types and their characteristics including:
  - 6.1.1. solid
  - 6.1.2. stranded
  - 6.1.3. braided
- 6.2. Explain cabling attenuation and return loss
- 6.3. Explain the use of circuit protection devices including:
  - 6.3.1. fuses
  - 6.3.2. circuit breakers
  - 6.3.3. UPS (uninterruptible power supplies)
  - 6.3.4. motor overloads
  - 6.3.5. safety relays
- 6.4. Explain Electrical Code (NEC®, CEC, TIA-568, -598) wiring/conductor codes sections pertaining to:
  - 6.4.1. conductor/wire size (Articles 110, 210, 310, 600, et al)
    - 6.4.1.1. American Wire Gauge (AWG)
  - 6.4.2. wire color codes (Articles 210, 220, 230, 250, 300)
  - 6.4.3. wiring methods (Article 300)
  - 6.4.4. grounding and bonding (Article 250)
  - 6.4.5. low voltage standards (Article 393)
  - 6.4.6. high voltage standards (Article 490)
  - 6.4.7. standards for class 1, 2 and 3 circuit wiring (Article 725)
  - 6.4.8. cables and raceways (Article 770)
  - 6.4.9. color code identification and premises jacket colors (TIA-598-C)
- 6.5. Explain Industrial fiber optic cables and configurations including:
  - 6.5.1. difference between the uses of plenum and riser rated cabling
  - 6.5.2. cable length markings
  - 6.5.3. connector and endface cleaning
  - 6.5.4. insertion loss testing in accordance with TIA-568-
- 6.6. Describe Industrial networks cabling including:
  - 6.6.1. uses and bandwidth of balanced twisted-pair cabling in accordance with TIA-568-:
    - 6.6.1.1. unshielded (UTP)
    - 6.6.1.2. shielded (STP)
  - 6.6.2. mechanical performance characteristics of cabling:
    - 6.6.2.1. bend radius
    - 6.6.2.2. measurements
    - 6.6.2.3. DAS/small cell terminations
    - 6.6.2.4. splitters and couplers
    - 6.6.2.5. harnesses/hangers applications
  - 6.6.3. TIA 606B labeling standards

## 7.0 AC Power Sources and Motors

- 7.1. Describe the structure and operation of AC Motors including:
  - 7.1.1. asynchronous
  - 7.1.2. synchronous
- 7.2. Describe the structure and operation of AC power sources including:
  - 7.2.1. single-phase
  - 7.2.2. three-phase
  - 7.2.3. high-tension service distance distribution
- 7.3. Explain the use of transformers in power transmission systems including:
  - 7.3.1. the operation of a transformer for:

- 7.3.1.1. isolation
- 7.3.1.2. voltage step-up
- 7.3.1.3. current step-down
- 7.3.1.4. voltage step-down
- 7.3.1.5. current step-up
- 7.3.2. calculations, characteristics and properties for:
  - 7.3.2.1. inductance
  - 7.3.2.2. impedance
  - 7.3.2.3. capacity
  - 7.3.2.4. efficiency
  - 7.3.2.5. power ratings
  - 7.3.2.6. winding characteristics
- 7.3.3. how single phase are used in the plant power grid systems:
  - 7.3.3.1. generation
  - 7.3.3.2. transmission
  - 7.3.3.3. distribution
  - 7.3.3.4. end user
- 7.3.4. how multi- phase are used in the plant power grid systems:
  - 7.3.4.1. generation
  - 7.3.4.2. transmission
  - 7.3.4.3. distribution
  - 7.3.4.4. end user
- 7.3.5. the applications of three-phase systems:
  - 7.3.5.1. Delta connection to Wye
  - 7.3.5.2. Wye connection to Delta
- 7.4. Explain the calculation of sine wave variables
- 7.5. Identify AC monitoring and troubleshooting devices, power losses and loss calculations
- 7.6. Explain all elements of power quality including:
  - 7.6.1. impedance
  - 7.6.2. voltage drop
  - 7.6.3. ambient temperature
  - 7.6.4. leading
  - 7.6.5. lagging
  - 7.6.6. voltage spike
  - 7.6.7. peak voltage
  - 7.6.8. RMS (root mean square) voltage
  - 7.6.9. power factor
  - 7.6.10. harmonics
  - 7.6.11. frequency
  - 7.6.12. reactance
    - 7.6.12.1. inductive
    - 7.6.12.2. capacitive
  - 7.6.13. how to circumvent power quality issues
- 7.7. Explain how to load and size a motor actuator
- 7.8. Explain how AC variable frequency drive (VFD) motors are used and controlled

