Industrial Technologies Service Specialist - (IND)

Competency Requirements: CET Core and Specialties

Industrial electronics technicians 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, there are additional specialty areas covering a broad range of additional automation technologies. The IND Core covers twelve different categories while there are five IND Specialty areas covering additional categories.

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

1.0 Safety

- 1.1. List First Aid equipment and describe industrial first aid procedures
- 1.2. Identify fire hazards and how to handle different classes of fires in the workplace including:
  - 1.2.1. Class A
  - 1.2.2. Class B
  - 1.2.3. Class C
  - 1.2.4. Class D
  - 1.2.5. Class K
- 1.3. List basic rules associated with workplace safety including:
  - 1.3.1. Identify surrounding conditions and possible safety issues
  - 1.3.2. Explain the safe use of ladders as described in ANSI A.14 standards
  - 1.3.3. List and explain industrial electrical safety rules
  - 1.3.4. Explain safe lifting procedures
  - 1.3.5. Identify climbing and safety rules that OSHA dictates for workers at heights
  - 1.3.6. Identify potential environmental hazards in the workplace
- 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. Other injuries and the required work apparel
- 1.5. Describe safety procedures required while working with and around industrial equipment including:
  - 1.5.1. Tools and Machines
  - 1.5.2. Products
  - 1.5.3. 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 using Programmable Logic Controllers (PLCs)
- 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

2.0 Industrial Mathematics

- 2.1. Identify the use of Vectors and Trigonometry for industrial applications
- 2.2. Explain single load electrical circuits including:
  - 2.2.1. Power Calculations
  - 2.2.2. Ohm's Law Calculations
- 2.3. Explain Transformer Calculations including:
  - 2.3.1. Voltage Ratios
  - 2.3.2. Current Ratios
  - 2.3.3. Turns Ratios
  - 2.3.4. Coefficient of Coupling
  - 2.3.5. Identifying electrical power:
    - 2.3.5.1. output
    - 2.3.5.2. input
- 2.4. Compare the most common Computer Numbering Systems including:
  - 2.4.1. Conversion algorithms for:
    - 2.4.1.1. Decimal
    - 2.4.1.2. Binary
    - 2.4.1.3. Hexadecimal
    - 2.4.1.4. Octal
- 2.5. Explain Mechanical Advantage including:
  - 2.5.1. Pivot/Lever law
  - 2.5.2. Torque
  - 2.5.3. Identifying Pulley Ratios
    - 2.5.3.1. Single
    - 2.5.3.2. Dual
  - 2.5.4. Gear Ratios
- 2.6. Explain electrical circuits including:
  - 2.6.1. Series
  - 2.6.2. Parallel
  - 2.6.3. Complex (series-parallel)
- 2.7. Explain Fluid Power Calculations
  - 2.7.1. State Pascal's Law

3.0 Reading Diagrams

- 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
- 3.5. Identify Pictorial Diagrams for:
  - 3.5.1. Parts Placement
  - 3.5.2. Assembly

4.0 Electro-Mechanical Devices

- 4.1. Explain the use of Timers for the following purposes:
  - 4.1.1. General purpose
  - 4.1.2. Delay
  - 4.1.3. Interval
  - 4.1.4. Programmable
  - 4.1.5. Elapsed
- 4.2. Recognize Counters used for:
  - 4.2.1. Products
  - 4.2.2. Cycles
- 4.3. Identify and explain Thermal:
  - 4.3.1. Circuit Breakers
  - 4.3.2. Cut-Outs
  - 4.3.3. Overloads
- 4.4. Identify the structure and use of the following relays:
  - 4.4.1. Stepping
  - 4.4.2. Latching
  - 4.4.3. Motor Starter – Contactor
  - 4.4.4. Solid State
- 4.5. Define the component features of the following Sounding Devices:
  - 4.5.1. Speaker
  - 4.5.2. Buzzer
  - 4.5.3. Bell
- 4.6. Describe the use of Solenoids as:
  - 4.6.1. Actuators
  - 4.6.2. Control Valves
  - 4.6.3. Clamps

5.0 Operational Amplifiers

- 5.1. Explain the Circuit Function application for:
  - 5.1.1. Unity or Follower Amplifier
  - 5.1.2. Comparator Amplifier
  - 5.1.3. Inverting Amplifier
  - 5.1.4. Non-Inverting Amplifier
  - 5.1.5. Summing Amplifier
- 5.2. Recognize Operational Amplifier Characteristics of:
  - 5.2.1. Low Noise
  - 5.2.2. High Input Impedance
  - 5.2.3. Low Output Impedance
  - 5.2.4. Very High Gain

