ANALOG BASICS (EM3) – of the Associate C.E.T.

BASIC ELECTRONICS CERTIFICATION COMPETENCIES

(As suggested from segmenting the Associate CET Competencies into 6 BASIC areas: DC; AC; Analog; Digital; Comprehensive; and RF)

1.0 Diodes

- 1.1 Describe the electrical characteristics of semiconductors.
- 1.2 Explain the difference between intrinsic and doped semiconductors.
- 1.3 Explain the difference between an intrinsic semiconductor and a doped semiconductor as it relates to current flow.
- 1.4 Describe the construction of a PN junction diode.
- 1.5 Explain the behavior of a:
  - 1.5.1 forward biased diode
  - 1.5.2 reverse biased diode
- 1.6 Identify diodes with a proper front to back ratio.
- 1.7 Describe the forward and reverse current-voltage characteristics of a typical zener diode.
- 1.8 Describe how the zener diode is used to provide voltage regulation.
- 1.9 Identify a zener voltage regulator diagram.
  - 1.9.1 Explain how a simple zener voltage regulator operates
- 1.10 Describe how capacitance is produced in a varactor diode.
  - 1.10.1 Explain how capacitance is affected by a change in a varicap's operating voltage
- 1.11 Explain the operational and electrical characteristics of the following types of diodes:
  - 1.11.1 Pin
  - 1.11.2 Gunn
  - 1.11.3 Tunnel
  - 1.11.4 Schottky
  - 1.11.5 Laser Diodes
  - 1.11.6 Light Emitting
  - 1.11.7 Photodiodes
  - 1.11.8 Super-Barrier
- 1.12 Identify types of diodes by their:
  - 1.12.1 schematic symbols
  - 1.12.2 alphanumerical designation
- 1.13 Explain the proper procedure for diode testing
- 1.14 List the safety precautions to be taken when working with diodes

2.0 Transistors

- 2.1 Explain the operational and electrical characteristics of bipolar junction transistors (BJT).
  - 2.1.1 Describe the construction of PNP and NPN bipolar junction transistors.
- 2.2 Explain the proper biasing of BJTs for normal operation.
- 2.3 Explain the relationship between emitter, base, and collector currents in BJTs.
- 2.4 Explain the function of the three basic (Emitter, Base and Collector) BJT amplifier circuits.
  - 2.4.1 Identify the schematic diagram for the three basic BJTs.
- 2.5 Explain the differences between heterojunction bipolar transistors (HBTs) and BJTs.
- 2.6 Describe the operational and electrical characteristics of a unijunction transistor (UJT).
  - 2.6.1 Explain the conditions necessary to turn on and off a UJT.
- 2.7 Determine an amplifier gain using a transistor collector characteristic curve.
- 2.8 Determine transistor amplifier circuit:
  - 2.8.1 input resistance
  - 2.8.2 output resistance
- 2.9 Explain the meaning of and calculate:
  - 2.9.1 alpha cutoff frequency
  - 2.9.2 beta cutoff frequency
- 2.10 Explain the operational and electrical characteristics of junction field effect transistors (JFETs).
- 2.11 Explain the proper biasing of N-channel and P-channel JFETs for normal operation.

2.12 Determine the transconductance of the device using an FET's drain characteristic curve.
2.13 Explain the operational and electrical characteristics of a metal oxide semiconductor field effect transistor (MOSFET).
2.13.1 Identify enhancement mode MOSFET characteristics.
2.13.2 Identify depletion mode MOSFET characteristics.
2.14 Explain the operational and electrical characteristics of insulated-gate bipolar transistors (IGBT).
2.14.1 Describe the operational improvements IGBTs have over BJTs and MOSFETs.
2.15 Identify various types of transistors by their:
2.15.1 schematic symbols
2.15.2 alphanumerical designation
2.15.3 color code
2.16 Explain the proper procedure for transistor testing
2.17 List the safety precautions to be taken when working with transistors.