## 8.0 DC Power Sources and Motors

- 8.1. Identify methods of creating DC energy and storage in systems
- 8.2. Explain calculating variables and feedback in DC circuits
- 8.3. Explain AC to DC power supply conversions including:
  - 8.3.1. Half Wave

- 8.3.2. Full Wave
  - 8.3.2.1. Conventional
  - 8.3.2.2. Bridge
- 8.4. Identify DC monitoring and troubleshooting devices
- 8.5. Describe the structure and operation of DC Motors including:
  - 8.5.1. Servo
  - 8.5.2. Stepper
  - 8.5.3. Wound:
    - 8.5.3.1. Series
    - 8.5.3.2. Shunt
    - 8.5.3.3. Compound

## 9.0 Networking, Interfacing, and Programming

- 9.1. Identify the differences in modes of data transmission including:
  - 9.1.1. Ethernet
  - 9.1.2. Wireless
  - 9.1.3. Supervisory Control and Data Acquisition (SCADA)
- 9.2. Describe addressing modes including:
  - 9.2.1. internet protocol (IP)
  - 9.2.2. devices
- 9.3. Describe Highway Addressable Remote Transducer automation protocol (HART®)
- 9.4. Describe the 4-20 ma current loop Industrial Analog Communication standard
- 9.5. Describe how an Input Output (I/O) communication bus works
- 9.6. Identify the digital communication forms and their structure
  - 9.6.1. serial (RS-232, -422, -485)
  - 9.6.2. parallel
- 9.7. Demonstrate ability to utilize the following types of discrete controller modules:
  - 9.7.1. DC and AC
  - 9.7.2. analog
  - 9.7.3. specialty (such as communications; coprocessors; encoders; motion)
  - 9.7.4. signal conditioning
- 9.8. Explain syncing/sourcing of I/O modules
- 9.9. Describe common connection diagrams used with PLCs
- 9.10. Define scan time and scan cycle
- 9.11. Compare memory size and mapping
- 9.12. Explain how data is input, output, filed and addressed
- 9.13. Describe the requirements for hardware and software interfacing including optical couplers
  - 9.13.1. HMI (human machine interface)
- 9.14. Compare CPU speed requirements
- 9.15. Calculate the power requirements for a PLC power supply
- 9.16. Identify the symbols for relays and other common ladder diagram devices and graphics
- 9.17. Describe a short software program typical of a simple PLC application

## 10.0 Test Equipment and Troubleshooting

- 10.1. Identify how to use the following measuring devices including:
  - 10.1.1. tape and rigid rulers
  - 10.1.2. calipers
  - 10.1.3. micrometer
  - 10.1.4. torque gauge
  - 10.1.5. angle and level devices
- 10.2. Explain how to use a hydrometer

- 10.3. Explain how to use the following electrical monitoring instruments:
  - 10.3.1. oscilloscope
  - 10.3.2. Earth Ground Resistance meter
  - 10.3.3. MegaOhm meter
  - 10.3.4. power quality analyzer
  - 10.3.5. wattmeter
  - 10.3.6. DMM (digital multimeter)
    - 10.3.6.1. ammeter
      - 10.3.6.1.1. AC clamp on
      - 10.3.6.1.2. DC inline
    - 10.3.6.2. ohmmeter
    - 10.3.6.3. voltmeter
    - 10.3.6.4. diode check
    - 10.3.6.5. capacitor check
    - 10.3.6.6. frequency measurement
    - 10.3.6.7. temperature reading
  - 10.3.7. logic probe
- 10.4. Describe the differences in applications of the above monitoring devices to include:
  - 10.4.1. trending/tuning/adjusting of analog or “bars”
  - 10.4.2. accuracy of digital readouts
  - 10.4.3. overemphasizing minor variations and apparent precision
  - 10.4.4. locating hardware and software errors
- 10.5. Identify fluid power measuring instruments and their use:
  - 10.5.1. fluid flow meter
  - 10.5.2. pressure gauge
- 10.6. Describe how to use the following network test instruments:
  - 10.6.1. toner and probe kit
  - 10.6.2. multifunctional cable tester
  - 10.6.3. network auto tester
- 10.7. Describe a visual and continuity inspection of a circuit
- 10.8. Describe an emergency stop test-emergency disconnect test
  - 10.8.1. Explain how to perform a program reload
- 10.9. Explain how to calibrate test equipment

## **SPECIALTY AREAS:**

Industrial Technologies Service Specialist should be knowledgeable in the following additional technical Specialty areas in addition to the prior Core areas:

