

# ASSOCIATE C.E.T. (CETa)

## BASIC ELECTRONICS CERTIFICATION

### COMPETENCY REQUIREMENTS



The Associate Certified Electronics Technician (CETa) is designed for encompassing the basic electronics theory and applications used in all electronics disciplines. By doing so, the Associate is the foundation for journeyman/senior/master certification program. The CETa is designed for technicians having less than two years' experience or training in electronics.

The competencies listed below are considered the foundation of component based general electronics knowledge and skills.

#### 1.0 Safety Precautions

- 1.1. Describe the physiological reactions electrical shock causes; list various degrees of current the human body can tolerate
- 1.2. Explain the First Aid concepts and its particular importance to workers in electric and electronics fields explaining precautions for the untrained
- 1.3. Explain what the National Electrical Code® (NEC®) is describing various rules technicians must abide by
  - 1.3.1. Explain additional National Fire Protection Association (NFPA®) 70 rules describing how technicians comply with the NEC®
- 1.4. Describe fusing and circuit breaker rules and reasons for different type of fuses
- 1.5. Explain static causes, electrostatic discharge and CMOS damage prevention straps, mats and grounding
- 1.6. List tools hazards which are associated with technician activities in the workplace and in the field.
- 1.7. Describe lockout/tag out rules for potentially unsafe electrical or mechanical hazards
- 1.8. Explain RF transmitter and transmission hazards and precautions including MPE (maximum permissible exposure)
- 1.9. List optical fibers hazards to skin and eyes
- 1.10. Explain personal protection needed by technicians:
  - 1.10.1. Describe PPE (personal protection equipment) needs, i.e. NFPA Table 130.5(c)
  - 1.10.2. Describe MPE (maximum permissible exposure) in RF Safety (OSHA and ANSI)
  - 1.10.3. Describe other OSHA safety rules
- 1.11. List ladder handling and usage (ANSI A14) and OSHA working at heights safety rules
- 1.12. List service vehicle safety concerns such as ladder or transporting security and flying objects, driver screens inside the vehicle
- 1.13. Differentiate the classes of fires (A, B, C, D & K) and the types of extinguishers used to fight them
- 1.14. Explain emergency responses/treatments for the above safety issues

#### 2.0 Electrical Theory

- 2.1. Describe atomic structure, the components of the atom, their charges and importance to electronics technology
- 2.2. Describe the principles of electromagnetism
  - 2.2.1. Explain the different types of magnetic fields
    - 2.2.1.1. Ferromagnetism (common magnetism, permanent magnets)
    - 2.2.1.2. Diamagnetism (repelled, repulsive force)
    - 2.2.1.3. Paramagnetism (weak attraction)
  - 2.2.2. Explain the direct relationship between electricity and magnetism
- 2.3. Explain uses for magnetism in electronics technology
- 2.4. Explain basic uses for electricity
- 2.5. Describe the basic methods of using electricity to operate a motor and how mechanical motion causes a generator to produce electrical current
- 2.6. Explain the differences between current, voltage and resistance
- 2.7. Differentiate between the types of resistive materials and how resistors are used in electronics
- 2.8. Show the different purposes for capacitors and list common types and construction
- 2.9. Explain how inductance relates to magnetism and describe coil construction, cores and usages
- 2.10. Comparison between reactance and resistance and describe current/voltage relationships

- 2.11. Compare impedance with reactance and resistance and explain the causes and effects of impedance, combined reactance
- 2.12. List voltage sources, AC and DC, batteries and natural generation
- 2.13. List Ohms law formulas for current, voltage, resistance and power.
  - 2.13.1. Explain how to calculate problems utilizing each formula
- 2.14. Explain how to calculate power consumption and requirements