6.0 AC Power

- 6.1. Describe the structure and operation of AC Motors including:
  - 6.1.1. Asynchronous
  - 6.1.2. Synchronous
- 6.2. Describe the structure and operation of AC Generators including:
  - 6.2.1. Single-Phase
  - 6.2.2. Three-Phase
- 6.3. Describe the development and use of transformers in power transmission systems including:
  - 6.3.1. the construction of transformers
  - 6.3.2. the operation of a transformer for:
    - 6.3.2.1. Isolation and advantages of isolation transformer
    - 6.3.2.2. voltage step-up, current step-down
    - 6.3.2.3. voltage step-down, current step-up
  - 6.3.3. transformer power losses and explain loss calculations
  - 6.3.4. calculating input power and output power in a transformer system
  - 6.3.5. how transformers are used in the power grid:

6.3.5.1. Home service (local distribution)
6.3.5.2. High tension service (distant distribution)
6.3.6. the design of three-phase systems:
6.3.6.1. Delta Connection to Wye
6.3.6.2. Wye Connection to Delta
6.4. Explain the calculation of sine wave variables
6.5. Identify AC monitoring and troubleshooting devices
6.6. Explain the calculation of phase & power factor in reactive circuits

7.0 DC Power

7.1. Identify methods of creating DC energy
7.2. Explain calculating variables in DC circuits
7.3. Explain AC to DC Power Supply conversions including:
7.3.1. Half Wave
7.3.2. Full Wave
7.3.2.1. Conventional
7.3.2.2. Bridge
7.4. Identify DC monitoring and troubleshooting devices
7.5. Describe the structure and operation of DC Motors including:
7.5.1. Servo
7.5.2. Stepper
7.5.3. Wound:
7.5.3.1. Series
7.5.3.2. Shunt
7.5.3.3. Compound

8.0 Digital Logic

8.1. Describe TTL and CMOS logic levels including:
8.1.1. logic zero (0)
8.1.2. logic one (1)
8.1.3. undefinable region
8.1.4. differences/tolerances of supply voltages for CMOS versus TTL
8.2. Describe the signals concept of:
8.2.1. “fan out” (drive)
8.2.2. “fan in” (loading)
8.3. Describe the input conditioning functions of:
8.3.1. non-inverting buffers
8.3.2. “Schmitt trigger”
8.4. Identify the schematic symbol, truth table and Boolean equation for:
8.4.1. AND gate
8.4.2. OR gate
8.4.3. NOT or Inverter gate Inverter or Inverted?
8.4.4. NAND gate
8.4.5. NOR gate
8.4.6. XOR gate
8.4.7. XNOR gate
8.5. Design using combinational logic:
8.5.1. Decoders to
8.5.1.1. drive a 7-segment display
8.5.1.2. activate an output action
8.5.2. Multiplexer/data selector
8.5.3. Demultiplexer/data distributor
8.5.4. Half adder
8.6. Explain how to simplify digital equations using:
8.6.1. Boolean algebra
8.6.2. K map
8.7. Define Encoder and its use
8.8. Define digital signal process Flip-flops (bi-stable gates)

8.8.1. Identify:
8.8.1.1. RS/SC
8.8.1.2. Clocked RS
8.8.1.3. T-type
8.8.1.4. D-latch
8.8.1.5. JK
8.8.2. Define circuits for:
8.8.2.1. shift register
8.8.2.2. ring counter
8.8.2.3. binary counter
8.8.2.4. decade counter
8.9. Explain a Monostable multivibrators (“one shots”) electronic circuit
8.9.1. 555 Timer
8.9.2. Distinguish between retriggerable versus non-retriggerable