### **Specialty 1:**

#### **11.0 Industrial Communications**

- 11.1. Define industrial communications information transmission methods
- 11.2. Identify the differences in modes of data transmission
- 11.3. Identify the structures of network digital communications
- 11.4. Describe how an Input Output (I/O) communication bus works
- 11.5. Explain Highway Addressable Remote Transducer automation protocol (HART®) communications
- 11.6. Identify the difference between physical and logical network topologies
- 11.7. Explain addressing in a digital network
- 11.8. Identify addressing modes
- 11.9. Explain network protocols as they relate to the:



- 11.9.1. Open Systems Interconnection (OSI) model
- 11.9.2. ISO IS 7498 standard for the OSI model
- 11.10. Explain the data link layer of the OSI model and the terms including:
  - 11.10.1. “MAC”, Media Access Control
  - 11.10.2. “LLC”, Logical Link Control
- 11.11. Identify the digital communication forms and their structure
  - 11.11.1. serial (RS-232 both )
  - 11.11.2. parallel
- 11.12. List the seven types of communication cabling
- 11.13. Describe XbaseY communication cable classifications and their use
- 11.14. Identify the advantages optical fiber cabling has over wire

## 12.0 Networks

- 12.1. Describe network bus classifications and the devices with which they connect
- 12.2. Explain fieldbus protocols associated with a process bus network
- 12.3. Describe common basic network terminology
- 12.4. Explain how the TIA 606B standard is used to label cabling systems
- 12.5. Identify the basis of an industrial wireless communication system
- 12.6. Explain the difference between single channel radio and spread spectrum wireless communication
- 12.7. Identify the transmission protocols used for wireless communications
- 12.8. Identify the wireless protocol standards
- 12.9. Identify the advantages/disadvantages wireless networks have over wired networks
- 12.10. Explain network cybersecurity systems
- 12.11. Identify wireless cybersecurity encryption methods
- 12.12. Describe how a Supervisory Control and Data Acquisition (SCADA) system manages a network

## Specialty 2:

### 13.0 Fluid Power

- 13.1. Describe Pascal's law calculations (principle of transmission of fluid-pressure)
- 13.2. Identify compressor types and how they work
- 13.3. Identify the types of prime movers used with pumps
- 13.4. Describe hydraulic pump types and identify the terms:
  - 13.4.1. accumulator
  - 13.4.2. cavitation
- 13.5. Explain filter dryer methods
- 13.6. Identify pneumatic system components and their function
- 13.7. Identify pneumatic valve types
  - 13.7.1. Describe valve actuation methods
- 13.8. Describe the function of linear cylinders/actuator types
- 13.9. Identify pneumatic plumbing methods
  - 13.9.1. Describe an air distribution systems design

## Specialty 3:

### 14.0 Instrumentation

- 14.1. Specify items typically regulated by process control
- 14.2. List types of final elements used in process control
- 14.3. Explain the application of the 4-20 ma current loop system

- 14.4. Identify methods used in process control for measurements of:
  - 14.4.1. position
  - 14.4.2. temperature
  - 14.4.3. pressure
  - 14.4.4. level
  - 14.4.5. flow
- 14.5. Identify analyzers used in process control to measure:
  - 14.5.1. gas
  - 14.5.2. humidity
  - 14.5.3. solids moisture
  - 14.5.4. liquid
    - 14.5.4.1. density
    - 14.5.4.2. viscosity
- 14.6. Identify types of electrochemical instrumentation
- 14.7. Describe methods of automatic control and calculations for:
  - 14.7.1. ON-OFF
  - 14.7.2. proportional
  - 14.7.3. integral
  - 14.7.4. derivative
- 14.8. Describe methods of magnetic control and calculations
- 14.9. Explain how HMI and 'Touch Technology' monitor contacts use:
  - 14.9.1. SAW (Surface Acoustic Wave)
  - 14.9.2. Resistive
  - 14.9.3. Infrared
  - 14.9.4. Surface capacitive
  - 14.9.5. Projected capacitive
- 14.10. Explain how to calibrate instruments, gauges, sensors, switches, meters and transmitters

#### **Specialty 4:**

#### **15.0 PLCs (Programmable Logic Controllers)**

- 15.1. Explain the information derived from a PLC nomenclature tag
- 15.2. Identify PLC output types
- 15.3. Describe the process and methods used to input / program a PLC including:
  - 15.3.1. PLC schematic symbols
  - 15.3.2. PLC ladder diagrams functions including:
    - 15.3.2.1. logic
    - 15.3.2.2. math
    - 15.3.2.3. compare
  - 15.3.3. PLC expansion addressing
- 15.4. Describe methods used for networking PLCs
- 15.5. Describe the following types of discrete controller modules:
  - 15.5.1. DC and AC
  - 15.5.2. analog
  - 15.5.3. microcontrollers
  - 15.5.4. specialty (such as communications; coprocessors; encoders; motion)
  - 15.5.5. signal conditioning
- 15.6. Describe open source protocols and devices that use them to include:
  - 15.6.1. Arduinos
  - 15.6.2. PIC microcontrollers and DSCs
  - 15.6.3. Raspberry Pi