3.0 Thyristors

3.1 Describe the operational and electrical characteristics of a:
3.1.1 silicon-controlled rectifier (SCR).
3.1.2 diode for alternating current (DIAC).
3.1.3 bidirectional triode thyristor (TRIAC).
3.4 Identify types of thyristors by their:
3.4.1 schematic symbols
3.4.2 alphanumerical designation
3.5 Explain the proper procedure for thyristor testing
3.6 List the safety precautions to be taken when working with thyristors.

4.0 Integrated Circuits

4.1 Describe the operational and electrical characteristics of integrated circuits.
4.2 Explain the difference between linear and digital integrated circuits.
3.3 Identify the types of integrated circuits and explain their use by their:
3.3.1 schematic symbols
3.3.2 alphanumerical designation
3.4 Explain the proper procedure for integrated circuit testing
4.5 List the safety precautions to be taken when working with integrated circuits.

5.0 Optoelectronic Devices

5.1 Describe the basic characteristics of light.
5.2 Given a light frequency, determine its wavelength.
5.3 Describe the operational and electrical characteristics of light emitting devices.
5.3.1 Define light emitting diodes (LEDs)
5.3.2 Define laser diodes
5.4 Describe the operational and electrical characteristics of light sensitive (photosensitive) devices.
5.4.1 Define photoconductive devices
5.4.2 Define photovoltaic devices
5.5 Explain the proper optoelectronic interfaces for light sensitive and light emitting devices.
5.6 Explain the operational and physical characteristics of light transmission media.
5.6.1 Define Fiber Optic material
5.7 Explain the operation of optoelectronic couplers and isolators.
5.8 Explain the operation of light amplifiers.
5.9 Explain the proper procedure for optoelectronic device testing
5.9 List the safety precautions to be taken when working with optoelectronic devices.

6.0 Power Supplies

6.1 Define "power supply".
6.1.1 Describe a linear power supply

6.1.2 Describe a switching power supply
6.2 Describe the configuration of power supply filters:
6.2.1 Capacitor
6.2.2 Inductor
6.3 Describe the electrical and operational characteristics of and the configuration of:
6.3.1 rectifier circuits
6.3.2 voltage multipliers
6.3.3 voltage regulators
6.3.4 switching power supplies
6.3.5 series, shunt and biased clippers
6.3.6 clampers
6.3.7 inverters
6.4 Describe “synchronous rectification”
6.5 Describe “uninterruptible power supply”
6.6 List the shock hazards and safety precautions to be taken when working with power supplies.

7.0 Basic Test Equipment and Measurements

7.1 Describe “meter loading” and precautions.
7.2 Explain the purposes of frequency counters and list their limitations.
7.3 Explain proper use of the oscilloscope.
7.4 Explain fundamental block diagram of an oscilloscope
7.4.1 Explain the function and purpose of each block
7.5 Describe oscilloscope usage;
7.5.1 Explain the purposes of each front panel control.
7.6 List the uses for pattern generators.
7.7 Define dummy load; show where and why used.

8.0 Mathematics and Formulas

8.1 Calculate wavelength, frequency and power values.
8.2 Explain decibels and show reasons for using dBs in signal level, voltage, and power level calculations:
8.2.1 dBm
8.2.2 dBW
8.2.3 dBV
8.2.4 dB(SPL) including the dB(C) scale
8.2.5 dBu
8.3 Describe how graphs are used to demonstrate electronic functions
8.4 Calculate PRF/PRR (pulse recurring frequency/pulse recurring rate)
8.5 Calculate duty cycle

9.0 Amplifiers

9.1 Describe basic amplifier configuration, biasing, coupling, and operation.
9.2 Describe the electrical and operational characteristics of the following types of amplifiers:
9.2.1 DC (direct-coupled, direct-current)
9.2.2 Audio
9.2.3 Video
9.2.4 IF
9.2.5 RF
9.3 Explain the proper procedure for amplifier testing
9.4 List the safety precautions to be taken when working with amplifiers.

