



**NIDA CORPORATION  
COMPUTER ASSISTED INSTRUCTION**

**LESSON AND OBJECTIVE LISTING**

**HTML Lessons**

**2012-01-25**



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## OBJECTIVE LISTING - HTML Lessons

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### **GENERAL**

#### **Prerequisites**

- 1011-120-130 Safety Practices ..... ---
- Understand the nature of electric shock.
  - Understand the effects of electric shock.
  - Know how to prevent electrical hazards.
  - Know how to provide treatment for electrical shock.
  - Know how to work on an energized circuit.
  - Know how to suppress fires.
  - Recognize safety colors.
  - Follow hand and power tool precautions.
- 1011-120-160 Electrostatic Sensitive Devices ..... ---
- Define an electrostatic sensitive device.
  - Describe the sources of electrostatic discharge and list its hazards to electronic components.
  - Identify the static-producing materials in the work area.
  - Explain the principles of static control and methods employed in developing static control facilities.
  - Describe the special handling, identification, packaging, and protection requirements for electrostatic sensitive devices.

### **DC CIRCUITS - CORE (MODEL 1401T)**

#### **Introduction to Electricity**

- 5021-112-130 Metric Notation ..... ---
- Convert decimal numbers to powers of ten and vice versa.
  - Convert decimal numbers to metric prefixes and vice versa.
  - Add, subtract, multiply, and divide powers of ten.
  - Add, subtract, multiply, and divide metric prefixes.
- 5021-112-160 Voltage and Current ..... ---
- Describe an atom and its structure.
  - Define electric charge as it relates to electrons and protons.
  - Describe the law of electrostatic force.
  - Define voltage and the volt as a unit of voltage.
  - Define the relationship between voltage and potential difference.
  - Identify six ways of producing voltage.
  - Define current and the ampere as a unit of current.
  - Describe a conductor and the behavior of electrons within a conductor.
  - Describe an insulator and the behavior of the electrons within an insulator.
  - Identify the three basic parts of an electrical circuit.
  - Describe an electrical circuit load and its relationship to the flow of current.
- 5021-112-190 Resistors ..... ---
- Identify the purpose of a resistor.
  - Identify the unit of resistance as the ohm.
  - Identify the resistor reference designator code.
  - Identify resistor schematic symbols.
  - Identify fixed resistors.
  - Identify variable resistors.
  - Define power rating.

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### **DC CIRCUITS - CORE (MODEL 1401T) (cont.)**

#### **Introduction to Electricity (cont.)**

5021-112-190 Resistors (cont.)

- Define tolerance.
- Identify number/letter codes.

5021-112-220 Switches, Fuses, and Circuit Breakers . . . . . ---

- Identify the purpose of a switch.
- Identify switch schematic symbols.
- Describe Single and Double Pole.
- Describe Single and Double Throw.
- Describe four types of switches.
- Identify the schematic symbol for each switch.
- Identify the purpose of protection devices.
- identify a fuse and a circuit breaker.
- Identify schematic symbols for fuses and circuit breakers.

5021-112-250 Tools for Electronic Troubleshooting . . . . . ---

- Identify the basic hand tools used for troubleshooting and repair.
- Describe the types of tasks performed with each tool.
- Describe the safe and proper use of hand tools.

5021-112-910 Introduction to Electricity Post-Test (Theory) . . . . . ---

#### **Multimeter Measurements**

5021-114-130 Magnetism, Relays, and Meters . . . . . ---

- Define magnetism.
- Identify characteristics of magnets.
- Define laws of magnetic attraction and repulsion.
- Describe properties of magnetic lines of force.
- Identify non-magnetic materials.
- Define electromagnetism.
- Identify the characteristics of electromagnetism.
- Describe the operation of a relay.
- Describe the operation of a magnetic circuit breaker.
- Describe the operation of a meter.

5021-114-160 Introduction to Multimeters . . . . . ---

- Identify the quantities measured by multimeters.
- Identify multimeter characteristics.
- Describe the functional sections of a digital multimeter.
- Describe the purpose of each functional section.

5021-114-190 Multimeter Use . . . . . CF

- Understand how to operate a digital multimeter.
- Operate a digital multimeter.

5021-114-220 Voltage Measurements . . . . . 2

- Describe how to set up a digital multimeter to measure voltage.
- Understand how to read a digital multimeter's display when measuring voltage.
- Describe the correct way to connect a multimeter to a circuit for measuring voltage.
- Perform voltage measurements with a digital multimeter.

5021-114-250 Current Measurements . . . . . 4A

- Describe how to set up a digital multimeter to measure current.
- Describe how to read a digital multimeter's display when measuring current.

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### **DC CIRCUITS - CORE (MODEL 1401T) (cont.)**

#### **Multimeter Measurements (cont.)**

5021-114-250 Current Measurements (cont.)

- Describe the correct way to connect a multimeter to a circuit for measuring current.
- Identify the precautions to observe when making current measurements.
- Perform current measurements with a digital multimeter.

5021-114-280 Resistance Measurements . . . . . 4A

- Describe how to set up a digital multimeter to measure resistance.
- Understand how to read a digital multimeter's display when measuring resistance.
- Describe the correct way to connect a multimeter to a circuit for measuring resistance.
- Identify the precautions to observe when making resistance measurements.
- Perform resistance measurements with a digital multimeter.

5021-114-910 Multimeter Use Post-Test (Theory) . . . . . ---

#### **Basic DC Circuits**

5021-116-130 Ohm's Law and Power . . . . . 5

- Learn what Ohm's Law is and how voltage, current, and resistance are related.
- Learn what power is and how voltage, current, and Ohm's Law are related to power.
- Prove the Ohm's Law relationship of voltage, current, and resistance.

5021-116-160 Series Circuits . . . . . 6A

- Identify a series circuit.
- Calculate total resistance in a series circuit.
- Calculate current in a series circuit.
- Calculate voltage drops across resistance.
- Measure current values in a series circuit.
- Measure voltage drops in a series circuit.

5021-116-190 Series Circuit Troubleshooting Theory . . . . . ---

- Follow a logical troubleshooting procedure.
- Identify an open, short, and a changed value component in a series circuit.
- Analyze a series circuit and determine if the circuit is defective.

5021-116-220 Series Circuit Troubleshooting Experiment . . . . . 6A

- Determine if a series circuit is open and identify which component is open.
- Determine if a series circuit has a short and identify which component is shorted.
- Determine if a series circuit has a changed value and identify which resistor has a changed value.

5021-116-280 Parallel Circuits . . . . . 8A

- Identify a parallel circuit.
- Recognize that the applied voltage is the same across each branch.
- Calculate current in each branch of a parallel circuit.
- Calculate total current from the sum of the individual branches of a parallel circuit.
- Calculate total resistance in a parallel circuit.
- Measure the applied voltage across each branch in a parallel circuit.
- Measure current across each branch in a parallel circuit.
- Measure total resistance in a parallel circuit.

5021-116-310 Parallel Circuit Troubleshooting Theory . . . . . ---

- Identify an open, short, and changed value component in a parallel circuit.
- Analyze a parallel circuit and determine if the circuit is defective.

5021-116-400 Series-Parallel Circuits . . . . . 9A

- Identify a series-parallel circuit.

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### **DC CIRCUITS - CORE (MODEL 1401T) (cont.)**

#### **Basic DC Circuits (cont.)**

5021-116-400 Series-Parallel Circuits (cont.)

- Calculate total resistance in a series-parallel circuit.
- Calculate current in a series-parallel circuit.
- Calculate voltage drops in a series-parallel circuit.
- Measure resistance values in a series-parallel circuit.
- Measure current values in a series-parallel circuit.
- Measure voltage drops in a series-parallel circuit.

5021-116-430 Series-Parallel Circuit Troubleshooting Theory ..... ---

- Identify an open, short, and changed value component in a series-parallel circuit.
- Analyze a series-parallel circuit and determine if the circuit is defective.

5021-116-910 Basic DC Circuits Post-Test (Theory) ..... ---

### **DC CIRCUITS (MODEL 1401)**

#### **Introduction to Electricity**

5021-112-130 Metric Notation ..... ---

- Convert decimal numbers to powers of ten and vice versa.
- Convert decimal numbers to metric prefixes and vice versa.
- Add, subtract, multiply, and divide powers of ten.
- Add, subtract, multiply, and divide metric prefixes.

5021-112-160 Voltage and Current ..... ---

- Describe an atom and its structure.
- Define electric charge as it relates to electrons and protons.
- Describe the law of electrostatic force.
- Define voltage and the volt as a unit of voltage.
- Define the relationship between voltage and potential difference.
- Identify six ways of producing voltage.
- Define current and the ampere as a unit of current.
- Describe a conductor and the behavior of electrons within a conductor.
- Describe an insulator and the behavior of the electrons within an insulator.
- Identify the three basic parts of an electrical circuit.
- Describe an electrical circuit load and its relationship to the flow of current.

5021-112-190 Resistors ..... ---

- Identify the purpose of a resistor.
- Identify the unit of resistance as the ohm.
- Identify the resistor reference designator code.
- Identify resistor schematic symbols.
- Identify fixed resistors.
- Identify variable resistors.
- Define power rating.
- Define tolerance.
- Identify number/letter codes.

5021-112-220 Switches, Fuses, and Circuit Breakers ..... ---

- Identify the purpose of a switch.
- Identify switch schematic symbols.
- Describe Single and Double Pole.



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### **DC CIRCUITS (MODEL 1401) (cont.)**

#### **Introduction to Electricity (cont.)**

5021-112-220 Switches, Fuses, and Circuit Breakers (cont.)

- Describe Single and Double Throw.
- Describe four types of switches.
- Identify the schematic symbol for each switch.
- Identify the purpose of protection devices.
- identify a fuse and a circuit breaker.
- Identify schematic symbols for fuses and circuit breakers.

5021-112-250 Tools for Electronic Troubleshooting . . . . . ---

- Identify the basic hand tools used for troubleshooting and repair.
- Describe the types of tasks performed with each tool.
- Describe the safe and proper use of hand tools.

5021-112-280 Schematic Diagrams . . . . . ---

- Understand the purpose of a schematic diagram.
- Understand general concepts concerning schematic diagrams.

5021-112-920 Introduction to Electricity Post-Test (Theory) . . . . . ---

#### **Multimeter Measurements**

5021-114-130 Magnetism, Relays, and Meters . . . . . ---

- Define magnetism.
- Identify characteristics of magnets.
- Define laws of magnetic attraction and repulsion.
- Describe properties of magnetic lines of force.
- Identify non-magnetic materials.
- Define electromagnetism.
- Identify the characteristics of electromagnetism.
- Describe the operation of a relay.
- Describe the operation of a magnetic circuit breaker.
- Describe the operation of a meter.

5021-114-160 Introduction to Multimeters . . . . . ---

- Identify the quantities measured by multimeters.
- Identify multimeter characteristics.
- Describe the functional sections of a digital multimeter.
- Describe the purpose of each functional section.

5021-114-190 Multimeter Use . . . . . CF

- Understand how to operate a digital multimeter.
- Operate a digital multimeter.

5021-114-220 Voltage Measurements . . . . . 2

- Describe how to set up a digital multimeter to measure voltage.
- Understand how to read a digital multimeter's display when measuring voltage.
- Describe the correct way to connect a multimeter to a circuit for measuring voltage.
- Perform voltage measurements with a digital multimeter.

5021-114-250 Current Measurements . . . . . 4A

- Describe how to set up a digital multimeter to measure current.
- Describe how to read a digital multimeter's display when measuring current.
- Describe the correct way to connect a multimeter to a circuit for measuring current.
- Identify the precautions to observe when making current measurements.
- Perform current measurements with a digital multimeter.

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### **DC CIRCUITS (MODEL 1401) (cont.)**

#### **Multimeter Measurements (cont.)**

- 5021-114-280 Resistance Measurements ..... 4A
- Describe how to set up a digital multimeter to measure resistance.
  - Understand how to read a digital multimeter's display when measuring resistance.
  - Describe the correct way to connect a multimeter to a circuit for measuring resistance.
  - Identify the precautions to observe when making resistance measurements.
  - Perform resistance measurements with a digital multimeter.
- 5021-114-920 Multimeter Use Post-Test (Theory) ..... ---

#### **Basic DC Circuits**

- 5021-116-130 Ohm's Law and Power ..... 5
- Learn what Ohm's Law is and how voltage, current, and resistance are related.
  - Learn what power is and how voltage, current, and Ohm's Law are related to power.
  - Prove the Ohm's Law relationship of voltage, current, and resistance.
- 5021-116-160 Series Circuits ..... 6A
- Identify a series circuit.
  - Calculate total resistance in a series circuit.
  - Calculate current in a series circuit.
  - Calculate voltage drops across resistance.
  - Measure current values in a series circuit.
  - Measure voltage drops in a series circuit.
- 5021-116-190 Series Circuit Troubleshooting Theory ..... ---
- Follow a logical troubleshooting procedure.
  - Identify an open, short, and a changed value component in a series circuit.
  - Analyze a series circuit and determine if the circuit is defective.
- 5021-116-220 Series Circuit Troubleshooting Experiment ..... 6A
- Determine if a series circuit is open and identify which component is open.
  - Determine if a series circuit has a short and identify which component is shorted.
  - Determine if a series circuit has a changed value and identify which resistor has a changed value.
- 5021-116-250 Series Circuit Troubleshooting Practice ..... 6A
- Troubleshoot a series circuit and identify if the circuit is operating properly.
  - Identify a faulted circuit as being open, shorted, or changed value.
  - Identify the component most likely to cause the fault.
- 5021-116-280 Parallel Circuits ..... 8A
- Identify a parallel circuit.
  - Recognize that the applied voltage is the same across each branch.
  - Calculate current in each branch of a parallel circuit.
  - Calculate total current from the sum of the individual branches of a parallel circuit.
  - Calculate total resistance in a parallel circuit.
  - Measure the applied voltage across each branch in a parallel circuit.
  - Measure current across each branch in a parallel circuit.
  - Measure total resistance in a parallel circuit.
- 5021-116-310 Parallel Circuit Troubleshooting Theory ..... ---
- Identify an open, short, and changed value component in a parallel circuit.
  - Analyze a parallel circuit and determine if the circuit is defective.
- 5021-116-340 Parallel Circuit Troubleshooting Experiment ..... 8A
- Determine if a parallel circuit is open and identify which component is open.

