

# **NCEE - BASIC ELECTRONICS**

## **BASIC ELECTRONICS COMPETENCIES**

(As recommended by the NCEE - National Coalition for Electronics Education)

### 1.0 Electrical Theory

- 1.1 Describe atomic structure, the components of the atom, their charges and importance to electronics technology
- 1.2 List ten uses for magnetism in electronics technology
- 1.3 Explain basic uses for electricity
- 1.4 Describe the basic methods of using electricity to operate a motor and how mechanical motion causes a generator to produce electrical current
- 1.5 Explain the differences between current, voltage and resistance
- 1.6 List different types of resistive materials and how resistors are used in electronics
- 1.7 Show the different purposes for capacitors and list common types and construction
- 1.8 Explain how inductance relates to magnetism and describe coil construction, cores and usages
- 1.9 Show a comparison between reactance and resistance and describe current/voltage relationships
- 1.10 Compare impedance with reactance and resistance and explain the causes and effects of impedance
- 1.11 List voltage sources, AC and DC, batteries and natural generation
- 1.12 List ohms law formulas for current, voltage, resistance and power. Solve math problems utilizing each
- 1.13 Calculate power consumption and requirements

### 2.0 Electronic Components

- 2.1 Identify resistor values from color code or other marks and list composition and reasons for different usages
- 2.2 Identify capacitor types; list common usages; methods of varying capacitance and explain the terms charge and coulomb
- 2.3 Identify inductor types and reasons for various core materials; how diameter and wire size affects the values
- 2.4 Identify common types of transformers and list uses for each; explain step up/down voltage methods; explain why laminations are used
- 2.5 Identify transistors as to type and usage, such as unijunction, FETs and MOSFETS; explain beta and alpha and provide common DC and bias voltage ranges; list common usages
- 2.6 Identify other semiconductors and explain their uses: Darlington pairs; unijunction transistors and Gunn diodes
- 2.7 Compare thyristors with other semiconductors; Identify diacs, triacs and SCRs and explain their operation.
- 2.8 Explain zeners diode ratings; describe usage in regulator circuits

- 2.9 List common optical devices (LEDs, LCDs, etc.); describe how photovoltaic cells are activated. Draw symbols for photo resistors, photodiodes and photo transistors; list materials from which these devices are made
- 2.10 Describe MOS, CMOS, FET applications

### 3.0 Soldering-Desoldering and Tools

- 3.1 Describe solder safety as it pertains to burns and potential fires or damage to facilities or customer products
- 3.2 Explain the cause of solder fumes and the effects of lead poisoning
- 3.3 List causes and precautions to prevent or reduce solder splatter
- 3.4 Explain the reasons for flux usage and describe types
- 3.5 List types of solder and reasons for choosing each, **including PbF lead free solder. Explain how PbF solder is environmentally safe**
- 3.6 Explain heat shunts, why and how they are used
- 3.7 Identify cold solder joints and explain causes
- 3.8 Describe the differences between good and bad mechanical and electrical solder connections
- 3.9 Demonstrate proper care of solder-desolder equipment and aids
- 3.10 Explain desoldering principles
- 3.11 Describe various types of desoldering equipment and how it is used
- 3.12 Demonstrate the use of braid-wick solder removers

### 4.0 Block Diagrams-Schematics-Wiring Diagrams

- 4.1 Draw common electrical/electronic symbols
- 4.2 Explain how block diagrams are used for trouble shooting and maintenance of electronics products
- 4.3 Explain the differences between wiring prints, schematics and block diagrams
- 4.4 Describe the purpose and use of test points and indicate their likely placement on schematics
- 4.5 Point out common drafting principles used for electronic and electrical drawings
- 4.6 Explain methods used for signal tracing
- 4.7 Describe basic building and house-wiring concepts and explain why technicians need to be familiar with them
- 4.8 Explain how schematics are used to locate component and wiring failures in electronics products
- 4.9 Explain the methods of using flow diagrams/charts

### 5.0 Cabling

- 5.1 List wire types and construction
- 5.2 List wire gauges used for various purposes
- 5.3 Explain construction of coaxial cable and the impedance characteristics
- 5.4 List common identifications for copper cables, such as #18 and #24, and UTP telephone cable