### **3.0 Electronic Components**

- 3.1. Identify resistor values from color code or other marks and list composition and reasons for different usages
  - 3.1.1. Explain how thermally sensitive components are used
- 3.2. Identify capacitor types; list common usages; methods of varying capacitance and explain the terms charge and coulomb
- 3.3. Identify inductor types and reasons for various core materials; how diameter and wire size affects the values
- 3.4. Identify common types of transformers and list uses for each; explain step up/down voltage methods; explain why laminations are used
- 3.5. Identify transistors as to type and usage, biasing and applications:
  - 3.5.1. Describe MOS, CMOS, FET applications
  - 3.5.2. Analyze biasing voltages for NPN & PNP bipolar transistors, JFETs, and MOSFETs
  - 3.5.3. Explain beta and alpha, enhance/depletion mode MOSFETs
- 3.6. Identify other semiconductors and explain their uses: Darlington pairs;
- 3.7. Compare thyristors with other semiconductors; identifying diacs, triacs and SCRs and explain their operation
- 3.8. Identify various diode types including Silicon, Schottky, germanium, LED, photo, Zener AND analyze their usage, voltage bias, current, and power consumption in a circuit
  - 3.8.1. Explain Zener diode ratings; describe usage in regulator circuits
- 3.9. List common optical devices (LEDs, LCDs, etc.);
- 3.10. Describe how photo-electronic components operate:
  - 3.10.1. photovoltaic cells are activated
  - 3.10.2. symbols for photo resistors, photodiodes and photo transistors
  - 3.10.3. materials from which these devices are made
- 3.11. Describe types of integrated circuits, such as microprocessors, identifying the basic components and pin-outs

### **4.0 Electronic Circuits: Series and Parallel**

- 4.1. Identify and describe the operation of common DC circuits
- 4.2. Identify and describe the operation of common AC circuits, including waveforms and cycle
- 4.3. Explain how series circuits, R, L, C are used in electronics equipment
- 4.4. Explain how parallel circuits, R, L, C are used in electronics equipment, loads
- 4.5. Explain the purpose of oscillators: crystal
- 4.6. Differentiate between oscillators and multivibrators
- 4.7. Classify circuits as inductive, capacitive and resistive
- 4.8. Explain resonance and show how to calculate resonant frequency
- 4.9. Describe polar and rectangular presentations of L, R, C circuits
- 4.10. Explain Kirchhoff's law and its importance to electronics technicians
- 4.11. Explain the purposes and types of differentiator or integrator circuits
- 4.12. Describe the sections of a PLL (phase locked loop) circuit and PLL circuit use
- 4.13. Describe filter circuits, why and how they are used
- 4.14. Explain wave shaping circuits and explain their purposes
- 4.15. Describe the relationships between bandwidth and "Q" in an electronics circuit
- 4.16. Explain the piezoelectric effect
- 4.17. Describe exponential transients
- 4.18. Explain series and parallel calculations for resistive networks; voltage drop, etc

### **5.0 Soldering - Desoldering Tools**

- 5.1. Describe solder safety as it pertains to burns and potential fires or damage to facilities or customer products
- 5.2. Explain the cause of solder fumes and the effects of lead poisoning

- 5.3. List causes and precautions to prevent or reduce solder splatter
- 5.4. Explain the reasons for flux usage and describe types
- 5.5. List types of solder and reasons for choosing each
- 5.6. Explain heat shunts, why and how they are used
- 5.7. Identify cold solder joints and explain causes
- 5.8. Describe the differences between good and bad mechanical and electrical solder connections
  - 5.8.1. Explain basic handling procedures of surface mount (SMT), ball grid array (BGA), gold finger contacts on a printed circuit board (PCB)
  - 5.8.2. Explain basic procedures for pad repairs (SMT, BGA), plated through hole (PTH), and PCB trace repair.
- 5.9. Describe proper care of solder and de-solder equipment and aids
- 5.10. Explain de-soldering principles
- 5.11. Describe various types of de-soldering equipment and how it is used
- 5.12. Demonstrate the use of braid-wick solder removers