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### **DC CIRCUITS (MODEL 1401) (cont.)**

#### **Basic DC Circuits (cont.)**

- 5021-116-340 Parallel Circuit Troubleshooting Experiment (cont.)
- Determine if a parallel circuit has a short and identify which component is shorted.
  - Determine if a parallel circuit has a changed value and identify which resistor has changed value.
- 5021-116-370 Parallel Circuit Troubleshooting Practice ..... 8A
- Troubleshoot a parallel circuit and identify if the circuit is operating properly.
  - Identify a faulted circuit as being open, shorted, or changed value.
  - Identify the component most likely to cause the fault.
- 5021-116-400 Series-Parallel Circuits ..... 9A
- Identify a series-parallel circuit.
  - Calculate total resistance in a series-parallel circuit.
  - Calculate current in a series-parallel circuit.
  - Calculate voltage drops in a series-parallel circuit.
  - Measure resistance values in a series-parallel circuit.
  - Measure current values in a series-parallel circuit.
  - Measure voltage drops in a series-parallel circuit.
- 5021-116-430 Series-Parallel Circuit Troubleshooting Theory ..... ---
- Identify an open, short, and changed value component in a series-parallel circuit.
  - Analyze a series-parallel circuit and determine if the circuit is defective.
- 5021-116-460 Series-Parallel Circuit Troubleshooting Experiment ..... 9A
- Determine if a series-parallel circuit is open and identify which component is open.
  - Determine if a series-parallel circuit has a short and identify which component is shorted.
  - Determine if a series-parallel circuit has a changed value and identify which component has a changed value.
- 5021-116-490 Series-Parallel Circuit Troubleshooting Practice ..... 9A
- Troubleshoot a series-parallel circuit and identify if the circuit is operating properly.
  - Identify a faulted circuit as being open, shorted, or changed value.
  - Identify the component most likely to cause the fault.
- 5021-116-920 Basic DC Circuits Post-Test (Theory) ..... ---

#### **Complex DC Circuits**

- 5021-118-130 Voltage Divider Circuits ..... 9C
- Identify a voltage divider circuit.
  - Identify a voltage divider as being loaded or unloaded.
  - Calculate voltage, current, and resistance for loaded and unloaded voltage dividers.
  - Calculate % regulation for a voltage divider circuit.
  - Measure unloaded voltage divider voltages.
  - Measure loaded voltage divider voltages.
- 5021-118-160 Bridge Circuits ..... 10A
- State the purpose of a bridge circuit.
  - Identify a bridge circuit.
  - Solve for voltage outputs.
  - Solve for unknown resistance.
  - Voltage measurements.
  - Resistance measurements.
- 5021-118-190 Introduction to Kirchhoff's Voltage and Current Laws ..... 9C
- Identify a complex circuit.

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### **DC CIRCUITS (MODEL 1401) (cont.)**

#### **Complex DC Circuits (cont.)**

- 5021-118-190 Introduction to Kirchhoff's Voltage and Current Laws (cont.)
- State Kirchhoff's Current Law.
  - State Kirchhoff's Voltage Law.
  - Compare calculated and measured voltage in a circuit using Kirchhoff's Laws.
- 5021-118-220 Kirchhoff's Voltage and Current Laws ..... 9C
- Identify a complex circuit.
  - State Kirchhoff's current law.
  - State Kirchhoff's voltage law.
  - Calculate current using Kirchhoff's laws.
  - Calculate voltage using Kirchhoff's laws.
  - Compare calculated and measured voltage in a circuit using Kirchhoff's Laws
- 5021-118-250 Norton's Theorem ..... ---
- Describe the purpose of Norton's Theorem.
  - Describe the procedure in solving circuits using Norton's Theorem.
  - Nortonize a series-parallel circuit.
- 5021-118-280 Thevenin's Theorem ..... ---
- Describe the purpose of Thevenin's Theorem.
  - Describe the 6-step process in solving circuits using Thevenin's Theorem.
  - Thevenize a series-parallel circuit.
  - Thevenize a complex circuit.
- 5021-118-310 Multimeter Loading ..... 9C
- Describe the circuit loading effect of multimeters.
  - Describe how the multimeter loading is reduced.
  - Describe the Ohms per volt rating of analog multimeters.
  - Measure circuit voltages using an analog and digital multimeter.
  - Observe the loading effect of an analog multimeter.
- 5021-118-920 Complex DC Circuits Post-Test (Theory) ..... ---

### **AC CIRCUITS - CORE (MODEL 1402T)**

#### **Introduction to AC Circuits**

- 5021-312-130 Alternating Current ..... ---
- Define alternating current.
  - Identify an AC sine wave.
  - Define frequency and cycle.
  - Describe Hertz
  - Determine the wavelength of a sine wave.
  - Determine the period of a sine wave.
- 5021-312-160 Generating AC Electricity ..... ---
- Define the characteristics of induction.
  - Determine magnitude and polarity of voltage produced in a magnetic field
  - Explain the operation of an AC generator.
  - Identify values of voltage and current at various electrical degrees
  - Calculate peak, peak-to-peak, average, and RMS values.
  - Identify in and out of phase.
  - Identify magnitude and degree of an AC wave using vectors

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### **AC CIRCUITS - CORE (MODEL 1402T) (cont.)**

#### **Introduction to AC Circuits (cont.)**

- 5021-312-190 Non-Sinusoidal Waves ..... ---
- Identify harmonic frequencies.
  - Identify harmonic frequencies used to produce non-sinusoidal waves.
  - Define square waves.
  - Identify square wave cycles.
  - Define ramp waveforms.
  - Identify ramp waveforms.
- 5021-312-220 Resistance in AC Circuits ..... ---
- Use Ohm's Law to determine resistance in an AC series circuit.
  - Identify the relationship between voltage, current, and resistance in an AC series circuit.
  - Use Ohm's Law to determine resistance in an AC parallel circuit.
  - Identify the relationship between voltage, current, and resistance in an AC parallel circuit.
  - Use Ohm's Law to determine resistance in an AC series-parallel circuit.
  - Identify the relationship between voltage, current, and resistance in an AC series-parallel circuit.
- 5021-312-910 Introduction to AC Post-Test (Theory) ..... ---

#### **AC Test Equipment**

- 5020-314-130 Introduction to Oscilloscopes ..... ---
- Describe the purpose of an analog oscilloscope.
  - Identify the quantities measured by an oscilloscope.
  - Identify different types of oscilloscopes.
  - Identify the four major functional sections of an oscilloscope.
  - Describe the purpose of each control and switch.
  - Describe the purpose of a digital oscilloscope.
  - Identify the quantities measured by an oscilloscope.
  - Identify the four major functional sections of a digital oscilloscope.
  - Describe the purpose of menus and controls.
- 5020-314-160 Oscilloscope Use ..... 10, 804
- Set up an oscilloscope for normal use.
  - Measure voltage using an oscilloscope.
  - Measure frequency using an oscilloscope.
  - Save and recall a waveform using the storage function of an oscilloscope (only digital storage oscilloscopes).
- 5020-314-430 Introduction to the Function Generator ..... ---
- Describe the purpose of a function generator.
  - Identify the types of output signals generated by a function generator.
  - Identify the three major sections of a function generator.
  - Describe the purpose of each control and switch on a function generator.
- 5020-314-460 Function Generator Use ..... 10
- Set up a function generator for normal operation.
  - Adjust a function generator for various output signals.
  - Modulate an output signal.
- 5020-314-910 AC Test Equipment Post-Test (Theory) ..... ---

#### **Inductance and RL Circuits**

- 5021-316-130 Introduction to Inductors ..... ---
- Identify types of inductors.

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### **AC CIRCUITS - CORE (MODEL 1402T) (cont.)**

#### **Inductance and RL Circuits (cont.)**

5021-316-130 Introduction to Inductors (cont.)	11
▪ Describe the current opposing characteristic of an inductor.	
▪ Identify the schematic symbol for an inductor.	
▪ Identify characteristics of inductance.	
▪ Identify the unit of measurement for inductance.	
5021-316-160 Inductor Identification	11
▪ Identify inductors.	
▪ Identify inductor color codes.	
5021-316-190 RL Series Circuits	---
▪ Calculate total inductance in series circuits.	
▪ Calculate total inductive reactance in series circuits.	
▪ Calculate total impedance in series circuits.	
5021-316-220 RL Series Circuit Operation	13
▪ Measure the inductive phase relationship between voltage and current.	
▪ Verify normal operation of an RL series circuit.	
▪ Measure the phase relationship between the voltages developed across resistors and inductors.	
5021-316-310 RL Parallel Circuits	---
▪ Calculate total inductance in RL parallel circuits.	
▪ Calculate total inductive reactance in RL parallel circuits.	
▪ Calculate total impedance in RL parallel circuits.	
5021-316-340 RL Parallel Circuit Operation	13
▪ Measure the current phase difference between the inductive and resistive branches of a parallel RL circuit.	
▪ Verify normal operation of a parallel RL circuit.	
▪ Measure the total current phase difference in a parallel RL circuit.	
5021-316-910 Inductance and RL Circuits Post-Test (Theory)	---

#### **Capacitance and RC Circuits**

5021-318-130 Introduction to Capacitors	---
▪ Identify types of capacitors.	
▪ Describe charge and discharge characteristics of a capacitor.	
▪ Identify the schematic symbol for a capacitor	
▪ Identify characteristics of capacitance.	
▪ Identify the unit of measurement for capacitance	
5021-318-160 Capacitor Identification	11
▪ Identify ceramic, film, mica, and electrolytic capacitors.	
▪ Read the capacitance and voltage values.	
5021-318-190 RC Series Circuits	---
▪ Calculate total capacitance in series circuits.	
▪ Calculate total capacitive reactance in series circuits.	
▪ Calculate total impedance in series circuits.	
5021-318-220 RC Series Circuit Operation	12
▪ Measure the capacitive phase relationship between voltage and current.	
▪ Verify normal operation of an RC series circuit.	
5021-318-340 RC Parallel Circuits	---
▪ Calculate total capacitance in a parallel circuit.	

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### **AC CIRCUITS - CORE (MODEL 1402T) (cont.)**

#### **Capacitance and RC Circuits (cont.)**

5021-318-340 RC Parallel Circuits (cont.)

- Calculate total capacitive reactance in a parallel circuit.
- Calculate total impedance in a parallel circuit.

5021-318-370 RC Parallel Circuit Operation ..... 12

- Measure the phase difference between the capacitive and resistive branches.
- Verify normal circuit operation.
- Measure the total current phase difference.

5021-318-910 Capacitance and RC Circuits Post-Test (Theory) ..... ---

#### **RC Time Constants and Transients**

5021-320-130 RC and RL Time Constants ..... ---

- Describe RC time constants.
- Calculate the amount of charge or discharge of a capacitor using RC time constants.
- Describe RL time constants.
- Calculate the amount of current present in an inductor using RL time constants.

5021-320-160 RC Time Constants Operation ..... 15

- Observe capacitor charging and discharging using a multimeter.
- Observe capacitor charging and discharging using an oscilloscope.
- Verify RC time constants by the use of measurements.

#### **Resonance**

5021-322-130 Capacitive/Inductive Reactance and LCR Circuits ..... ---

- Describe the effects of inductors and capacitors when used in the same circuit.
- Calculate circuit values in a series LCR circuit.
- Calculate circuit values in a parallel LCR circuit.

5021-322-160 Series and Parallel LCR Circuit Experiment ..... 17, 19

- Calculate and measure the voltage drops in a series LCR circuit.
- Verify normal operation of a series LCR circuit.
- Measure the phase relationship between EA, ER, EC, and EL in a series LCR circuit.
- Calculate and measure the branch currents in a parallel LCR circuit.
- Verify normal operation of a parallel LCR circuit.
- Measure the phase relationship between IT, IR, IC, and IL in a parallel LCR circuit.

#### **Transformers**

5021-324-130 Introduction to Transformers ..... ---

- Describe the purpose of transformers.
- Identify transformer schematic symbols and the reference designation.
- Describe transformer operating characteristics.
- Calculate turn ratio.
- Calculate secondary voltage, current, and power.
- Calculate primary current and power.

5021-324-160 Transformer Operation ..... 21

- Measure primary voltage of a transformer.
- Measure secondary voltage of a transformer.
- Determine step up or step down transformer action.