9.0 Wiring and Codes

9.1. Identify Wire Types and their characteristics including:
9.1.1. Solid
9.1.2. Stranded
9.1.3. Braided
9.2. Explain the use of Circuit protection devices including:
9.2.1. fuses
9.2.2. circuit breakers
9.2.3. thermal overloads
9.3. Explain National Electrical Code (NEC®) wiring codes sections pertaining to:
9.3.1. Wire Size (Articles 110, 210)
9.3.2. Wire Color Codes (Articles 210, 220, 230, 250, 300)
9.3.3. Grounding and bonding (Article 250)
9.3.4. Low Voltage Standards (Article 393)
9.3.5. High Voltage Standards (Article 490)
9.4. Identify National Electrical Code (NEC®) standards for class 1, 2 and 3 circuit wiring (Article 725)
9.5. Recognize Industrial networks cables including:
9.5.1. differences between analog and digital communications signals
9.5.2. categories of balanced twisted-pair cabling:
9.5.3. unshielded twisted-pair (UTP)
9.5.4. shielded twisted-pair (STP)
9.5.5. difference between the uses of plenum and riser rated cabling
9.5.6. Bandwidth of twisted-pair cabling in accordance with ANSI/TIA-568-C.2:
9.5.7. transmission characteristics of 75 ohm coaxial cable
9.5.8. mechanical performance characteristics of twisted pair and coaxial cables
9.5.9. TIA 606B standards
9.6. Recognize Industrial fiber optic cables and configurations including:
9.6.1. cross-section diagrams
9.6.2. buffer type cables:
9.6.2.1. Loose buffer (stranded vs. central tube)
9.6.2.2. Tight buffer (distribution vs. breakout)
9.6.3. strength members tensile forces
9.6.4. jacket materials characteristics
9.6.5. Identify cable types according to application
9.6.6. hybrid cables in accordance with ANSI/TIA-568-C.1
9.6.7. kit difference
9.6.7.1. fanout kit (sometimes called a furcation kit)
9.6.7.2. breakout kit
9.6.8. blown microduct fibers
9.6.9. NEC® optical fiber cable categories including:
9.6.9.1. Abandoned
9.6.9.2. Nonconductive
9.6.9.3. Composite - Article 770.2

9.6.9.4. Conductive
9.6.10. NEC® listing requirements for:
9.6.10.1. cables
9.6.10.2. raceways
9.6.11. TIA-598-C color code identification
9.6.12. TIA-598-C premises cable jacket colors
9.6.13. cable length markings
9.7. Explain Wiring Methods per NEC® Article 300 standards
9.8. Explain the application of Transmission Lines including:
9.8.1. Types
9.8.2. Bend Radius
9.8.3. Data grade testing
9.8.4. Measurements of lines
9.8.5. the different DAS terminations
9.8.6. how connectivity must be maintained
9.8.7. the use of Splitters and Couplers
9.8.8. insertion loss testing for correct ratios
9.8.9. how harnesses/hangers can and must be used

10.0 Transducers

10.1. Describe the function of a transducer
10.2. Identify the transducer types and operation of:
10.2.1. Thermal transducer
10.2.2. Pressure Sensors
10.2.2.1. Load Cell transducer
10.2.3. Photo Sensors
10.2.4. Resistive Sensors
10.2.5. Capacitive Sensors
10.2.6. Strain Gauge
10.2.7. Linear variable differential transformer (LVDT)
10.2.8. Chemical transducer
10.2.9. Acoustic transducer
10.2.10. Magnetic Sensors
10.2.11. Proximity Sensors

11.0 Electrical Components

11.1. Identify the difference between a “pole” and the “throw of a switch”
11.2. Identify Switch types and their use (SPST, SPDT, DPDT, etc.)
11.3. Identify different light producing (emitting) devices
11.4. Identify NEMA® National Electrical Manufacturers Association plug and receptacle outlet patterns
11.5. Distinguish Resistive Device types and their use
11.6. Distinguish Overload Devices types and their use
11.7. Identify Capacitors types and how they are used
11.8. Explain how Inductors / Coils work and the structure of different types
11.9. Explain the function of Transformers and how they operate
11.10. List Solid State Device types and their function

12.0 Test Equipment

12.1. Identify how to use the following Measuring Devices including:
12.1.1. Rulers
12.1.2. Calipers
12.1.3. Micrometer
12.1.4. Tentelometer
12.1.5. Torque Gauge
12.2. Explain how to use a Hydrometer
12.3. Explain how to use the following Electrical Monitoring instruments:
12.3.1. Oscilloscope

- 12.3.2. Ground Resistance test set
- 12.3.3. Wattmeter
- 12.3.4. Clamp On Ammeter
  - 12.3.4.1. AC clamp on
  - 12.3.4.2. DC Clamp on
- 12.3.5. DMM (Digital Multimeter)
- 12.3.6. Ammeter
- 12.3.7. Ohmmeter
- 12.3.8. Voltmeter
- 12.3.9. Logic Probe

12.4. Describe the differences in applications of the above monitoring devices to include:
- 12.4.1. Trending/tuning/adjusting of analog or "bars"
- 12.4.2. Accuracy of digital readouts
- 12.4.3. Overemphasizing minor variations and apparent precision

12.5. Identify Fluid Power Measuring instruments and their use:
- 12.5.1. Fluid Flow Meter
- 12.5.2. Pressure Gauge

12.6. Describe how to use the following Network test instruments:
- 12.6.1. Toner and probe kit
- 12.6.2. Multifunctional cable tester
- 12.6.3. Network auto tester