- 5.5 Explain major differences between copper, coaxial and fiber optic cables
- 5.6 Describe impedance and its components; explain reasons for maintaining a cable's characteristics
- 5.7 Explain the effects of proper and improper termination
- 5.8 Explain the purposes of grounding and common conventions used in electrical and electronics work
- 5.9 Demonstrate splicing knowledge and ability for coaxial and copper cable; explain two types of fiber splices
- 5.10 Demonstrate testing methods for all three types of cables and compare dB loss measurements and techniques
- 5.11 Compare the fittings and connectors used in cabling and list potential defects a technician may encounter.
- 5.12 Describe proper crimping of communications wiring connectors
- 5.13 Explain how cable prep tools are used and demonstrate proper and improper crimping

## 6.0 Power Supplies

- 6.1 Explain shock hazards when servicing power supplies in electronic equipment
- 6.2 Describe the differences between transformer powered supplies and line connected supplies
- 6.3 Describe battery supplies and list common usages; also explain recharging principles
- 6.4 Explain the reasons for filtering, describe hum, identify common filter types (pi, t, l, etc.)
- 6.5 Explain the reasons for power supply regulation and list common components used in regulated supplies
- 6.6 Explain how switching power supplies operate, and explain the advantages of filtering and lower power consumption as compared to series regulated supplies.
- 6.7 Explain the term 'Integrated high voltage transformer' supply and explain how it differs from direct or other power supply types
- 6.8 Explain how multiple output supplies are able to supply more than one voltage
- 6.9 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

## 7.0 Test Equipment & Measurements

- 7.1 Describe how volt-ohm-current meters operate
- 7.2 Explain meter construction and components
- 7.3 Identify meter protection, safety and usage
- 7.4 Explain care of equipment and test leads
- 7.5 List the purposes and types of signal generators
- 7.6 Describe meter loading and precautions
- 7.7 Explain the purposes of frequency counters and list their limitations
- 7.8 Explain what R-C-L substitution equipment is and its purposes; explain ESR capacitance measurement equipment

- 7.9 List the uses and precautions for logic test probes
- 7.10 Explain how logic pulsers are used
- 7.11 Describe oscilloscope uses; explain the purposes of each front panel control
- 7.12 List the uses for pattern generators
- 7.13 Define dummy load; show where and why used
- 7.14 Explain reasons for using reostats, isolation transformers and variacs and why size matters

## 8.0 Safety Precautions

- 8.1 Describe the physiological reactions electrical shock causes; list various degrees of current the human body can tolerate
- 8.2 Explain the concept of First Aid and its particular importance to workers in electric and electronics fields; explain precautions for untrained people
- 8.3 Explain what the National Electric Code is and describe various rules technicians must abide by
- 8.4 Explain NFPA rules and describe how technicians comply and may violate them
- 8.5 Describe fusing and circuit breaker rules and reasons for different type of fuses
- 8.6 Explain static causes and CMOS damage prevention straps, mats and grounding
- 8.7 List tools hazards which are associated with technician activities in the workplace and in the field.
- 8.8 Describe lockout and tagging rules for potentially unsafe electrical or mechanical hazards
- 8.9 Explain RF transmitter hazards and precautions
- 8.10 List fiber optics hazards to skin and eyes
- 8.12 Explain eye and ear protection needed by technicians
- 8.13 List ladder handling/usage and OSHA heights safety rules
- 8.14 List service vehicle safety concerns such as ladder or transporting security and flying objects, driver screens inside the vehicle
- 8.15 Describe the types and usage of fire extinguishers

## 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 Calculate wavelength, frequency and power values
- 9.4 Convert binary, decimal, octal, hex number
- 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 Demonstrate how graphs are used to demonstrate electronics functions

## 10.0 Radio Communications Technology

- 10.1 Explain wave propagation and its importance to wireless communications

- 10.2 Describe the theory of how antennas work; list the types of transmission lines
- 10.3 Explain polarization, electromagnetic and electro- static fields and their relationships to each other
- 10.4 Explain the differences between AM, FM radio and TV
- 10.5 Describe the differences in the usage of communi- cations radios and commercial broadcast receivers.
- 10.6 Describe the major radio receiver circuitry sections
- 10.7 List common frequency bands
- 10.8 Demonstrate radio circuit tuning and adjustments
- 10.9 Demonstrate the relationships between frequency and wavelength