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### **AC CIRCUITS (MODEL 1402)**

#### **Introduction to AC Circuits**

- 5021-312-130 Alternating Current ..... ---
- Define alternating current.
  - Identify an AC sine wave.
  - Define frequency and cycle.
  - Describe Hertz
  - Determine the wavelength of a sine wave.
  - Determine the period of a sine wave.
- 5021-312-160 Generating AC Electricity ..... ---
- Define the characteristics of induction.
  - Determine magnitude and polarity of voltage produced in a magnetic field
  - Explain the operation of an AC generator.
  - Identify values of voltage and current at various electrical degrees
  - Calculate peak, peak-to-peak, average, and RMS values.
  - Identify in and out of phase.
  - Identify magnitude and degree of an AC wave using vectors
- 5021-312-190 Non-Sinusoidal Waves ..... ---
- Identify harmonic frequencies.
  - Identify harmonic frequencies used to produce non-sinusoidal waves.
  - Define square waves.
  - Identify square wave cycles.
  - Define ramp waveforms.
  - Identify ramp waveforms.
- 5021-312-220 Resistance in AC Circuits ..... ---
- Use Ohm's Law to determine resistance in an AC series circuit.
  - Identify the relationship between voltage, current, and resistance in an AC series circuit.
  - Use Ohm's Law to determine resistance in an AC parallel circuit.
  - Identify the relationship between voltage, current, and resistance in an AC parallel circuit.
  - Use Ohm's Law to determine resistance in an AC series-parallel circuit.
  - Identify the relationship between voltage, current, and resistance in an AC series-parallel circuit.
- 5021-312-920 Introduction to AC Post-Test (Theory) ..... ---

#### **AC Test Equipment**

- 5020-314-130 Introduction to Oscilloscopes ..... ---
- Describe the purpose of an analog oscilloscope.
  - Identify the quantities measured by an oscilloscope.
  - Identify different types of oscilloscopes.
  - Identify the four major functional sections of an oscilloscope.
  - Describe the purpose of each control and switch.
  - Describe the purpose of a digital oscilloscope.
  - Identify the quantities measured by an oscilloscope.
  - Identify the four major functional sections of a digital oscilloscope.
  - Describe the purpose of menus and controls.
- 5020-314-160 Oscilloscope Use ..... 10, 804
- Set up an oscilloscope for normal use.
  - Measure voltage using an oscilloscope.
  - Measure frequency using an oscilloscope.



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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **AC Test Equipment (cont.)**

5020-314-160 Oscilloscope Use (cont.)	10
▪ Save and recall a waveform using the storage function of an oscilloscope (only digital storage oscilloscopes).	
5020-314-190 Oscilloscope Use with Function Generator	10
▪ Set up an oscilloscope for normal use.	
▪ Measure voltage using an oscilloscope.	
▪ Measure frequency using an oscilloscope.	
▪ Set up an oscilloscope for normal use.	
▪ Measure voltage using an oscilloscope.	
▪ Measure frequency using an oscilloscope.	
▪ Set up an oscilloscope for normal use.	
▪ Measure voltage using an oscilloscope.	
▪ Measure frequency using an oscilloscope.	
▪ Save and recall a waveform using the storage function of an oscilloscope.	
5020-314-430 Introduction to the Function Generator	---
▪ Describe the purpose of a function generator.	
▪ Identify the types of output signals generated by a function generator.	
▪ Identify the three major sections of a function generator.	
▪ Describe the purpose of each control and switch on a function generator.	
5020-314-460 Function Generator Use	10
▪ Set up a function generator for normal operation.	
▪ Adjust a function generator for various output signals.	
▪ Modulate an output signal.	
5020-314-730 Introduction to the Frequency Counter	---
▪ Describe the purpose of a frequency counter.	
▪ Describe the four major functions a frequency counter performs.	
▪ Determine the quantity measured from the display.	
▪ Identify the controls of a frequency counter and their purpose.	
5020-314-760 Frequency Counter Use	10
▪ Set up a frequency counter for normal operation.	
▪ Perform check, period, frequency, and totalize measurements.	
▪ Compare frequency and period measurements using a frequency counter and an oscilloscope.	
5020-314-920 AC Test Equipment Post-Test (Theory)	---

#### **Inductance and RL Circuits**

5021-316-130 Introduction to Inductors	---
▪ Identify types of inductors.	
▪ Describe the current opposing characteristic of an inductor.	
▪ Identify the schematic symbol for an inductor.	
▪ Identify characteristics of inductance.	
▪ Identify the unit of measurement for inductance.	
5021-316-160 Inductor Identification	11
▪ Identify inductors.	
▪ Identify inductor color codes.	
5021-316-190 RL Series Circuits	---
▪ Calculate total inductance in series circuits.	

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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **Inductance and RL Circuits (cont.)**

5021-316-190 RL Series Circuits (cont.)	13
▪ Calculate total inductive reactance in series circuits.	
▪ Calculate total impedance in series circuits.	
5021-316-220 RL Series Circuit Operation	13
▪ Measure the inductive phase relationship between voltage and current.	
▪ Verify normal operation of an RL series circuit.	
▪ Measure the phase relationship between the voltages developed across resistors and inductors.	
5021-316-250 RL Series Circuit Troubleshooting Experiment	16B
▪ Identify an open component in an RL series circuit.	
▪ Identify a shorted component in an RL series circuit.	
▪ Identify a changed value component in an RL series circuit.	
▪ Observe an open component in an RL series circuit.	
▪ Observe a shorted component in an RL series circuit.	
5021-316-310 RL Parallel Circuits	---
▪ Calculate total inductance in RL parallel circuits.	
▪ Calculate total inductive reactance in RL parallel circuits.	
▪ Calculate total impedance in RL parallel circuits.	
5021-316-340 RL Parallel Circuit Operation	13
▪ Measure the current phase difference between the inductive and resistive branches of a parallel RL circuit.	
▪ Verify normal operation of a parallel RL circuit.	
▪ Measure the total current phase difference in a parallel RL circuit.	
5021-316-370 RL Parallel Circuit Troubleshooting Experiment	16B
▪ Identify an open component in an RL parallel circuit.	
▪ Identify a shorted component in an RL parallel circuit.	
▪ Identify a changed value component in an RL parallel circuit.	
▪ Observe an open component in an RL parallel circuit.	
▪ Observe a shorted component in an RL parallel circuit.	
5021-316-430 RL Filters	16B
▪ Identify RL filter circuits.	
▪ Describe RL filter circuit characteristics.	
▪ Calculate RL filter circuit values.	
▪ Measure RL filter circuit values.	
▪ Compare measured RL filter circuit values with calculated circuit values.	
5021-316-920 Induction and RL Circuits Post-Test (Theory)	---

#### **Capacitance and RC Circuits**

5021-318-130 Introduction to Capacitors	---
▪ Identify types of capacitors.	
▪ Describe charge and discharge characteristics of a capacitor.	
▪ Identify the schematic symbol for a capacitor	
▪ Identify characteristics of capacitance.	
▪ Identify the unit of measurement for capacitance	
5021-318-160 Capacitor Identification	11
▪ Identify ceramic, film, mica, and electrolytic capacitors.	
▪ Read the capacitance and voltage values.	

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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **Capacitance and RC Circuits (cont.)**

5021-318-190 RC Series Circuits . . . . .	---
▪ Calculate total capacitance in series circuits.	
▪ Calculate total capacitive reactance in series circuits.	
▪ Calculate total impedance in series circuits.	
5021-318-220 RC Series Circuit Operation . . . . .	12
▪ Measure the capacitive phase relationship between voltage and current.	
▪ Verify normal operation of an RC series circuit.	
5021-318-250 RC Series Circuit Troubleshooting Experiment . . . . .	14A
▪ Identify an open component in an RC series circuit.	
▪ Identify a shorted component in an RC series circuit.	
▪ Identify a changed value component in an RC series circuit.	
▪ Observe an open component in an RC series circuit.	
5021-318-340 RC Parallel Circuits . . . . .	---
▪ Calculate total capacitance in a parallel circuit.	
▪ Calculate total capacitive reactance in a parallel circuit.	
▪ Calculate total impedance in a parallel circuit.	
5021-318-370 RC Parallel Circuit Operation . . . . .	12
▪ Measure the phase difference between the capacitive and resistive branches.	
▪ Verify normal circuit operation.	
▪ Measure the total current phase difference.	
5021-318-400 RC Parallel Circuit Troubleshooting Experiment . . . . .	14A
▪ Identify an open component in an RC parallel circuit.	
▪ Identify a shorted component in an RC parallel circuit.	
▪ Identify a changed value component in an RC parallel circuit.	
▪ Observe an open component in an RC parallel circuit.	
▪ Observe a shorted component in an RC parallel circuit.	
5021-318-490 RC Filters . . . . .	14A, 14B
▪ Identify RC filter circuits.	
▪ Describe RC filter circuit characteristics.	
▪ Calculate RC filter circuit values.	
▪ Measure RC low pass filter circuit values.	
▪ Compare measured RC low pass filter circuit values with calculated circuit values.	
▪ Measure RC high pass filter circuit values.	
▪ Compare measured RC high pass filter circuit values with calculated circuit values.	
5021-318-920 Capacitance and RC Circuits Post-Test (Theory) . . . . .	---

#### **RC Time Constants and Transients**

5021-320-130 RC and RL Time Constants . . . . .	---
▪ Describe RC time constants.	
▪ Calculate the amount of charge or discharge of a capacitor using RC time constants.	
▪ Describe RL time constants.	
▪ Calculate the amount of current present in an inductor using RL time constants.	
5021-320-160 RC Time Constants Operation . . . . .	15
▪ Observe capacitor charging and discharging using a multimeter.	
▪ Observe capacitor charging and discharging using an oscilloscope.	
▪ Verify RC time constants by the use of measurements.	

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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **RC Time Constants and Transients (cont.)**

5021-320-190 RC Circuit Transient Analysis . . . . .	---
▪ Describe the effects a capacitor has on non-sinusoidal waveshapes.	
▪ Describe how long and short RC time constants affect waveshapes.	
▪ Describe how RC time constants relate to capacitive reactances.	
5021-320-220 RC Circuit Transient Experiment . . . . .	14A
▪ Predict effects on voltage and current as frequency changes.	
▪ Measure voltage waveform across a capacitor with a square wave applied.	
▪ Measure current waveform across a capacitor using a sampling resistor.	
5021-320-250 RC Circuit Transient Troubleshooting Experiment . . . . .	14A
▪ Describe typical faults in an RC transient circuit.	
▪ Describe RC circuit transient troubleshooting procedures.	
▪ Describe the effects of open, shorted, and changed value components.	
▪ Recognize that an RC transient circuit is faulted.	
▪ Observe the effects of an open and shorted component in an RC transient circuit.	
5021-320-920 RC Time Constants and Transients Post-Test (Theory) . . . . .	---

#### **Resonance**

5021-322-130 Capacitive/Inductive Reactance and LCR Circuits . . . . .	---
▪ Describe the effects of inductors and capacitors when used in the same circuit.	
▪ Calculate circuit values in a series LCR circuit.	
▪ Calculate circuit values in a parallel LCR circuit.	
5021-322-160 Series and Parallel LCR Circuit Experiment . . . . .	17, 19
▪ Calculate and measure the voltage drops in a series LCR circuit.	
▪ Verify normal operation of a series LCR circuit.	
▪ Measure the phase relationship between EA, ER, EC, and EL in a series LCR circuit.	
▪ Calculate and measure the branch currents in a parallel LCR circuit.	
▪ Verify normal operation of a parallel LCR circuit.	
▪ Measure the phase relationship between IT, IR, IC, and IL in a parallel LCR circuit.	
5021-322-190 LCR Circuit Troubleshooting . . . . .	18A
▪ Identify an open component in a series and parallel LCR circuit.	
▪ Identify a shorted component in a series and parallel LCR circuit.	
▪ Identify a changed value component in a series and parallel LCR circuit.	
▪ Observe the effects of an open component in a series LCR circuit.	
▪ Observe the effects of a shorted component in a series LCR circuit.	
5021-322-220 Series Resonance . . . . .	---
▪ Describe series resonance.	
▪ Calculate the resonant frequency of a series LCR circuit.	
▪ Describe series LCR circuit values at resonance.	
5021-322-250 Series Resonant Circuits . . . . .	18A
▪ Calculate and measure the resonant frequency in a series LCR circuit.	
▪ Observe the effects of voltage magnification.	
▪ Observe the values of Er, It, and Zt below resonance in a series LCR circuit.	
5021-322-280 Parallel Resonance . . . . .	---
▪ Describe parallel resonance.	
▪ Calculate the resonant frequency of the parallel LCR circuit.	
▪ Describe parallel LCR circuit values at resonance.	