## **6.0 Block Diagrams - Schematics - Wiring Diagrams**

- 6.1. Describe common electrical/electronic symbols
- 6.2. Explain block diagrams use for troubleshooting and maintenance of electronics products
- 6.3. Explain the differences between wiring prints, schematics and block diagrams
- 6.4. Describe the purpose and use of test points and indicate their likely placement on schematics
- 6.5. Point out common drafting principles used for electronic and electrical drawings
- 6.6. Explain methods used for signal tracing
- 6.7. Describe basic building and house wiring concepts and explain why technicians need to be familiar with them
- 6.8. Explain schematics use to locate component and wiring failures in electronics products
- 6.9. Explain the methods of using flow diagrams/charts
- 6.10. Describe basic wiring concepts for I.C. types and pinouts

## **7.0 Cabling**

- 7.1. List wire types and construction
- 7.2. List wire gauges used for various purposes
- 7.3. Explain construction of coaxial cable and the impedance characteristics
- 7.4. List common identifications for copper cables in standards, such as #18 and #24 diameter in the American Wire Gauge (AWG) and UTP telephone cable in ANSI/TIA 568
- 7.5. Explain major differences between copper, coaxial and fiber optic cables
- 7.6. Describe impedance and its causes; explain reasons for maintaining a cable's characteristics
- 7.7. Explain the effects of proper and improper termination
- 7.8. Explain the purposes of grounding and common conventions used in electrical / electronics work
- 7.9. Describe splicing knowledge and ability of coaxial and copper cable
  - 7.9.1. Explain two types of fiber splices
- 7.10. Briefly explain testing methods for all three types of cables and compare dB loss measurements and techniques
- 7.11. Compare the fittings and connectors used in cabling and list potential defects a technician may encounter
- 7.12. Describe proper crimping of communications wiring connectors
- 7.13. Explain how cable prep tools are used and demonstrate proper and improper crimping

## **8.0 Test Equipment and Measurements**

- 8.1. Describe how volt-ohm-current meters operate
- 8.2. Explain meter construction and components
- 8.3. Identify meter protection, safety and usage
- 8.4. Explain care of equipment and test leads
- 8.5. List the purposes and types of signal generators
- 8.6. Describe meter loading and precautions
- 8.7. Explain the purposes of frequency counters and list their limitations
- 8.8. Explain what R-C-L substitution equipment is and its purposes; explain ESR (Equivalent Series Resistance) capacitance measurement equipment
- 8.9. List the uses and precautions for logic test probes
- 8.10. Explain how logic pulsers are used

- 8.11. Describe oscilloscope uses; explain the purposes of each front panel control
- 8.12. List the uses for pattern generators
- 8.13. Define dummy load; show where and why used
- 8.14. Explain reasons for using rheostats, isolation transformers and variacs and why size matters
- 8.15. Explain how a potentiometer functions and its use as a variable voltage divider

## 9.0 Mathematics and Formulas

- 9.1. Quote Ohms law power, voltage, current and resistance formulas and solve for circuit values
- 9.2. List other common basic electronic formulas
- 9.3. Explain how to calculate wavelength, frequency and power values
- 9.4. Convert binary, decimal, octal, hexadecimal numbers
- 9.5. Explain boolean algebra and its use in digital circuitry
- 9.6. Explain decibels and show reasons for using dBs in signal level, power and audio calculations
- 9.7. Explain how graphs are used to demonstrate electronics functions
- 9.8. Explain the International System of Units (SI) prefixes (metric) and conversions
  - 9.8.1. Define exponents (powers of 10) and their calculations