10.0 Operational Amplifiers

10.1 Describe operational amplifier configurations, biasing, coupling, and operation of an:
10.1.1 Inverting amplifier

10.1.2 Non-inverting amplifier
10.1.3 Voltage follower
10.1.4 Summing amplifier
10.1.5 Integrator
10.1.6 Differentiator
10.1.7 Comparator

10.2 Describe various operational amplifier-circuits input and output:
10.2.1 impedance characteristics
10.2.2 phase relationships
10.2.3 gain characteristics

10.3 Explain the proper procedure for operational amplifier testing

10.4 List the safety precautions to be taken when working with operational amplifiers.

11.0 Oscillators

11.1 Describe the fundamentals of oscillation.

11.2 Describe the electrical and operational characteristics of and the configuration of:
11.2.1 Armstrong (aka Meissner) oscillator circuit
11.2.2 Hartley oscillator circuit
11.2.3 Colpitts oscillator circuit
11.2.4 Clapp oscillator circuit
11.2.5 crystal controlled oscillator circuit
11.2.6 resistive-capacitive oscillator circuit
11.2.7 transformer oscillator circuit
11.2.7.1 Define blocking

11.3 Explain the piezoelectric effect.

11.4 Explain regenerative feedback.

11.5 Explain frequency multiplication.

11.6 Explain the Barkhausen Criterion

11.7 Explain the proper procedure for oscillator testing

11.8 List the safety precautions to be taken when working with oscillators.

12.0 Filters

12.1 Describe the electrical and operational characteristics of the various combinations of the following filters:
12.1.1 RC
12.1.2 RL
12.1.3 LC
12.1.4 RLC
12.1.5 high pass
12.1.6 low pass
12.1.7 band pass
12.1.8 band stop
12.1.9 parallel
12.1.10 L -type
12.1.11 PI(π)-type
12.1.12 T-type
12.1.13 “Notch”
12.1.14 “Knee”

12.2 Describe the configuration of various active filters.
12.2.1 Butterworth
12.2.2 Chebyshev
12.2.3 Bessel
12.2.4 Elliptical (Cauer)
12.2.5 Multiple-Feedback Bandpass
12.2.6 Phase-locked loop

12.3 Describe the relationship between bandwidth and Q of a circuit.
12.4 Describe selectivity;
12.4.1 Define Bandwidth
12.5 Define Attenuation slopes

13.0 Wave-shaping Circuits

13.1 Describe the electrical, operational characteristics, and the configuration of:
13.1.1 a square wave generating circuit
13.1.2 a sawtooth wave generating circuit
13.1.3 a trapezoidal wave generating circuit
13.1.4 various differentiator and integrator circuits
13.1.5 a ramp generator circuit
13.2 Explain the proper procedure for wave-shaping circuit testing
13.3 List the safety precautions to be taken when working with wave-shaping circuits.

End of ANALOG BASICS Electronics Competencies Listing
(with 13 major Categories)

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.

Find An ETA Test Site: http://www.eta-i.org/testing.html

Suggested study texts:

The Associate CET Study Guide, 6E; ISBN 1-891749-072; ETA International; 2012; —Available through ETA®International at 800-288-3824 or www.eta-i.org, $60
Study Guide for ETA International EM3 Analog Electronics; Karl Eilers; self-published; Feb.2013, pp. 314; through ETA at 800-288-3824, www.eta-i.org
Electronics; Principles and Applications, 8E; ISBN 978-0077567705; Schuler; Glencoe/McGraw Hill, 2012, pp.594
Introduction to Electricity, Electronics, and Electromagnetics, 5E; ISBN 978-0130105738; Boylestad, Nashelsky; Prentice Hall; 2001, pp.666
Mastering Technical Mathematics, 3E; ISBN 978-0071494489; Gibilisco, Crowhurst; McGraw-Hill / TAB Electronics; 2007, pp.627
Electronics Principles, 7E; ISBN 978-0072975277; Malvino, Bates; McGraw-Hill Higher Education; 2007, pp.1116
Electrical Principles and Practices, 3E; ISBN 978-0826918031; Mazur, Zurlis; American Technical Publishers, Inc.; 2007, pp.517
Electronic Communications, 6E; ISBN 978-0070571570; Shrader; McGraw-Hill Co; 1990, pp.864
How to Test Almost Everything Electronic; ISBN 978-0830641277; Horn; McGraw-Hill/TAB Elec. 1993
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
Introductory DC / AC Electronics, 5E; ISBN 978-0130310859; Cook; Prentice Hall; 2002
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