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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **Resonance (cont.)**

- 5021-322-310 Parallel Resonant Circuits ..... 20A
- Calculate and measure the resonant frequency in a parallel LCR circuit.
  - Observe the values of  $I_t$  and  $Z_t$  below resonance, at resonance, and above resonance in a parallel LCR circuit.
- 5021-322-340 Resonant Circuit Troubleshooting Experiment ..... 18A, 20A
- Identify an open component in a resonant circuit.
  - Identify a shorted component in a resonant circuit.
  - Identify a changed value component in a resonant circuit.
  - Observe the effects of an open component in a resonant series and parallel circuit.
  - Observe the effects of a shorted component in a resonant series and parallel circuit.
- 5021-322-920 Resonance Post-Test (Theory) ..... ---

#### **Transformers**

- 5021-324-130 Introduction to Transformers ..... ---
- Describe the purpose of transformers.
  - Identify transformer schematic symbols and the reference designation.
  - Describe transformer operating characteristics.
  - Calculate turn ratio.
  - Calculate secondary voltage, current, and power.
  - Calculate primary current and power.
- 5021-324-160 Transformer Operation ..... 21
- Measure primary voltage of a transformer.
  - Measure secondary voltage of a transformer.
  - Determine step up or step down transformer action.
- 5021-324-190 Troubleshooting Transformers ..... 21
- Describe typical faults in transformer circuits.
  - Describe transformer troubleshooting procedures.
  - Recognize that a transformer is faulted.
  - Observe the effects of an open and shorted secondary in a transformer circuit.
- 5021-324-920 Transformers Post-Test (Theory) ..... ---

#### **Relays and Switches**

- 5021-326-130 Relays ..... ---
- Describe the purpose and types of relays.
  - Describe basic relay construction and operation.
  - Identify the schematic symbol and reference designator for relays.
  - Describe the latched and time delay relay.
  - Describe a solenoid.
- 5021-326-160 Relay Operation Experiment ..... 84B
- Trace signal flow through a relay circuit.
  - Measure voltages in a relay circuit.
- 5021-326-190 Troubleshooting Relays and Switches ..... 84B
- Describe typical faults in relays.
  - Describe relay troubleshooting procedures.
  - Recognize that a relay circuit is faulted.
  - Identify the fault in a faulted relay circuit.
- 5021-326-220 Electrical Circuits ..... ---
- Identify component symbols from a schematic drawing.

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### **AC CIRCUITS (MODEL 1402) (cont.)**

#### **Relays and Switches (cont.)**

- 5021-326-220 Electrical Circuits (cont.)
- Describe the operation of an electrical circuit using a schematic drawing.
- 5021-326-250 Electrical Circuits Experiment ..... 82, 83
- Trace signal flow through an electrical circuit.
  - Measure AC and DC voltages in an electrical circuit.
- 5021-326-280 Electrical Circuits Troubleshooting ..... 82, 83
- Describe typical faults in an electrical circuit.
  - Describe electrical circuit troubleshooting procedures.
  - Recognize that an electrical circuit is faulted.
  - Identify the fault in a faulted electrical circuit.
- 5021-326-920 Relays and Switches Post-Test (Theory) ..... ---

### **ANALOG CIRCUITS - CORE (MODEL 1403T)**

#### **Diode and Diode Circuits**

- 5021-514-130 Introduction to Diodes ..... ---
- Identify the purpose of a diode.
  - Recognize the common types of diodes.
  - Recognize diode schematic symbols and reference designators.
  - Describe the uses of diodes.
  - Describe semiconductor material.
  - Describe P and N-type semiconductor material.
  - Describe forward and reverse biasing.
- 5021-514-160 Junction Diodes ..... ---
- Describe the purpose of a junction diode.
  - Identify the schematic symbol for a junction diode.
  - Describe forward and reverse bias.
  - Calculate circuit current based on the knee voltage of the diode.
- 5021-514-190 Junction Diode Operation ..... 22A
- Recognize normal operation of a junction diode.
  - Measure current through a junction diode.
- 5021-514-280 Diode Limiter Operation ..... 77A
- Describe the purpose of diode limiters.
  - Identify the two different types of diode limiter circuits.
  - Describe diode limiter operation.
  - Measure input and output waveforms of diode limiter circuits.
  - Recognize normal operation of diode limiter circuits.
- 5021-514-400 Electron Tube Principles ..... ---
- Identify the purpose of electron tubes.
  - Describe types, symbols, and characteristics of vacuum tubes, and the function of their elements.
  - Identify electron tube operation principles.
  - Identify electron tube configurations.
  - Identify characteristics of cathode ray tubes (CRTs).
  - Identify cathode ray tube (CRT) operating principles.

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### **ANALOG CIRCUITS - CORE (MODEL 1403T) (cont.)**

#### **Diode and Diode Circuits (cont.)**

5021-514-910 Diodes and Diode Circuits Post-Test (Theory) ..... ---

#### **Transistor Circuits**

5021-516-130 Introduction to Transistors ..... ---

- Describe the purpose of a transistor.
- Describe types of transistors.
- Identify transistor schematic symbols.
- Identify leads on transistors.
- Describe the purpose of DC bias in transistors.
- Describe NPN transistor bias.
- Describe PNP transistor bias.

5021-516-160 Transistor Operation ..... 28, 29

- Describe transistor cutoff and saturation.
- Describe transistor alpha and beta.
- Identify fixed, self, and combinational biasing.
- Measure alpha and beta.
- Observe cutoff and saturation.
- Measure collector current with varying load resistors.

5021-516-190 Introduction to Transistor Amplifiers ..... ---

- Describe the purpose of an amplifier.
- Describe classes of amplifier operation.
- Describe common emitter amplifiers.
- Describe common collector amplifiers.
- Describe common base amplifiers.

5021-516-220 Common Emitter Amplifier ..... ---

- Describe the operating characteristics of a common emitter amplifier.
- Describe the purpose of individual components in a common emitter amplifier.
- Describe methods to determine class of operation.
- Describe methods to determine voltage gain.

5021-516-250 Common Emitter Amplifier Experiment ..... 30A

- Measure the input and output waveforms of a common emitter amplifier circuit to determine normal operation.
- Observe waveforms in a common emitter amplifier circuit.

5021-516-280 Common Collector Amplifier ..... ---

- Describe the operating characteristics of a common collector amplifier.
- Describe the purpose of individual components in a common collector amplifier.
- Describe methods to determine class of operation.
- Describe methods to determine voltage gain.

5021-516-310 Common Collector Amplifier Experiment ..... 31

- Measure the input and output waveforms of a common collector amplifier circuit to determine normal operation.
- Observe waveforms in a common collector amplifier circuit.

5021-516-340 Common Base Amplifier ..... ---

- Describe the operating characteristics of a common base amplifier.
- Describe the purpose of individual components in a common base amplifier.
- Describe methods to determine class of operation.
- Describe methods to determine voltage gain.

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### **ANALOG CIRCUITS - CORE (MODEL 1403T) (cont.)**

#### **Transistor Circuits (cont.)**

- 5021-516-370 Common Base Amplifier Experiment ..... 32
- Measure the input and output waveforms of a common base amplifier circuit to determine normal operation.
  - Observe waveforms in a common base amplifier circuit.
- 5021-516-910 Transistor Circuits Post-Test (Theory) ..... ---

#### **Power Supplies**

- 5021-518-130 Introduction to Power Supplies and Diode Rectifiers ..... ---
- Describe the purpose of power supplies.
  - Describe the sections of a typical power supply.
  - Identify half-wave rectifiers.
  - Identify full-wave rectifiers.
  - Identify bridge rectifiers.
- 5021-518-160 Full- and Half-Wave Rectifier Operation ..... 23
- Identify full- and half-wave rectifier circuits.
  - Identify the purpose of individual rectifier components.
  - Describe rectifier operating characteristics.
  - Measure the input and output waveforms of half and full-wave rectifiers.
  - Recognize normal operation of half and full-wave rectifiers.
- 5021-518-190 Bridge Rectifier Operation ..... 24
- Identify bridge rectifier circuits.
  - Identify the purpose of individual bridge rectifier components.
  - Describe bridge rectifier operating characteristics.
  - Measure the input and output waveforms of a bridge rectifier.
  - Recognize normal operation of a bridge rectifier.
- 5021-518-220 Introduction to Voltage Regulators ..... ---
- Describe the purpose of series voltage regulators.
  - Describe the operation of basic series voltage regulator circuits.
  - Describe the purpose of parallel voltage regulators.
  - Describe the operation of basic parallel voltage regulator circuits.
- 5021-518-250 Zener Diode Operation ..... 22B
- Identify a zener schematic symbol.
  - Identify the purpose of a zener diode.
  - Describe the operation of zener diodes.
  - Recognize the proper method of using a multimeter to verify zener diode operation.
  - Predict the voltage drop of a reverse biased zener diode.
  - Measure the voltage drop of a reverse biased zener diode.
  - Recognize normal operation of a zener diode.
- 5021-518-910 Power Supplies Post-Test (Theory) ..... ---

#### **Transistor Amplifiers**

- 5021-520-130 Multistage Transistor Amplifiers ..... ---
- State the purpose of cascade amplifiers.
  - Calculate total gain of a cascade amplifier.
- 5021-520-160 RC Coupled Transistor Amplifier Operation ..... 33
- Describe the operating characteristics of an RC coupled transistor amplifier.
  - Describe the effect of an input signal's amplitude and frequency in an RC coupled transistor amplifier.



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### **ANALOG CIRCUITS - CORE (MODEL 1403T) (cont.)**

#### **Transistor Amplifiers (cont.)**

5021-520-160 RC Coupled Transistor Amplifier Operation (cont.)

- Measure the input and output waveforms of an RC coupled transistor amplifier.
- Recognize normal operation of an RC coupled transistor amplifier.
- Observe the effect of an input signal's amplitude and frequency in an RC coupled transistor amplifier.

5021-520-280 Field Effect Transistor Amplifiers . . . . . 49

- Recognize field effect transistor schematic symbols.
- Describe the construction of field effect transistors.
- Describe operating characteristics of field effect transistors.
- Identify basic FET amplifier configuration.
- Describe the operation of common source FET amplifiers.
- Describe the method to check for normal operation of common source FET amplifiers.
- Measure the input and output waveforms of a common source FET amplifier.
- Recognize normal operation of a common source FET amplifier.

5021-520-910 Transistor Amplifiers Post-Test (Theory) . . . . . ---

#### **Transistor Oscillators**

5021-522-130 Introduction to Sine Wave Oscillators . . . . . ---

- Describe the purpose of sine wave oscillators.
- Describe a basic sine wave oscillator circuit.
- Identify LC oscillators.
- Identify RC oscillators.
- Identify crystal oscillators.

5021-522-160 Hartley Oscillator Operation . . . . . 35

- Identify the circuits in a Hartley oscillator.
- Describe operating characteristics of a Hartley oscillator.
- Identify the purpose of individual components in a Hartley oscillator.
- Measure the input and output waveforms of a Hartley oscillator.
- Recognize normal operation of a Hartley oscillator.

5021-522-910 Transistor Oscillators Post-Test (Theory) . . . . . ---

#### **Transistor Pulse Amplifiers**

5021-524-130 Introduction to Multivibrator Circuits . . . . . ---

- Describe the purpose of multivibrators.
- Describe a basic multivibrator circuit.
- Identify astable multivibrators.
- Identify monostable multivibrators.
- Identify bistable multivibrators.

5021-524-160 Astable Multivibrator Operation . . . . . 44

- Identify astable multivibrator circuits.
- Identify the purpose of individual components in astable multivibrators.
- Describe the operation of astable multivibrators.
- Measure the input and output waveforms of an astable multivibrator.
- Recognize normal operation of an astable multivibrator.

5021-524-190 Monostable Multivibrator Operation . . . . . 46

- Identify monostable multivibrator circuits.
- Identify the purpose of individual multivibrators.
- Describe the operating characteristics of monostable multivibrators.

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### **ANALOG CIRCUITS - CORE (MODEL 1403T) (cont.)**

#### **Transistor Pulse Amplifiers (cont.)**

5021-524-190 Monostable Multivibrator Operation (cont.)

- Measure the input and output waveforms of a monostable multivibrator.
- Recognize normal operation of a monostable multivibrator.

5021-524-220 Bistable Multivibrator Operation ..... 45

- Identify bistable multivibrator circuits.
- Identify the purpose of individual multivibrators.
- Describe the operating characteristics of bistable multivibrators.
- Measure the input and output waveforms of a bistable multivibrator.
- Recognize normal operation of a bistable multivibrator.

5021-524-910 Transistor Pulse Circuits Post-Test (Theory) ..... ---

#### **Trigger Device Circuits**

5021-526-130 Introduction to Trigger Devices ..... ---

- Describe the purpose of unijunction transistors.
- Identify unijunction transistor schematic symbols.
- Describe the operating characteristics of unijunction transistors.
- Describe the purpose of silicon control rectifiers.
- Identify silicon rectifier schematic symbols.
- Describe the operating characteristics of silicon control rectifiers.

5021-526-160 Unijunction Transistor Oscillator Operation ..... 51

- Describe the purpose of UJT oscillators.
- Recognize UJT oscillator circuits.
- Describe the operation of UJT oscillators.
- Recognize normal operation of a UJT oscillator circuit.
- Measure waveforms in a UJT oscillator.

5021-526-190 SCR Trigger Circuit Operation ..... 52A

- Describe the purpose of SCR trigger circuits.
- Recognize SCR trigger circuits.
- Describe the operation of an SCR trigger circuit.
- Measure the gate and anode current in an operating SCR trigger circuit.
- Recognize normal operation of an SCR trigger circuit.

5021-526-340 Programmable Unijunction Transistors ..... ---

- Recognize the PUT schematic symbol.
- Describe the construction of PUT devices.
- Describe the operation of PUT devices.
- Identify PUT device applications.

5021-526-910 Trigger Device Circuits Post-Test (Theory) ..... ---

#### **Operational Amplifiers**

5021-528-130 Introduction to Operational Amplifiers ..... ---

- Describe operational amplifiers.
- Describe the types of circuits used in an operational amplifier.
- Describe the basic construction of IC operational amplifiers.
- Recognize differential amplifier circuits.
- Describe basic operating characteristics of differential amplifiers.