## 10.0 Power Supplies

- 10.1. Explain shock hazards when servicing power supplies in electronic equipment
- 10.2. Describe the differences between transformer powered supplies and line-connected supplies
- 10.3. Describe battery supplies and list common usages; also explain recharging principles
- 10.4. Explain the reasons for filtering, describe hum, and identify common filter types (pi, t, l, etc.)
- 10.5. Explain the reasons for power supply regulation and list common components used in regulated supplies
- 10.6. Explain the term 'Integrated high voltage transformer' supply and explain how it differs from direct or other power supply types
- 10.7. Explain how multiple output supplies are able to supply more than one voltage
- 10.8. Explain where fuses and circuit breakers are commonly and electrically located in circuits; approximate sizes for common circuits; house service box common fuses and circuit breaker configuration and precautions for replacement
- 10.9. Explain how to calculate DC voltages from power supply circuits
- 10.10. Identify and analyze rectifier circuits

## 11.0 Amplifiers

- 11.1. List common amplifier devices: such as power amps, audio preamps, video amps
- 11.2. Describe the purpose of each component in an amplifier circuit
- 11.3. List the usages and classes of amplifiers
- 11.4. Explain frequency response of an amplifier circuit and why it is important
- 11.5. Explain the words 'preamplifier' and 'line amplifier' and where these units are commonly used
- 11.6. Explain the uses of operational amplifiers and how they differ from other amplifiers
  - 11.6.1. Describe how to analyze op-amp circuits to determine gain
- 11.7. Explain how distortion occurs in amplifiers and list ways to reduce or eliminate it
- 11.8. Explain how inaccurate measurements can be experienced due to meter or scope loading.
  - 11.8.1. List ways to overcome loading problems
- 11.9. Describe specifications for broadband amplifiers as compared with common narrow band units
- 11.10. Explain how MMIC (monolithic microwave i.c.) and older high-power electron tubes perform

## 12.0 Interfacing of Electronics Products

- 12.1. List input circuit signal levels which may be expected for various common electronics products or test equipment
- 12.2. List anticipated signal or voltage levels for output circuits in audio and video equipment
- 12.3. Explain the importance of impedance matching; list causes of mismatches
- 12.4. Explain the purposes of plugs and connectors and why it is necessary to use the proper ones
- 12.5. Explain grounding, proper and improper methods, and the results of power source mismatch
- 12.6. List potential signal conflict symptoms
- 12.7. Describe other electronic interfacing such as USB, Zigbee, I<sup>2</sup>C (inter-integrated circuit)

### **13.0 Digital Concepts and Circuitry**

- 13.1. Identify each basic digital gate
- 13.2. Construct truth tables for common gates
- 13.3. Explain how counters operate
- 13.4. Explain the purpose of flip flops and list common types
- 13.5. Explain the purpose of a digital bus and show how it is connected to various sections of a product
- 13.6. List types of display circuitry and describe how numbers and letters are activated digitally
- 13.7. Explain the purpose of computer clocks
- 13.8. Show how pulsers are used for digital signal tracing and how logic probes are used to verify states in digital equipment
- 13.9. Explain how to troubleshoot digital signals
- 13.10. Describe digital clock usage and circuitry
- 13.11. Explain voltages and logic families (TTL, CMOS)
- 13.12. Define microcontrollers and simple programming commands

### **14.0 Computer Electronics**

- 14.1. Describe the major sections of a computer
- 14.2. Differentiate how the computer block diagram and flow charts are utilized
- 14.3. Describe the major blocks contained in a microprocessor chip and describe the purpose of each block
- 14.4. Describe different types of computer memory and how storage is accomplished
- 14.5. Explain programmable logic controls (PLCs) and list usages
- 14.6. Describe basic programming concepts
- 14.7. Describe the reasons for different computer languages and their relationships
- 14.8. Define the word 'peripheral' and list various types
- 14.9. Explain the reasons for using interface devices/chips/cards and name common types

### **15.0 Computer Applications**

- 15.1. Explain knowledge of basic computer operation
- 15.2. Explain steps in installation/set up of a computer
- 15.3. Explain the reasons and choices used in configuring a computer
- 15.4. Describe proper loading and storage of common programs and applications
- 15.5. Explain basic and common utilities programs and list reasons for their use
- 15.6. List ways to backup data and the importance of doing so
- 15.7. Explain the causes of line surges and viruses and protection procedures against each
- 15.8. Explain how to access the Internet, cybersecurity best practices and common applications
- 15.9. Describe how to download a service or application, data or programs
- 15.10. Explain how to use the Internet to locate parts and service literature
- 15.11. Explain the differences between an individual computer and basic networking