SPECIALTY AREAS:

Industrial Technologies Service Specialist can be knowledgeable in the following additional technical specialty areas:

Specialty 1:

13.0 Industrial Communications

13.1. Define industrial communications information transmission methods
13.2. Identify the differences in modes of data transmission
13.3. Identify the structures of network digital communications
13.4. Describe how an Input Output (I/O) communication bus works
13.5. Identify the difference between physical and logical network topologies
13.6. Explain addressing in a digital network
13.7. Identify addressing modes
13.8. Explain network protocols as they relate to the:
- 13.8.1. Open Systems Interconnection (OSI) model
- 13.8.2. ISO IS 7498 standard for the OSI model

13.9. Explain the data link layer of the OSI model and the terms including:
- 13.9.1. "MAC", Media Access Control
- 13.9.2. "LLC", Logical Link Control

13.10. Identify the digital communication forms and their structure
- 13.10.1. serial (RS-232)
- 13.10.2. parallel

13.11. List the seven categories of communication cabling
13.12. Describe XbaseY communication cable classifications and their use
13.13. Identify the advantages optical fiber cabling has over wire

14.0 Networks

14.1. Describe network bus classifications and the devices they connect with
14.2. Explain fieldbus protocols associated with a Process Bus Network
14.3. Describe common basic network terminology
14.4. Explain how the TIA 606b Standard is used to label cabling systems
14.5. Identify the basis of an industrial wireless communication system
14.6. Explain the difference between single channel radio and spread spectrum wireless communication
14.7. Identify the transmission protocols used for wireless communications

14.8. Identify the wireless protocol standards
14.9. Explain network cybersecurity systems
14.10. Identify wireless cybersecurity encryption methods

Specialty 2:

15.0 Fluid Power

15.1. Describe Pascal's law calculations (principle of transmission of fluid-pressure)
15.2. Identify compressor types and how they work
15.3. Identify the types of Prime movers used with pumps
15.4. Describe Hydraulic Pump types and identify the terms:
  15.4.1. accumulator
  15.4.2. cavitation
15.5. Explain Filter Dryer methods
15.6. Identify Pneumatic system components and their function
15.7. Identify Pneumatic valve types
  15.7.1. Describe valve actuation methods
15.8. Describe the function of Linear cylinders/actuator types
15.9. Identify Pneumatic plumbing methods
  15.9.1. Describe an air distribution systems design

Specialty 3:

16.0 Instrumentation

16.1. Specify what items typically are regulated by process control
16.2. List types of final elements used in process control
16.3. Identify methods used in process control for measurements of:
  16.3.1. position
  16.3.2. temperature
  16.3.3. pressure
  16.3.4. level
  16.3.5. flow
16.4. Identify Analyzers used in process control to measure:
  16.4.1. gas
  16.4.2. humidity
  16.4.3. solids moisture
  16.4.4. liquid
    16.4.4.1. density
    16.4.4.2. viscosity
  16.4.5. Identify types of electrochemical instrumentation
16.5. Describe methods of Automatic Control and calculations for:
  16.5.1. ON-OFF
  16.5.2. Proportional
  16.5.3. Integral
  16.5.4. Derivative

Specialty 4:

17.0 PLCs (Programmable Logic Controllers)

17.1. Explain the information derived from a PLC nomenclature tag
17.2. Identify PLC output types
17.3. Describe the process and methods used to input / program a PLC including:
  17.3.1. PLC schematic symbols
  17.3.2. PLC Ladder Diagrams
  17.3.3. PLC expansion addressing
17.4. Describe methods used for networking PLCs

Specialty 5:

18.0 Robotics

18.1. Explain robot design that is created to perform one or more of the “three D’s” (dull, dirty, or dangerous)
18.2. Describe the characteristic robot types to include:
  18.2.1. Autonomous
    18.2.1.1. Programmable
  18.2.2. Guided
  18.2.3. Remote Control
    18.2.3.1. ROVs types
18.3. Explain the term “End of Arm Tooling”
18.4. List the six axis of movement in a typical robotic arm
18.5. Define a robotic work-cell to include:
  18.5.1. subsystems
18.6. Identify Robot power sources
18.7. List Robot feedback devices
18.8. Describe the following sources of robot hazards as listed in OSHA Instruction PUB 8-1.3 SEP 21, 1987 Office of Science and Technology Assessment
18.9. Describe the purpose of ISO 9283 as it relates to robotics
18.10. Explain how the ANSI/RIA R-15.06-2012 standard will affect the robotics industry

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**

ETA certification programs are accredited through the ICAC, complying with the ISO/IEC 17024 standard.