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### **ANALOG CIRCUITS (MODEL 1403)**

#### **Diode and Diode Circuits**

- 5021-514-130 Introduction to Diodes ..... ---
- Identify the purpose of a diode.
  - Recognize the common types of diodes.
  - Recognize diode schematic symbols and reference designators.
  - Describe the uses of diodes.
  - Describe semiconductor material.
  - Describe P and N-type semiconductor material.
  - Describe forward and reverse biasing.
- 5021-514-160 Junction Diodes ..... ---
- Describe the purpose of a junction diode.
  - Identify the schematic symbol for a junction diode.
  - Describe forward and reverse bias.
  - Calculate circuit current based on the knee voltage of the diode.
- 5021-514-190 Junction Diode Operation ..... 22A
- Recognize normal operation of a junction diode.
  - Measure current through a junction diode.
- 5021-514-220 Junction Diode Troubleshooting Experiment ..... 22A
- Identify an open junction diode circuit.
  - Identify a shorted junction diode in a circuit.
  - Identify a changed value junction diode in a circuit.
  - Observe an open junction diode in a circuit.
  - Observe a shorted junction diode in a circuit.
- 5021-514-280 Diode Limiter Operation ..... 77A
- Describe the purpose of diode limiters.
  - Identify the two different types of diode limiter circuits.
  - Describe diode limiter operation.
  - Measure input and output waveforms of diode limiter circuits.
  - Recognize normal operation of diode limiter circuits.
- 5021-514-310 Diode Clamper Operation ..... 77B
- Describe the purpose of diode clampers.
  - Identify the two different types of diode clamper circuits.
  - Describe diode clamper operation.
  - Measure input and output waveforms of diode clamper circuits.
  - Recognize normal operation of diode clamper circuits.
- 5021-514-340 Limiter and Clamper Troubleshooting Experiment ..... 77A, 77B
- Describe typical faults in diode limiter and clamper circuits.
  - Describe diode limiter and clamper troubleshooting procedures.
  - Recognize that a parallel diode limiter circuit is faulted.
  - Observe the effects of a defective diode in a parallel limiter circuit.
  - Recognize that a diode clamper circuit is faulted.
  - Observe the effects of a defective diode in a clamper circuit.
- 5021-514-400 Electron Tube Principles ..... ---
- Identify the purpose of electron tubes.
  - Describe types, symbols, and characteristics of vacuum tubes, and the function of their elements.
  - Identify electron tube operation principles.

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Diode and Diode Circuits (cont.)**

5021-514-400 Electron Tube Principles (cont.)

- Identify electron tube configurations.
- Identify characteristics of cathode ray tubes (CRTs).
- Identify cathode ray tube (CRT) operating principles.

5021-514-920 Diodes and Diode Circuits Post-Test (Theory) ..... ---

#### **Transistor Circuits**

5021-516-130 Introduction to Transistors ..... ---

- Describe the purpose of a transistor.
- Describe types of transistors.
- Identify transistor schematic symbols.
- Identify leads on transistors.
- Describe the purpose of DC bias in transistors.
- Describe NPN transistor bias.
- Describe PNP transistor bias.

5021-516-160 Transistor Operation ..... 28, 29

- Describe transistor cutoff and saturation.
- Describe transistor alpha and beta.
- Identify fixed, self, and combinational biasing.
- Measure alpha and beta.
- Observe cutoff and saturation.
- Measure collector current with varying load resistors.

5021-516-190 Introduction to Transistor Amplifiers ..... ---

- Describe the purpose of an amplifier.
- Describe classes of amplifier operation.
- Describe common emitter amplifiers.
- Describe common collector amplifiers.
- Describe common base amplifiers.

5021-516-220 Common Emitter Amplifier ..... ---

- Describe the operating characteristics of a common emitter amplifier.
- Describe the purpose of individual components in a common emitter amplifier.
- Describe methods to determine class of operation.
- Describe methods to determine voltage gain.

5021-516-250 Common Emitter Amplifier Experiment ..... 30A

- Measure the input and output waveforms of a common emitter amplifier circuit to determine normal operation.
- Observe waveforms in a common emitter amplifier circuit.

5021-516-280 Common Collector Amplifier ..... ---

- Describe the operating characteristics of a common collector amplifier.
- Describe the purpose of individual components in a common collector amplifier.
- Describe methods to determine class of operation.
- Describe methods to determine voltage gain.

5021-516-310 Common Collector Amplifier Experiment ..... 31

- Measure the input and output waveforms of a common collector amplifier circuit to determine normal operation.
- Observe waveforms in a common collector amplifier circuit.

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Transistor Circuits (cont.)**

5021-516-340 Common Base Amplifier .....	---
▪ Describe the operating characteristics of a common base amplifier.	
▪ Describe the purpose of individual components in a common base amplifier.	
▪ Describe methods to determine class of operation.	
▪ Describe methods to determine voltage gain.	
5021-516-370 Common Base Amplifier Experiment .....	32
▪ Measure the input and output waveforms of a common base amplifier circuit to determine normal operation.	
▪ Observe waveforms in a common base amplifier circuit.	
5021-516-920 Transistor Circuits Post-Test (Theory) .....	---

#### **Power Supplies**

5021-518-130 Introduction to Power Supplies and Diode Rectifiers .....	---
▪ Describe the purpose of power supplies.	
▪ Describe the sections of a typical power supply.	
▪ Identify half-wave rectifiers.	
▪ Identify full-wave rectifiers.	
▪ Identify bridge rectifiers.	
5021-518-160 Full- and Half-Wave Rectifier Operation .....	23
▪ Identify full- and half-wave rectifier circuits.	
▪ Identify the purpose of individual rectifier components.	
▪ Describe rectifier operating characteristics.	
▪ Measure the input and output waveforms of half and full-wave rectifiers.	
▪ Recognize normal operation of half and full-wave rectifiers.	
5021-518-190 Bridge Rectifier Operation .....	24
▪ Identify bridge rectifier circuits.	
▪ Identify the purpose of individual bridge rectifier components.	
▪ Describe bridge rectifier operating characteristics.	
▪ Measure the input and output waveforms of a bridge rectifier.	
▪ Recognize normal operation of a bridge rectifier.	
5021-518-220 Introduction to Voltage Regulators .....	---
▪ Describe the purpose of series voltage regulators.	
▪ Describe the operation of basic series voltage regulator circuits.	
▪ Describe the purpose of parallel voltage regulators.	
▪ Describe the operation of basic parallel voltage regulator circuits.	
5021-518-250 Zener Diode Operation .....	22B
▪ Identify a zener schematic symbol.	
▪ Identify the purpose of a zener diode.	
▪ Describe the operation of zener diodes.	
▪ Recognize the proper method of using a multimeter to verify zener diode operation.	
▪ Predict the voltage drop of a reverse biased zener diode.	
▪ Measure the voltage drop of a reverse biased zener diode.	
▪ Recognize normal operation of a zener diode.	
5021-518-280 Zener Diode Regulator Operation .....	23, 25
▪ Identify zener diode regulator circuits.	
▪ Identify the purpose of individual zener diode regulator components.	
▪ Describe zener diode regulator operating characteristics.	

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Power Supplies (cont.)**

- 5021-518-280 Zener Diode Regulator Operation (cont.)
- Measure the input and output voltages of a zener diode regulator.
  - Recognize normal operation of a zener diode regulator.
- 5021-518-310 Voltage Regulator Operation ..... 23, 26
- Identify voltage regulator circuits.
  - Identify the purpose of individual voltage regulator components.
  - Describe voltage regulator operating characteristics.
  - Measure the input and output voltages of a voltage regulator.
  - Recognize normal operation of a voltage regulator.
- 5021-518-340 Voltage Regulator Troubleshooting Experiment ..... 23, 25, 26
- Describe typical faults in voltage regulator circuits.
  - Describe voltage regulator troubleshooting procedures.
  - Recognize that a zener diode voltage regulator circuit is faulted.
  - Observe the effects of a faulted component in a zener.
  - Recognize that a variable voltage regulator circuit is faulted.
  - Observe the effects of a faulted component in a variable voltage regulator circuit.
- 5021-518-400 IC Regulator Operation ..... 74
- Describe the purpose of an IC regulator.
  - Describe the operation of an IC regulator.
  - Verify normal operation of an IC regulator.
  - Define the advantages of an IC regulator.
- 5021-518-430 Voltage Doubler Operation ..... 27
- Identify the purpose of a voltage doubler.
  - Describe operation of half- and full-wave voltage doublers.
  - Describe advantages and disadvantages of half- and full-wave voltage doublers.
  - Identify normal operation of half- and full-wave voltage doublers.
  - Observe the effect of loading a voltage doubler's output.
  - Observe the effect of adding additional filter capacitance to a voltage doubler.
- 5021-518-920 Power Supplies Post-Test (Theory) ..... ---

#### **Transistor Amplifiers**

- 5021-520-130 Multistage Transistor Amplifiers ..... ---
- State the purpose of cascade amplifiers.
  - Calculate total gain of a cascade amplifier.
- 5021-520-160 RC Coupled Transistor Amplifier Operation ..... 33
- Describe the operating characteristics of an RC coupled transistor amplifier.
  - Describe the effect of an input signal's amplitude and frequency in an RC coupled transistor amplifier.
  - Measure the input and output waveforms of an RC coupled transistor amplifier.
  - Recognize normal operation of an RC coupled transistor amplifier.
  - Observe the effect of an input signal's amplitude and frequency in an RC coupled transistor amplifier.
- 5021-520-190 Push-Pull Amplifier Operation ..... 34
- Identify push-pull amplifier circuits.
  - Describe the operating characteristics of push-pull amplifiers.
  - Measure the input and output waveforms of a common collector push-pull amplifier circuit.
  - Recognize normal operation of a common collector push-pull amplifier circuit.

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Transistor Amplifiers (cont.)**

- 5021-520-220 Multistage Amplifier Troubleshooting Experiment ..... 33, 34
- Describe the troubleshooting method of signal tracing.
  - Identify common faults in a multistage amplifier circuit.
  - Recognize that a multistage amplifier circuit is faulted.
  - Troubleshoot a faulted multistage amplifier circuit.
- 5021-520-280 Field Effect Transistor Amplifiers ..... 49
- Recognize field effect transistor schematic symbols.
  - Describe the construction of field effect transistors.
  - Describe operating characteristics of field effect transistors.
  - Identify basic FET amplifier configuration.
  - Describe the operation of common source FET amplifiers.
  - Describe the method to check for normal operation of common source FET amplifiers.
  - Measure the input and output waveforms of a common source FET amplifier.
  - Recognize normal operation of a common source FET amplifier.
- 5021-520-310 FET Amplifier Troubleshooting Experiment ..... 49
- Describe typical faults in FET amplifier circuits.
  - Describe FET amplifier troubleshooting procedures.
  - Recognize that a FET amplifier circuit is faulted.
  - Identify the faulted component in a FET amplifier circuit.
- 5021-520-370 Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) ..... ---
- Recognize Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) schematic symbols.
  - Describe the construction of MOSFET devices.
  - Describe the operation of Depletion-mode MOSFETs.
  - Describe the operation of Enhancement-mode MOSFETs.
  - Identify various MOSFET device applications.
- 5021-520-920 Transistor Amplifiers Post-Test (Theory) ..... ---

#### **Transistor Oscillators**

- 5021-522-130 Introduction to Sine Wave Oscillators ..... ---
- Describe the purpose of sine wave oscillators.
  - Describe a basic sine wave oscillator circuit.
  - Identify LC oscillators.
  - Identify RC oscillators.
  - Identify crystal oscillators.
- 5021-522-160 Hartley Oscillator Operation ..... 35
- Identify the circuits in a Hartley oscillator.
  - Describe operating characteristics of a Hartley oscillator.
  - Identify the purpose of individual components in a Hartley oscillator.
  - Measure the input and output waveforms of a Hartley oscillator.
  - Recognize normal operation of a Hartley oscillator.
- 5021-522-190 Colpitts Oscillator Operation ..... 36
- Identify the circuits in a Colpitts oscillator.
  - Describe operating characteristics of a Colpitts oscillator.
  - Identify the purpose of individual components in a Colpitts oscillator.
  - Measure the input and output waveforms of a Colpitts oscillator.
  - Recognize normal operation of a Colpitts oscillator.