### **16.0 Audio and Video Systems**

- 16.1. Explain major components of the most common home entertainment products
- 16.2. Describe carbon versus condenser, MEMS, dynamic and ribbon microphone technology usage
- 16.3. Explain speaker construction and precautions
- 16.4. Explain basic recording and playback products operation, mechanical and electrical technology
- 16.5. Explain how alarm-security systems may be interfaced with entertainment/information products
- 16.6. Describe the differences between good quality and distorted sound and electronic/acoustical reasons for each
- 16.7. Explain how signals may conflict and the symptoms the conflict may produce
- 16.8. Explain how to isolate troubles between discrete equipment units

### **17.0 Optical Electronics**

- 17.1. List common electronics display devices
- 17.2. Explain how LCD displays operate, their advantages and disadvantages
- 17.3. Explain the basics of electronic cameras and sensors
- 17.4. Describe how LED remote hand units work
- 17.5. Describe plasma technology and its uses in TV and computer displays

- 17.6. Explain why and list some locations or circuits in which opto-isolators are used
- 17.7. List uses for light activated controls and how photo devices are incorporated
- 17.8. Describe how broadband signal RF and optical links are used

## **18.0 Radio Communications Technology**

- 18.1. Explain wave propagation and its importance to wireless communications
- 18.2. Describe the theory of how antennas work; list the types of transmission lines
- 18.3. Explain polarization, electromagnetic and electro-static fields and their relationships to each other
- 18.4. Differentiate between the signals/signaling of AM, FM radio/TV, LMR including CDMA, GSM, LTE
- 18.5. Differentiate usage of communications radios and commercial broadcast receivers
- 18.6. Describe the major radio receiver circuitry sections
- 18.7. List common frequency bands
- 18.8. Explain radio circuit tuning and adjustments
- 18.9. Explain the relationships between frequency and wavelength

## **19.0 Telecommunications Basics**

- 19.1. Describe major types of two-way radio communications (avionics, land mobile, maritime, etc.)
- 19.2. Describe wireless telephone/video/data technology basics and list the TIA standard which applies
- 19.3. Describe satellite communications principles
- 19.4. Describe wired data and voice communications network technology
- 19.5. Describe a basic telephone (POTS) circuit.
  - 19.5.1. List common wiring and splicing conventions for POTS

## **20.0 Technician Work Procedures**

- 20.1. Explain major invoice and billing concepts for service businesses
- 20.2. Describe ways to procure service literature
- 20.3. Describe location/cross referencing of parts and product in catalogs
- 20.4. Explain the purposes and requirements for proper record keeping, report generation
- 20.5. Explain how to calculate individual and department productivity for a specific period
- 20.6. Describe contacting product maker help desks and service departments
- 20.7. Explain estimate concepts for service work including test planning
- 20.8. Describe field technician work procedures that may differ from in-shop routines
- 20.9. Explain project management and list steps to follow to achieve maximum results

## **End of Basic Electronics Competencies Listing (with 20 major Categories)**

Notes:

ETA International and allied associations encourage the nation's school systems to adopt these competencies for their basic electronics courses.