## 11.0 Electronic Circuits: Series and Parallel

- 11.1 Identify and describe the operation of common DC circuits
- 11.2 Identify and describe the operation of common AC circuits
- 11.3 Explain how series circuits, R, L, C are used in electronics equipment
- 11.4 Explain the purpose of oscillators
- 11.5 Show how oscillators and multivibrators are similar and how they differ
- 11.6 Classify circuits as inductive, capacitive and resistive
- 11.7 Explain resonance and show how to calculate resonant frequency
- 11.8 Describe polar and rectangular presentations of L, R, C circuits
- 11.9 Explain Kirkhoff's law and its importance to electronics technicians
- 11.10 Explain the purposes and types of differentiator or integrator circuits
- 11.11 Describe the sections of a PLL (phase locked loop) circuit and PLL circuit use
- 11.12 Describe filter circuits, why and how they are used
- 11.13 Explain wave shaping circuits and explain their purposes
- 11.14 Describe the relationships between bandwidth and "Q" in an electronics circuit

## 12.0 Amplifiers

- 12.1 List common amplifier devices
- 12.2 Describe the purpose of each component in an amplifier circuit
- 12.3 List the usages and classes of amplifiers
- 12.4 Describe biasing and gain characteristics
- 12.5 Explain frequency response of an amplifier circuit and why it is important
- 12.6 Explain the words 'preamplifier' and 'line amplifier' and where these units are commonly used
- 12.7 Explain the uses of operational amplifiers and how they differ from other amplifiers
- 12.8 Show causes of distortion in amplifiers and list ways to reduce or eliminate it
- 12.9 Explain how inaccurate measurements can be experienced due to meter or scope loading. List ways to overcome loading problems
- 12.10 Describe specifications for broadband amplifiers as compared with common narrow band units
- 12.11 Explain the operation of high power electron tubes

## 13.0 Interfacing of Electronics Products

- 13.1 List input circuit signal levels which may be expected for various common electronics products or test equipment
- 13.2 List anticipated signal or voltage levels for output circuits in audio and video equipment
- 13.3 Explain the importance of impedance matching; list causes of mismatches
- 13.4 Explain the purposes of plugs and connectors and why it is necessary to use the proper types
- 13.5 Explain grounding, proper and improper methods, and the results of power source mismatch
- 13.6 List potential signal conflict symptoms
- 13.7 Draw a basic telephone circuit. List common wiring conventions for POTS and splicing methods
- 13.8 Explain how products such as Mobil Electronics communicate with each other, i.e. bus lines; data, clock, strobe etc.

#### 14.0 Digital Concepts and Circuitry

- 14.1 Describe ASCII code
- 14.2 Identify each basic digital gate
- 14.3 Construct truth tables for common gates
- 14.4 Explain how counters operate
- 14.5 Explain the purpose of flip flops and list common types
- 14.6 Explain the purpose of a digital bus and show how it is connected to various sections of a product
- 14.7 List types of display circuitry and describe how numbers and letters are activated digitally
- 14.8 Explain the purpose of computer clocks
- 14.9 Show how pulsers are used for digital signal tracing and how logic probes are used to verify states in digital equipment
- 14.10 Describe digital clock usage and circuitry
- 14.11 Describe how microprocessors function and identify the basic components and pinouts

#### 15.0 Computer Electronics

- 15.1 Describe the major sections of a computer
- 15.2 Demonstrate how the computer block diagram and flow charts are utilized
- 15.3 Sketch the major blocks contained in a microprocessor chip and describe the purpose of each blocks
- 15.4 Describe different types of computer memory and how storage is accomplished
- 15.5 Explain programmable logic controls (PLCs) and list usages
- 15.6 Describe basic programming concepts
- 15.7 Describe the reasons for different computer languages and their relationships
- 15.8 Define the word peripheral and list various types
- 15.9 Explain the reasons for using interface devices/ chips/cards and name common types