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Transistor Oscillators (cont.)**

5021-522-220 RC Phase Shift Oscillator Operation .....	37
<ul style="list-style-type: none"><li>▪ Identify RC phase shift oscillator circuits.</li><li>▪ Describe operating characteristics of RC phase shift oscillators.</li><li>▪ Identify the purpose of individual components in RC phase shift oscillators.</li><li>▪ Measure the input and output waveforms of an RC phase shift oscillator.</li><li>▪ Recognize normal operation of an RC phase shift oscillator.</li></ul>	
5021-522-250 Crystal Controlled Oscillator Operation .....	50
<ul style="list-style-type: none"><li>▪ Describe characteristics of a quartz crystal.</li><li>▪ Identify and describe crystal oscillator circuits.</li><li>▪ Identify the purpose of individual components in a crystal oscillator.</li><li>▪ Measure the input and output waveforms of a crystal oscillator.</li><li>▪ Recognize normal operation of a crystal oscillator.</li></ul>	
5021-522-280 Sine Wave Oscillator Troubleshooting Experiment I .....	35, 36
<ul style="list-style-type: none"><li>▪ Describe typical faults in Hartley and Colpitts oscillators.</li><li>▪ Describe Hartley and Colpitts oscillator troubleshooting procedures.</li><li>▪ Recognize that a Hartley oscillator is faulted.</li><li>▪ Identify the faulted component in a Hartley oscillator.</li><li>▪ Recognize that a Colpitts oscillator is faulted.</li><li>▪ Identify the faulted component in a Colpitts oscillator.</li></ul>	
5021-522-310 Sine Wave Oscillator Troubleshooting Experiment II .....	37, 50
<ul style="list-style-type: none"><li>▪ Describe typical faults in RC phase shift and crystal oscillators.</li><li>▪ Describe RC phase shift and crystal oscillator troubleshooting procedures.</li><li>▪ Recognize that an RC phase shift oscillator is faulted.</li><li>▪ Identify the faulted component in an RC phase shift oscillator.</li><li>▪ Recognize that a crystal oscillator is faulted.</li><li>▪ Identify the faulted component in a crystal oscillator.</li></ul>	
5021-522-340 Sawtooth Generator Operation .....	43A
<ul style="list-style-type: none"><li>▪ Describe the purpose of a sawtooth generator.</li><li>▪ Identify and describe input and output waveforms of a sawtooth generator.</li><li>▪ Measure the input and output waveforms of a sawtooth generator.</li><li>▪ Recognize normal operation of a sawtooth generator.</li></ul>	
5021-522-370 Blocking Oscillator Operation .....	42
<ul style="list-style-type: none"><li>▪ Identify the purpose of blocking oscillators.</li><li>▪ Describe the operation of free-running and triggered blocking oscillators.</li><li>▪ Observe normal operation of free-running blocking oscillators.</li><li>▪ Observe normal operation of triggered blocking oscillators.</li></ul>	
5021-522-400 Non-Sine Wave Oscillator Troubleshooting Experiment .....	42, 43A
<ul style="list-style-type: none"><li>▪ Describe typical faults in blocking oscillators and sawtooth generators.</li><li>▪ Describe blocking oscillator and sawtooth generator troubleshooting procedures.</li><li>▪ Recognize that a blocking oscillator is faulted.</li><li>▪ Identify the faulted component in a blocking oscillator.</li><li>▪ Recognize that a sawtooth generator is faulted.</li><li>▪ Identify the faulted component in a sawtooth generator.</li></ul>	
5021-522-920 Transistor Oscillators Post-Test (Theory) .....	---



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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Transistor Pulse Amplifiers**

5021-524-130 Introduction to Multivibrator Circuits . . . . .	---
▪ Describe the purpose of multivibrators.	
▪ Describe a basic multivibrator circuit.	
▪ Identify astable multivibrators.	
▪ Identify monostable multivibrators.	
▪ Identify bistable multivibrators.	
5021-524-160 Astable Multivibrator Operation . . . . .	44
▪ Identify astable multivibrator circuits.	
▪ Identify the purpose of individual components in astable multivibrators.	
▪ Describe the operation of astable multivibrators.	
▪ Measure the input and output waveforms of an astable multivibrator.	
▪ Recognize normal operation of an astable multivibrator.	
5021-524-190 Monostable Multivibrator Operation . . . . .	46
▪ Identify monostable multivibrator circuits.	
▪ Identify the purpose of individual multivibrators.	
▪ Describe the operating characteristics of monostable multivibrators.	
▪ Measure the input and output waveforms of a monostable multivibrator.	
▪ Recognize normal operation of a monostable multivibrator.	
5021-524-220 Bistable Multivibrator Operation . . . . .	45
▪ Identify bistable multivibrator circuits.	
▪ Identify the purpose of individual multivibrators.	
▪ Describe the operating characteristics of bistable multivibrators.	
▪ Measure the input and output waveforms of a bistable multivibrator.	
▪ Recognize normal operation of a bistable multivibrator.	
5021-524-250 Multivibrator Troubleshooting Experiment . . . . .	44, 45, 46
▪ Describe typical faults in astable, monostable, and bistable multivibrators.	
▪ Describe multivibrator troubleshooting procedures.	
▪ Recognize that an astable multivibrator is faulted.	
▪ Identify the faulted component in an astable multivibrator.	
▪ Recognize that a monostable multivibrator is faulted.	
▪ Identify the faulted component in a monostable multivibrator.	
▪ Recognize that a bistable multivibrator is faulted.	
▪ Identify the faulted component in a bistable multivibrator.	
5021-524-310 Schmitt Trigger Operation . . . . .	47N
▪ Describe the purpose of a Schmitt trigger.	
▪ Identify and describe Schmitt trigger circuits.	
▪ Measure the input and output waveforms of a Schmitt trigger.	
▪ Recognize normal operation of a Schmitt trigger with various inputs.	
5021-524-340 Schmitt Trigger Troubleshooting Experiment . . . . .	47N
▪ Describe typical faults in Schmitt trigger circuits.	
▪ Describe Schmitt trigger troubleshooting procedures.	
▪ Recognize that a Schmitt trigger is faulted.	
▪ Identify the faulted component in a Schmitt trigger.	
5021-524-920 Transistor Pulse Circuits Post-Test (Theory) . . . . .	---

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Trigger Device Circuits**

5021-526-130 Introduction to Trigger Devices ..... --- <ul style="list-style-type: none"> <li>▪ Describe the purpose of unijunction transistors.</li> <li>▪ Identify unijunction transistor schematic symbols.</li> <li>▪ Describe the operating characteristics of unijunction transistors.</li> <li>▪ Describe the purpose of silicon control rectifiers.</li> <li>▪ Identify silicon rectifier schematic symbols.</li> <li>▪ Describe the operating characteristics of silicon control rectifiers.</li> </ul>	---
5021-526-160 Unijunction Transistor Oscillator Operation ..... 51 <ul style="list-style-type: none"> <li>▪ Describe the purpose of UJT oscillators.</li> <li>▪ Recognize UJT oscillator circuits.</li> <li>▪ Describe the operation of UJT oscillators.</li> <li>▪ Recognize normal operation of a UJT oscillator circuit.</li> <li>▪ Measure waveforms in a UJT oscillator.</li> </ul>	51
5021-526-190 SCR Trigger Circuit Operation ..... 52A <ul style="list-style-type: none"> <li>▪ Describe the purpose of SCR trigger circuits.</li> <li>▪ Recognize SCR trigger circuits.</li> <li>▪ Describe the operation of an SCR trigger circuit.</li> <li>▪ Measure the gate and anode current in an operating SCR trigger circuit.</li> <li>▪ Recognize normal operation of an SCR trigger circuit.</li> </ul>	52A
5021-526-220 SCR Power Control Operation ..... 52B <ul style="list-style-type: none"> <li>▪ Describe the purpose of SCR power control circuits.</li> <li>▪ Describe the operation of an SCR power control circuit.</li> <li>▪ Recognize normal operation of an SCR power control circuit.</li> <li>▪ Measure the waveforms in an operating SCR power control circuit.</li> </ul>	52B
5021-526-250 SCR Trigger Circuit Troubleshooting Experiment ..... 52A, 52B <ul style="list-style-type: none"> <li>▪ Describe typical faults in SCR trigger and power control circuits.</li> <li>▪ Describe SCR trigger and power control circuit troubleshooting procedures.</li> <li>▪ Recognize when an SCR trigger circuit is faulted.</li> <li>▪ Identify the faulted component in an SCR trigger circuit.</li> <li>▪ Recognize when an SCR power control circuit is faulted.</li> <li>▪ Identify the faulted component in an SCR power control circuit.</li> </ul>	52A, 52B
5021-526-310 Triacs, Diacs, and Four-Layer Diodes ..... 88 <ul style="list-style-type: none"> <li>▪ Describe the relationship between triacs and SCRs.</li> <li>▪ Recognize triac circuit operation based on input conditions.</li> <li>▪ Describe the relationship between diacs and four-layer diodes.</li> <li>▪ Explain the beneficial use of a diac with a triac.</li> <li>▪ Observe the effect of AC voltages with basic triac operation.</li> <li>▪ Observe the effect of DC voltages with basic triac operation.</li> <li>▪ Understand the effects of triggering a triac with AC waveforms.</li> </ul>	88
5021-526-340 Programmable Unijunction Transistors ..... --- <ul style="list-style-type: none"> <li>▪ Recognize the PUT schematic symbol.</li> <li>▪ Describe the construction of PUT devices.</li> <li>▪ Describe the operation of PUT devices.</li> <li>▪ Identify PUT device applications.</li> </ul>	---
5021-526-920 Trigger Device Circuits Post-Test (Theory) ..... ---	---

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### **ANALOG CIRCUITS (MODEL 1403) (cont.)**

#### **Operational Amplifiers**

5021-528-130 Introduction to Operational Amplifiers . . . . .	---
▪ Describe operational amplifiers.	
▪ Describe the types of circuits used in an operational amplifier.	
▪ Describe the basic construction of IC operational amplifiers.	
▪ Recognize differential amplifier circuits.	
▪ Describe basic operating characteristics of differential amplifiers.	
5021-528-160 Operational Amplifier Operation . . . . .	54
▪ Identify operational amplifier circuits.	
▪ Describe the operating characteristics of operational amplifier circuits.	
▪ Identify the purpose of operational amplifier components.	
▪ Measure the input and output waveforms of operational amplifier circuits.	
▪ Recognize normal operation of operational amplifier circuits.	
5021-528-190 Operational Amplifier Troubleshooting Experiment . . . . .	54
▪ Describe typical faults in operational amplifier circuits.	
▪ Describe operational amplifier troubleshooting procedures.	
▪ Recognize that an operational amplifier circuit is faulted.	
▪ Verify correct circuit operation for a repaired op-amp circuit.	
5021-528-920 Operational Amplifiers Post-Test (Theory) . . . . .	---

#### **Introduction to RF Circuits**

5021-530-130 Introduction to AM Receivers . . . . .	---
▪ List the primary functions of an AM receiver.	
▪ Describe AM receiver primary functions.	
▪ Identify the basic functional blocks of an AM receiver.	
5021-530-160 AM Receiver Operation . . . . .	38, 39, 40
▪ Recognize AM receiver circuits.	
▪ Describe the operating characteristics of AM receiver circuits.	
▪ Measure the input and output waveforms of AM receiver circuits.	
▪ Recognize normal operation of an AM receiver.	
5021-530-190 AM Receiver Troubleshooting . . . . .	38, 39, 40
▪ Describe the four-step method for troubleshooting electronic equipment.	
▪ Describe how the four-step method is applied to AM receivers.	
▪ Use the four-step method to troubleshoot a defective AM receiver.	
▪ Troubleshoot a defective AM receiver to a faulty circuit.	
5021-530-920 Introduction to RF Electronics Post-Test (Theory) . . . . .	---

### **DIGITAL CIRCUITS (MODEL 1404)**

#### **Introduction to Digital Circuits**

5021-712-130 Introduction to Digital Electronics . . . . .	101
▪ Identify developments of digital electronics.	
▪ Describe the growth of computing equipment.	
▪ Identify uses of digital electronics.	
▪ Describe input and output conditions for digital circuits.	
▪ Identify the AND, OR, and NOT functions.	
▪ Recognize the digital truth table.	
▪ Recognize the AND, OR, and NOT Boolean equations.	

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Introduction to Digital Circuits (cont.)**

5021-712-130 Introduction to Digital Electronics (cont.)	
▪ Observe the operation of various digital gates.	
▪ Read a truth table.	
▪ Recognize HIGH and LOW outputs.	
5021-712-160 Digital Electronics Hardware .....	---
▪ Define integrated circuit.	
▪ Identify three forms of integrated circuit packaging.	
▪ Identify markings associated with integrated circuits.	
▪ Identify integrated circuit functions.	
▪ Describe the purpose of a data book.	
5021-712-190 Buffers and Inverters .....	106
▪ Describe the purpose of a buffer.	
▪ Describe the purpose of an inverter.	
▪ Describe input threshold voltages.	
▪ Describe output threshold voltages.	
▪ Measure threshold voltages.	
5021-712-220 Digital Test Equipment .....	112
▪ Describe the purpose of a clock generator circuit.	
▪ Identify the signals produced by the clock generator.	
▪ Identify the basic components of a clock generator.	
▪ Describe the purpose of a logic probe.	
▪ Describe basic operation of a logic probe.	
▪ Operate a simple clock generator circuit.	
▪ Operate a logic probe.	
5021-712-250 555 Timer .....	153
▪ Describe the purpose of the 555 timer.	
▪ Describe the internal operation of the 555 timer.	
▪ Describe the operation of a 555 timer used as an astable multivibrator.	
▪ Describe the operation of a 555 timer used as a monostable multivibrator.	
▪ Observe the operation of a 555 timer circuit.	
▪ Operate a 555 timer in astable and monostable multivibrator configurations.	
5021-712-280 Introduction to Integrated Circuits .....	---
▪ Identify the different IC construction classifications.	
▪ Identify integration classifications.	
▪ Explain the construction of a basic IC.	
▪ Understand the various IC packaging arrays.	
▪ Identify basic IC packaging materials.	
▪ Identify various integrated components.	
▪ Interpret basic IC numbers.	
▪ Locate information on an IC using an IC data book.	
5021-712-910 Introduction to Digital Circuits Post-Test (Theory) .....	---
5021-712-920 Introduction to Digital Circuits Post-Test (Theory) .....	---
<b><u>Digital Logic Functions</u></b>	
5021-714-130 AND Gates .....	102, 112
▪ Identify AND operation.	
▪ Identify AND logic symbols.	