**Find an ETA approved school and approved test site:** [http://www.eta-i.org/test\\_sites.html](http://www.eta-i.org/test_sites.html)

**Additional suggested study materials and resources:**

**The Associate CET Study Guide, 6E;** ISBN 1-891749-07-2; ETA International; 2012; —Available through ETA at 800-288-3824, \$60

**EM Study Guide series;** Karl Eilers; download through ETA at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)

**Electronics; Principles and Applications, 8E;** Schuler; ISBN 978-0077567705; McGraw Hill; 2012

**Introduction to Electricity, Electronics, and Electromagnetics, 5E;** ISBN 978-0130105738; Boylestad, Nashelsky; Prentice Hall; 2001

**Teach Yourself Electricity and Electronics, 5E;** ; Gibilisco ISBN 978-0071741354; McGraw-Hill / TAB Books; 2011

**Contemporary Electronics: Fundamentals, Devices, Circuits, and Systems;** ISBN 978- 0073373805; Frenzel; McGraw-Hill Education; 2013

**Electronics Principles, 8E;** Malvino, Bates; ISBN 978-0073373881; McGraw-Hill Higher Ed; 2015

**Electricity & Electronics, 10E;**, Gerrish, Dugger & Roberts; ISBN 978-159070-883-5, Goodheart-Wilcox; 2008

**Discrete and Integrated Electronics: Analysis and Design for Engineers and Engineering**

**Technologists [Print Replica] Kindle Edition;** Prof. Fleeman; ASIN: B0823XLHJ3; 24.3 MB; 2019

**Discrete and Integrated Electronics, Volume Two: Analysis and Design for Engineers and**

**Engineering Technologists [Print Replica] Kindle Edition;** Prof. Fleeman; ASIN: B08FPYVF6M; 27.2 MB; August 2020

**Electricity; Principles and Applications, 8E;** Fowler; ISBN 978-0077567620; McGraw Hill, 2012

**Arduino Electronics Blueprints;** Wilcher; ISBN 978-1-7843-93606; Packt Publishing, 2015

**Digital Electronics: Principles and Applications, 8E;** Tokheim; ISBN 978-00733733775; McGraw Hill, 2013

**Cabling: The Complete Guide to Copper and Fiber-Optic Networking, 5E;** Oliviero & Woodward; ISBN 978-1-118-80732-3; Sybex, Inc.; 2014; Available through ETA at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)

**Introductory DC / AC Electronics, 6E;** ISBN 978-0131139848; Cook; Prentice Hall; 2004

**Electronic Devices and Circuit Theory, 11E;** ISBN 978- 0132622264; Boylestad & Nashelsky ; Pearson; 2012

**Electronic Communications, 6E;** ISBN 978-0070571570; Shrader ; McGraw-Hill Co; 1990

**How to Diagnose and Fix Everything Electronic;** Geier; ISBN 978- 0071744225; McGraw-Hill/TAB Elec. 2011

**Basic Electronics Theory With Projects & Experiments, 4E;** ISBN 978-0830642007; Horn; McGraw-Hill/TAB Elec. 1993

**The Soldering Handbook, 3E;** ISBN 978-0871716187; Vianco; American Welding Society; 2000

**Mastering Technical Mathematics, 3E;** ISBN 978-0071494489; Gibilisco, Crowhurst; McGraw-Hill / TAB Electronics; 2007

**Introduction to Electronics;** ISBN 978-0534012434; Crozier; Breton Pub.; 1983

**There Are No Electrons: Electronics for Earthlings;** ISBN 978-0962781599; Amdahl; Clearwater Pub.; 1991

**Becoming An Electronics Technician, 4E;** ISBN 978-0130932198; Reis; Prentice Hall; 2001

Review **MasteringElectronicsDesign.com** website; RMS material; Adrian S. Nastase; 2013

Review **Electronics-notes.com** website; electronics material; Ian Poole; 2001, 2006 and refined in 2015

Review **AwesomeCube.com** website; electronics projects; Jeff LeSueur; 2013

Review **IPC.org** website; soldering training, <https://www.ipc.org/about-ipc>; standards and solder certification

Check online for NEETS module content: [www.tpub.com/neets/index.htm](http://www.tpub.com/neets/index.htm)

In addition to the above please see the many other webpages/study materials/basic electronics webpages available. Contact ETA International (800-288-3824 or [eta@eta-i.org](mailto:eta@eta-i.org)) for details.

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