## 16.0 Computer Applications

- 16.1 Demonstrate knowledge of basic computer operation
- 16.2 Explain steps in installation/set up of a computer
- 16.3 Explain the reasons and choices used in configuring a computer
- 16.4 Demonstrate proper loading and storage of common programs and applications
- 16.5 Explain basic and common utilities programs and list reasons for their use
- 16.6 List ways to backup data and the importance of doing so
- 16.7 Explain the causes of line surges and viruses and protection procedures against each
- 16.8 Explain major components of the Internet, how it is accessed and common applications
- 16.9 Demonstrate how to download a service or application, data or programs
- 16.10 Explain how to use the Internet to locate parts and service literature
- 16.11 Explain the differences between an individual computer and basic networking

## 17.0 Audio & Video Systems

- 17.1 Explain major components of the most common home entertainment products
- 17.2 Describe microphone technology and usage
- 17.3 Explain speaker construction and precautions
- 17.4 Explain basic recording and playback products operation, mechanical and electrical technology
- 17.5 Explain the difference between individual home entertainment products and the Home Theater concept
- 17.6 Explain how alarm-security systems may be interfaced with entertainment/information products
- 17.7 Describe the differences between cable TV, off-air broadcast and telephone signals
- 17.8 Describe the differences between good quality and distorted sound and electronic/acoustical reasons for each
- 17.9 Explain how signals may conflict and the symptoms that the conflict may produce
- 17.10 Explain how to isolate troubles between discrete equipment units

## 18.0 Optical Electronics

- 18.1 List common electronics display devices
- 18.2 Explain the operation of a kinescope
- 18.3 Explain how LCD displays operate, their advantages and disadvantages
- 18.4 Explain the basics of electronic cameras and sensors
- 18.5 Describe how LED remote hand units work
- 18.6 Describe plasma TV technology and its uses in TV and computer displays
- 18.7 Explain why and list some locations or circuits in which opto isolators are used
- 18.8 List uses for light activated controls and how photo devices are incorporated
- 18.9 Describe how broadband signal RF and optical links are used

## 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-EIA standard which applies
- 19.3 Describe satellite communications principles
- 19.4 Describe wired data and voice communications network technology

## 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 Demonstrate location/cross referencing of parts and product in catalogs
- 20.4 Explain the purposes and requirements for proper record keeping
- 20.5 Calculate individual and department productivity for a specific period
- 20.6 Demonstrate contacting product maker help desks and service departments
- 20.7 Explain estimate concepts for service work
- 20.8 Describe field technician work procedures which 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, 205 ITEMS and Competencies)

Notes:

The purpose in distributing the above Competencies list is to provide a detailed syllabus for electronics educational institutions and instructors. Also to go further and explain what the student should be able to do with each of the items included in the Competencies listings.

The NCEE (**National Coalition for Electronics Education**) and allied associations encourage the nation's school systems to adopt these competencies as the outline for their basic electronics courses.

Suggested study texts:

The Associate CET Certification Study Guide 2003 - Available through ETA-I, 800-288-3824  
 Electronics; Principles and Applications 2002 6th ed., by Schuler; Glencoe/McGraw Hill  
 Publications ISBN-0078288932 .75, order at [www.barnesandnoble.com](http://www.barnesandnoble.com)

The CEA Study Guide by CEA (EIA), Anatonakos;

Electronics Theory, Delton Horn;

Electronic Communications 6th ed., by Robert Shrader; McGraw-Hill ISBN-0070571570, , order  
 at [www.barnesandnoble.com](http://www.barnesandnoble.com)

Soldering Handbook-3rd Edition, Paul T. Vianco, Published by American Welding Society;  
[www.SMTnet.com](http://www.SMTnet.com)

Mastering Technical Mathematics, 2nd ed; McGraw-Hill; 592 pgs .95; 1-800-2-MCGRAW

How to Test Almost Everything Electronic; Delton Horn, McGraw-Hill #030406-8; .95; 1-800-  
 2-MCGRAW

Introduction to Electronics; by Patrick Crozier; Jan 1983;  
ISBN: 0534012434; www.amazon.com

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