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Digital Logic Functions (cont.)**

5021-714-130 AND Gates (cont.)	
▪ Identify AND logic schematic representation.	
▪ Construct an AND gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-160 OR Gates . . . . .	104, 112
▪ Identify OR operation.	
▪ Identify OR logic symbols.	
▪ Identify OR logic schematic representation.	
▪ Construct an OR gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-190 NOT Gates . . . . .	106, 112
▪ Identify NOT operation.	
▪ Identify NOT logic symbols.	
▪ Identify NOT logic schematic representation.	
▪ Construct a NOT gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-220 NAND Gates . . . . .	103, 112
▪ Identify NAND operation.	
▪ Identify NAND logic symbols.	
▪ Identify NAND logic schematic representation.	
▪ Construct a NAND gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-250 NOR Gates . . . . .	105, 112
▪ Identify NOR operation.	
▪ Identify NOR logic symbols.	
▪ Identify NOR logic schematic representation.	
▪ Construct a NOR gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-280 XOR and XNOR Gates . . . . .	107, 112
▪ Identify XOR and XNOR operation.	
▪ Identify XOR and XNOR logic symbols.	
▪ Identify XOR and XNOR logic schematic representation.	
▪ Construct truth tables for XOR and XNOR gates.	
▪ Identify input and output waveforms of XOR and XNOR gates.	
▪ Measure the input and output waveforms of an XOR gate.	
5021-714-310 Introduction to Logic Functions . . . . .	---
▪ Identify AND operation.	
▪ Identify AND logic symbols.	
▪ Construct an AND gate truth table.	
▪ Identify input and output waveforms.	
▪ Identify OR operation.	

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Digital Logic Functions (cont.)**

5021-714-310 Introduction to Logic Functions (cont.)

- Identify OR logic symbols.
- Construct an OR gate truth table.
- Identify input and output waveforms.

5021-714-910 Digital Logic Circuits Post-Test (Theory) ..... ---

5021-714-920 Digital Logic Circuits Post-Test (Theory) ..... ---

#### **Combinational Logic Circuits**

5021-716-130 Introduction to Combinational Circuits ..... 103, 112

- Define combinational logic.
- Describe the uses of combinational logic.
- Trace inputs through a combinational logic circuit.
- Describe the universal property of the NAND gate.
- Describe the universal property of the NOR gate.
- Measure outputs in a combinational logic circuit.
- Verify NAND gates performing AND, OR, and NOR functions.

5021-716-160 Logic Families ..... ---

- Describe TTL logic.
- Identify supply voltage.
- Define fan-in and fan-out.
- Define propagation delay.
- Describe CMOS logic.
- Describe ECL logic.
- Describe IIL logic.

5021-716-190 Number Systems ..... 111, 124

- Recognize the decimal number system.
- Recognize the binary number system.
- Recognize the octal number system.
- Recognize the hexadecimal number system.
- Convert decimal numbers to binary numbers.
- Convert binary numbers to decimal numbers.
- Convert octal numbers to binary numbers.
- Convert hexadecimal numbers to binary numbers.
- Add binary numbers.
- Subtract binary numbers.
- Multiply binary numbers.
- Divide binary numbers.
- Observe binary to octal conversion.
- Observe binary to decimal conversion.
- Observe binary to hexadecimal conversion.

5021-716-220 Base 10 to Binary Conversion ..... 108

- Identify the purpose of a decimal encoder.
- Identify a decimal-to-binary encoder circuit.
- Predict the outputs of a decimal encoder.
- Probe the outputs of a decimal encoder.
- Recognize normal operation of a decimal encoder.

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Combinational Logic Circuits (cont.)**

5021-716-250 Binary to 7 Segment Conversion . . . . .	109
<ul style="list-style-type: none"> <li>▪ Identify the purpose of a binary decoder.</li> <li>▪ Describe a seven segment display.</li> <li>▪ Describe a binary to decimal seven segment decoder circuit.</li> <li>▪ Predict the outputs of a binary decoder.</li> <li>▪ Probe the outputs of a binary decoder.</li> <li>▪ Recognize normal operation of a binary decoder.</li> </ul>	
5021-716-280 4-Bit Comparator . . . . .	110
<ul style="list-style-type: none"> <li>▪ Identify the purpose of a comparator.</li> <li>▪ Describe a comparator circuit.</li> <li>▪ Apply binary codes to a 4-bit comparator.</li> <li>▪ Measure outputs from a 4-bit comparator.</li> </ul>	
5021-716-910 Combinational Logic Circuits Post-Test (Theory) . . . . .	---
5021-716-920 Combinational Logic Circuits Post-Test (Theory) . . . . .	---

#### **Flip-Flop Circuits**

5021-718-130 Introduction to Latches and Flip-Flops . . . . .	---
<ul style="list-style-type: none"> <li>▪ Identify the difference between a sequential circuit and a combinational circuit.</li> <li>▪ Recognize SET and RESET conditions.</li> <li>▪ Understand basic flip-flop operation.</li> <li>▪ Describe the operation of RS and <math>\sim R\sim S</math> latches.</li> <li>▪ Identify the RS and <math>\sim R\sim S</math> latch truth tables.</li> <li>▪ Describe the race condition in the RS and <math>\sim R\sim S</math> latches.</li> </ul>	
5021-718-160 RS Flip-Flops . . . . .	113
<ul style="list-style-type: none"> <li>▪ Identify the purpose of an RS flip-flop.</li> <li>▪ Describe an RS flip-flop circuit.</li> <li>▪ Predict the outputs of an RS flip-flop.</li> <li>▪ Probe the inputs and outputs of an RS flip-flop.</li> <li>▪ Recognize normal operation of an RS flip-flop.</li> </ul>	
5021-718-190 Clocked RS Flip-Flops . . . . .	111, 128
<ul style="list-style-type: none"> <li>▪ Identify the purpose of a clocked RS flip-flop.</li> <li>▪ Describe a clocked RS flip-flop circuit.</li> <li>▪ Predict outputs of an RS flip-flop.</li> <li>▪ Probe the inputs and outputs of a clocked RS flip-flop.</li> <li>▪ Recognize normal operations of a clocked RS flip-flop.</li> </ul>	
5021-718-220 D-Type Flip-Flops . . . . .	111, 114
<ul style="list-style-type: none"> <li>▪ Identify the purpose of a D-type flip-flop.</li> <li>▪ Describe a D-type flip-flop circuit.</li> <li>▪ Predict inputs and outputs of a D-type flip-flop.</li> <li>▪ Probe the normal operation of a D-type flip-flop.</li> <li>▪ Recognize outputs of a D-type flip-flop.</li> </ul>	
5021-718-250 JK Flip-Flops . . . . .	111, 115
<ul style="list-style-type: none"> <li>▪ Describe the JK flip-flop symbol and truth table.</li> <li>▪ Explain the operation of a JK flip-flop.</li> <li>▪ Develop a timing diagram for a JK flip-flop.</li> <li>▪ Predict the output of a JK flip-flop.</li> <li>▪ Probe inputs and outputs of a JK flip-flop.</li> </ul>	

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Flip-Flop Circuits (cont.)**

- 5021-718-250 JK Flip-Flops (cont.)
- Recognize normal operation of a JK flip-flop.
- 5021-718-280 Master-Slave Flip-Flops . . . . . 111, 137
- Describe flip-flop level triggering.
  - Describe flip-flop edge triggering.
  - Describe flip-flop pulse triggering.
  - Identify the purpose of a master slave flip-flop.
  - Recognize master slave flip-flop circuits.
  - Predict the outputs of a master-slave flip-flop.
  - Probe the inputs and outputs of a master-slave flip-flop.
  - Recognize normal operation of a master-slave flip-flop.
- 5021-718-910 Flip-Flop Circuits Post-Test (Theory) . . . . . ---
- 5021-718-920 Flip-Flop Circuits Post-Test (Theory) . . . . . ---

#### **Register Memory Circuits**

- 5021-720-130 Introduction to Registers and Memory . . . . . ---
- Describe the terms data, bit, and byte.
  - Describe serial data transfer.
  - Describe parallel data transfer.
  - Identify the purpose of a register.
  - Describe storage and shift registers.
- 5021-720-160 4-Bit Storage Register . . . . . 111, 118
- Identify the purpose of a 4-bit storage register.
  - Recognize 4-bit storage register circuits.
  - Predict the outputs of a 4-bit storage register.
  - Probe the inputs and outputs of a 4-bit storage register.
  - Recognize normal operation of a 4-bit storage register.
- 5021-720-190 4-Bit Shift Register . . . . . 111, 119
- Identify the purpose of a 4-bit shift register.
  - Describe right and left shifts.
  - Recognize 4-bit shift register circuits.
  - Predict outputs of a 4-bit shift register.
  - Probe the inputs and outputs of a 4-bit shift register.
  - Recognize normal operation of a 4-bit shift register.
- 5021-720-220 8-Bit Shift Register . . . . . 111, 127
- Identify the purpose of an 8-bit shift register.
  - Describe synchronous and asynchronous data transfer.
  - Recognize 8-bit shift register circuits.
  - Predict outputs of an 8-bit shift register.
  - Probe the inputs and outputs of an 8-bit shift register.
  - Recognize normal synchronous and asynchronous operation of an 8-bit shift register.
- 5021-720-250 64-Bit Memory Circuit . . . . . 111, 126
- Identify the purpose of a 64-bit memory circuit.
  - Describe word, address, read, write, RAM, ROM, volatile, and nonvolatile.
  - Recognize 64-bit memory circuits.
  - Predict outputs of a 64-bit memory circuit.
  - Probe the outputs of a 64-bit memory circuit.



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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Register Memory Circuits (cont.)**

5021-720-250 64-Bit Memory Circuit (cont.)

- Recognize normal operation of a 64-bit memory circuit.

5021-720-910 Register Memory Circuits Post-Test (Theory) ..... ---

5021-720-920 Register Memory Circuits Post-Test (Theory) ..... ---

#### **Arithmetic Counting Circuits**

5021-722-130 Introduction to Arithmetic Counting Circuits ..... ---

- Identify the purpose of a counter.
- Describe modulus.
- Recognize basic synchronous and asynchronous counter circuits.
- Describe how a counter divides and is used as a timing circuit.
- Identify the purpose of an adder.
- Describe how adders are used in addition, multiplication, subtraction, and division.

5021-722-160 Ripple Counter ..... 111, 116

- Identify the purpose of a ripple counter.
- Describe a basic ripple counter circuit.
- Recognize ripple counter circuits with different moduli.
- Predict the outputs of a ripple counter.
- Probe the outputs of a ripple counter.
- Recognize normal operation of a ripple counter.

5021-722-190 Up Counter ..... 111, 131

- Identify the purpose of an up counter.
- Describe a basic up counter circuit.
- Recognize free run and single step circuits of an up counter.
- Predict the outputs of an up counter.
- Probe the outputs of an up counter.
- Recognize normal operation of an up counter.

5021-722-220 Down Counter ..... 111, 132

- Identify the purpose of a down counter.
- Describe a basic down counter circuit.
- Recognize free run and single step circuits of a down counter.
- Predict the outputs of a down counter.
- Probe the outputs of a down counter.
- Recognize normal operation of a down counter.

5021-722-250 4-Bit Adder ..... 111, 121

- Identify the purpose of a 4-bit adder.
- Describe adder circuits.
- Recognize serial and parallel full adder circuits.
- Predict the outputs of a 4-bit adder.
- Probe the outputs of a 4-bit adder.
- Recognize normal operation of a 4-bit adder.

5021-722-280 4-Bit Subtractor ..... 111, 122

- Identify the purpose of a 4-bit subtractor.
- Describe two's complement.
- Recognize serial and parallel full subtractor circuits.
- Predict the outputs of a 4-bit subtractor.
- Probe the outputs of a 4-bit subtractor.

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### **DIGITAL CIRCUITS (MODEL 1404) (cont.)**

#### **Arithmetic Counting Circuits (cont.)**

5021-722-280 4-Bit Subtractor (cont.)

- Recognize normal operation of a 4-bit subtractor.

5021-722-910 Arithmetic Counting Circuits Post-Test (Theory) . . . . . ---

5021-722-920 Arithmetic Counting Circuits Post-Test (Theory) . . . . . ---

#### **Conversion and Data Circuits**

5021-724-130 Introduction to Conversion and Data Circuits . . . . . ---

- Identify the purpose of conversion circuits.
- Recognize basic A/D and D/A circuits.
- Identify the purpose of data circuits.
- Recognize basic data selector and data distributor circuits.

5021-724-160 D/A Conversion . . . . . 111, 136

- Identify the purpose of D/A conversion circuits.
- Recognize binary weighted D/A converter circuits.
- Recognize R/2R ladder D/A converter circuits and describe resolution.
- Predict the outputs of an R/2R ladder D/A converter.
- Measure the outputs of an R/2R ladder D/A converter.
- Recognize normal operation of an R/2R ladder D/A converter.