- 15.6.4. LocNet
- 15.6.5. DeviceNet
- 15.6.6. BacNet, etc.
- 15.7. Explain the advances of hardware and software interfacing including optical couplers
- 15.8. Describe the application to automation operation of and a production process for:
  - 15.8.1. ladder logic instructions
  - 15.8.2. timer instructions
  - 15.8.3. counter instructions
  - 15.8.4. sequencer instructions
  - 15.8.5. discrete control functions
  - 15.8.6. math comparisons
- 15.9. Explain how the following functions affect the process control cycle:
  - 15.9.1. loop
  - 15.9.2. data comparison
  - 15.9.3. branch
  - 15.9.4. add/subtract
  - 15.9.5. multiply/divide
- 15.10. Describe physical requirements/best practices in installation of:
  - 15.10.1. PLC panel layout
  - 15.10.2. enclosure environmental control
  - 15.10.3. maintenance
  - 15.10.4. surge protection

### **Specialty 5:**

#### **16.0 Robotics**

- 16.1. Explain robot design that is created to perform one or more of the “three D’s” (dull, dirty, or dangerous)
- 16.2. Describe the characteristic robot types to include:
  - 16.2.1. autonomous
    - 16.2.1.1. programmable
  - 16.2.2. guided
  - 16.2.3. remote control
    - 16.2.3.1. ROVs types
- 16.3. Explain the term “End of Arm Tooling”
- 16.4. List the six axis of movement in a typical robotic arm
- 16.5. Define a robotic work-cell to include:
  - 16.5.1. subsystems
- 16.6. Identify robot power sources
- 16.7. List robot feedback devices
- 16.8. Describe the sources of robot hazards as listed in OSHA Instruction PUB 8-1.3 SEP 21, 1987 Office of Science and Technology Assessment
- 16.9. Describe the purpose of ISO 9283 as it relates to robotics
- 16.10. Explain how the ANSI/RIA R-15.06-2012 standard will affect the robotics industry

### **Specialty 6; Additive Manufacturing ?; forthcoming**

## **End of Industrial Technologies Service Specialist Competencies (including all Core and Specialty categories)**

Find an ETA® Test Site

<http://www.eta-i.org/testing.html>

**Associated Suggested Study and Resource Materials:**

**Modern Industrial Electronics,5E**; Maloney; ISBN 978-0130487414; Prentice-Hall, 2003  
**Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3E**; Kissell; ISBN 978-0130602411; Prentice Hall, 2002  
**Solid State Devices and Systems,4E**; Rockis; ISBN 978-0826916372; ATP, 2012  
**Industrial Control Electronics,3E**; Bartelt; ISBN 978-1401862923; Delmar Cengage, 2005  
**Electrical Systems for Facilities Maintenance Personnel**; Mazur; ISBN 978- 0826915948; ATP, 2011  
**Troubleshooting Electric Motors,4E**; Mazur, Proctor; ISBN 978-0826917898; ATP, 2010  
**Electrical Principles and Practices,3E**; Mazur, Zurlis; ISBN 978-0826918031; ATP, 2007  
**Electronics Technology: Devices and Circuits**; Dugger, Gerrish; ISBN 978-0870060854; Goodheart-Willcox Co, 1994  
**Basic Electricity and Electronics,2E**; U.S. Navy Press; ISBN 978-0486209739; Dover Pub., 1970  
**Industrial Motor Control,6E**; Herman; ISBN 978-1435442399; Delmar Cengage, 2009  
**Printreading for Installing and Troubleshooting Electrical Systems**; Mazur, Weindorf; ISBN 978-0826920508; ATP, 2009  
**Programmable Logic Controllers,4E**; Petruzella; ISBN 978- 0073510880; McGraw-Hill, 2010  
**Microprocessor and Microcontroller Fundamentals: The 8085 and 8051 Hardware and Software**; Kleitz; ISBN 978-0132628259; Prentice-Hall, 1997  
**Industrial Electronics 4E**; Humphries, Sheets; ISBN 978-0827358256; Delmar Cengage 1993; Available through ETA-I at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)  
**Industrial Electrical Troubleshooting**; Lundquist; ISBN 978-0766806030; Delmar Cengage 1999; Available through ETA-I at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)  
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