5021-724-190 Data Selector Circuits . . . . . 112, 133

- Identify the purpose of data selector circuits.
- Recognize data selector circuits.
- Predict the outputs of a data selector circuit.
- Measure the outputs of a data selector circuit.
- Recognize normal operation of a data selector circuit.

5021-724-220 Data Distributor Circuits . . . . . 112, 133, 134

- Identify the purpose of data distributor circuits.
- Recognize data distributor circuits.
- Predict the outputs of a data distributor circuit.
- Measure the outputs of a data distributor circuit.
- Recognize normal operation of a data distributor circuit.

5021-724-920 Conversion and Data Circuits Post-Test (Theory) . . . . . ---

#### **Troubleshooting**

5021-726-130 Troubleshooting Digital Systems . . . . . ---

- Understand a basic troubleshooting method for ICs.
- Identify common internal digital IC faults and their symptoms.
- Identify common external digital IC faults and their symptoms.
- Understand basic procedures used to troubleshoot digital systems.

### **DIGITAL CIRCUITS - CORE (MODEL 2105T)**

#### **Introduction to Digital Circuits**

5022-712-130 Introduction to Digital Electronics . . . . . 2404

- Identify developments of digital electronics.
- Describe the growth of computing equipment.
- Identify uses of digital electronics.
- Describe input and output conditions for digital circuits.
- Identify the AND, OR, and NOT functions.

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### **DIGITAL CIRCUITS - CORE (MODEL 2105T) (cont.)**

#### **Introduction to Digital Circuits (cont.)**

5022-712-130 Introduction to Digital Electronics (cont.)

- Recognize the digital truth table.
- Recognize the AND, OR, and NOT Boolean equations.
- Observe the operation of various digital gates.
- Read a truth table.
- Recognize HIGH and LOW outputs.

5022-712-160 Digital Electronics Hardware ..... ---

- Define integrated circuit.
- Identify three forms of integrated circuit packaging.
- Identify markings associated with integrated circuits.
- Identify integrated circuit functions.
- Describe the purpose of a data book.

5022-712-190 Digital Test Equipment ..... 2402

- Describe the purpose of a clock generator circuit.
- Identify the signals produced by the clock generator.
- Identify the basic components of a clock generator.
- Describe the purpose of a logic probe.
- Describe basic operation of a logic probe.
- Operate a simple clock generator circuit.
- Operate a logic probe.

5022-712-910 ..... ---

#### **Digital Logic Functions**

5022-714-130 Buffers and Inverters ..... 2402

- Describe the purpose of a buffer.
- Describe the purpose of an inverter.
- Describe input threshold voltages.
- Describe output threshold voltages.
- Measure threshold voltages.

5022-714-160 AND Gates ..... 2404

- Identify AND operation.
- Identify AND logic symbols.
- Identify AND logic schematic representation.
- Construct an AND gate truth table.
- Identify input and output waveforms.
- Measure input and output waveforms.

5022-714-190 OR Gates ..... 2404

- Identify OR operation and logic symbols.
- Construct an OR gate truth table.
- Identify input and output waveforms.
- Measure input and output waveforms.

5022-714-220 NAND Gates ..... 2404

- Identify NAND operation.
- Identify NAND logic symbols.
- Identify NAND logic schematic representation.
- Construct a NAND gate truth table.
- Identify input and output waveforms.

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### **DIGITAL CIRCUITS - CORE (MODEL 2105T) (cont.)**

#### **Digital Logic Functions (cont.)**

5022-714-220 NAND Gates (cont.)

- Measure input and output waveforms.

5022-714-250 NOR Gates ..... 2404

- Identify NOR operation.
- Identify NOR logic symbols.
- Identify NOR logic schematic representation.
- Construct a NOR gate truth table.
- Identify input and output waveforms.
- Measure input and output waveforms.

5022-714-280 XOR and XNOR Gates ..... 2406

- Identify XOR and XNOR operation.
- Identify XOR and XNOR logic symbols.
- Identify XOR and XNOR logic schematic representation.
- Construct truth tables for XOR and XNOR gates.
- Identify input and output waveforms of XOR and XNOR gates.
- Measure the input and output waveforms of an XOR gate and an XNOR gate.

5022-714-910 ..... ---

#### **Combinational Logic Circuits**

5022-716-130 Introduction to Combinational Circuits ..... ---

- Define combinational logic.
- Describe the uses of combinational logic.
- Trace inputs through a combinational logic circuit.
- Describe the universal property of the NAND gate.
- Describe the universal property of the NOR gate.

5022-716-160 Logic Families ..... ---

- Describe TTL logic.
- Identify supply voltage.
- Define fan-in and fan-out.
- Define propagation delay.
- Describe CMOS logic.
- Describe ECL logic.
- Describe IIL logic.

5022-716-190 Number Systems ..... ---

- Recognize the decimal number system.
- Recognize the binary number system.
- Recognize the octal number system.
- Recognize the hexadecimal number system.
- Convert decimal numbers to binary numbers.
- Convert binary numbers to decimal numbers.
- Convert octal numbers to binary numbers.
- Convert hexadecimal numbers to binary numbers.
- Add binary numbers.
- Subtract binary numbers.
- Multiply binary numbers.
- Divide binary numbers.

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### **DIGITAL CIRCUITS - CORE (MODEL 2105T) (cont.)**

#### **Combinational Logic Circuits (cont.)**

- 5022-716-220 Base 10 to Binary Conversion ..... 2416
- Identify the purpose of a decimal encoder.
  - Identify a decimal-to-binary encoder circuit.
  - Predict the outputs of a decimal encoder.
  - Probe the outputs of a decimal encoder.
  - Recognize normal operation of a decimal encoder.
- 5022-716-250 Binary to Decimal Conversion ..... 2418, 2420
- Identify the purpose of a binary decoder.
  - Describe a seven segment display.
  - Describe a binary to LED decimal decoder circuit.
  - Describe a binary to decimal seven segment decoder circuit.
  - Predict the inputs and outputs of a BCD to discrete decimal decoder.
  - Examine the inputs and outputs of a BCD to discrete decimal decoder.
  - Recognize normal operation of a BCD to discrete decimal decoder.
  - Predict the inputs and outputs of a BCD to 7 segment decoder.
  - Examine the inputs and outputs of a BCD to 7 segment decoder.
  - Recognize normal operation of a BCD to 7 segment decoder.
- 5022-716-910 ..... ---

#### **Flip-Flop Circuits**

- 5022-718-130 Introduction to Latches and Flip-Flops ..... ---
- Identify the difference between a sequential circuit and a combinational circuit.
  - Recognize SET and RESET conditions.
  - Understand basic flip-flop operation.
  - Describe the operation of RS and  $\sim R\sim S$  latches.
  - Identify the RS and  $\sim R\sim S$  latch truth tables.
  - Describe the race condition in the RS and  $\sim R\sim S$  latches.
- 5022-718-160 RS Flip-Flops ..... 2408
- Identify the purpose of an RS flip-flop.
  - Describe an RS flip-flop circuit.
  - Predict the outputs of the RS and  $\sim R\sim S$  flip-flop.
  - Verify the inputs and outputs of the RS and  $\sim R\sim S$  flip-flops.
  - Understand the basic principles of the RS and  $\sim R\sim S$  flip-flops.
- 5022-718-250 JK Flip-Flops ..... 2410
- Describe the JK flip-flop symbol and truth table.
  - Explain the operation of a JK flip-flop.
  - Develop a timing diagram for a JK flip-flop.
  - Predict the inputs and outputs of a JK flip-flop.
  - Probe inputs and outputs of a JK flip-flop.
  - Recognize outputs of a JK flip-flop.
- 5022-718-910 ..... ---

#### **Register Memory Circuits**

- 5022-720-130 Introduction to Registers and Memory ..... ---
- Describe the terms data, bit, and byte.
  - Describe serial data transfer.
  - Describe parallel data transfer.
  - Identify the purpose of a register.

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### **DIGITAL CIRCUITS - CORE (MODEL 2105T) (cont.)**

#### **Register Memory Circuits (cont.)**

5022-720-130 Introduction to Registers and Memory (cont.)	
▪ Describe storage and shift registers.	
5022-720-160 Serial Shift Registers . . . . .	2422
▪ Identify the purpose of a 4-bit shift register.	
▪ Recognize 4-bit shift register circuits.	
▪ Predict the output of a serial shift register.	
▪ Examine inputs and outputs of a serial shift register.	
▪ Recognize normal operation of a serial shift register.	
5022-720-190 Parallel Shift Registers . . . . .	2422
▪ Identify the purpose of a 4-bit shift register.	
▪ Describe shift right and shift left.	
▪ Recognize 4-bit shift register circuits.	
▪ Predict the output of a parallel shift register.	
▪ Probe the inputs and outputs of a parallel shift register.	
▪ Recognize normal operation of a parallel shift register.	
5022-720-910 . . . . .	---

#### **Arithmetic Counting Circuits**

5022-722-130 Introduction to Arithmetic Counting Circuits . . . . .	---
▪ Identify the purpose of a counter.	
▪ Describe modulus.	
▪ Recognize basic synchronous and asynchronous counter circuits.	
▪ Describe how a counter divides and is used as a timing circuit.	
▪ Identify the purpose of an adder.	
▪ Describe how adders are used in addition, multiplication, subtraction, and division.	
5022-722-160 Ripple Counter . . . . .	2414
▪ Identify the purpose of a ripple counter.	
▪ Describe a basic ripple counter circuit.	
▪ Recognize ripple counter circuits with different moduli.	
▪ Predict the inputs and outputs of ripple and decade counters.	
▪ Probe the inputs and outputs of ripple and decade counters.	
▪ Recognize normal operation of ripple and decade counters.	
5022-722-190 Up Counter . . . . .	2412
▪ Identify the purpose of an up counter.	
▪ Describe a basic up counter circuit.	
▪ Recognize free run and single step circuits of an up counter.	
▪ Understand the operation of the up counter.	
▪ Predict the inputs and outputs of the up counter.	
5022-722-910 . . . . .	---

### **DIGITAL CIRCUITS (MODEL 2105)**

#### **Introduction to Digital Circuits**

5022-712-130 Introduction to Digital Electronics . . . . .	2404
▪ Identify developments of digital electronics.	
▪ Describe the growth of computing equipment.	
▪ Identify uses of digital electronics.	

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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Introduction to Digital Circuits (cont.)**

5022-712-130 Introduction to Digital Electronics (cont.)

- Describe input and output conditions for digital circuits.
- Identify the AND, OR, and NOT functions.
- Recognize the digital truth table.
- Recognize the AND, OR, and NOT Boolean equations.
- Observe the operation of various digital gates.
- Read a truth table.
- Recognize HIGH and LOW outputs.

5022-712-160 Digital Electronics Hardware ..... ---

- Define integrated circuit.
- Identify three forms of integrated circuit packaging.
- Identify markings associated with integrated circuits.
- Identify integrated circuit functions.
- Describe the purpose of a data book.

5022-712-190 Digital Test Equipment ..... 2402

- Describe the purpose of a clock generator circuit.
- Identify the signals produced by the clock generator.
- Identify the basic components of a clock generator.
- Describe the purpose of a logic probe.
- Describe basic operation of a logic probe.
- Operate a simple clock generator circuit.
- Operate a logic probe.

5022-712-220 Introduction to Integrated Circuits ..... ---

- Identify the different IC construction classifications.
- Identify integration classifications.
- Explain the construction of a basic IC.
- Understand the various IC packaging arrays.
- Identify basic IC packaging materials.
- Identify various integrated components.
- Interpret basic IC numbers.
- Locate information on an IC using an IC data book.

5022-712-920 Introduction to Digital Circuits Post-Test (Theory) ..... ---

#### **Digital Logic Functions**

5022-714-130 Buffers and Inverters ..... 2402

- Describe the purpose of a buffer.
- Describe the purpose of an inverter.
- Describe input threshold voltages.
- Describe output threshold voltages.
- Measure threshold voltages.

5022-714-160 AND Gates ..... 2404

- Identify AND operation.
- Identify AND logic symbols.
- Identify AND logic schematic representation.
- Construct an AND gate truth table.
- Identify input and output waveforms.
- Measure input and output waveforms.

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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Digital Logic Functions (cont.)**

5022-714-190 OR Gates . . . . .	2404
<ul style="list-style-type: none"> <li>▪ Identify OR operation and logic symbols.</li> <li>▪ Construct an OR gate truth table.</li> <li>▪ Identify input and output waveforms.</li> <li>▪ Measure input and output waveforms.</li> </ul>	
5022-714-220 NAND Gates . . . . .	2404
<ul style="list-style-type: none"> <li>▪ Identify NAND operation.</li> <li>▪ Identify NAND logic symbols.</li> <li>▪ Identify NAND logic schematic representation.</li> <li>▪ Construct a NAND gate truth table.</li> <li>▪ Identify input and output waveforms.</li> <li>▪ Measure input and output waveforms.</li> </ul>	
5022-714-250 NOR Gates . . . . .	2404
<ul style="list-style-type: none"> <li>▪ Identify NOR operation.</li> <li>▪ Identify NOR logic symbols.</li> <li>▪ Identify NOR logic schematic representation.</li> <li>▪ Construct a NOR gate truth table.</li> <li>▪ Identify input and output waveforms.</li> <li>▪ Measure input and output waveforms.</li> </ul>	
5022-714-280 XOR and XNOR Gates . . . . .	2406
<ul style="list-style-type: none"> <li>▪ Identify XOR and XNOR operation.</li> <li>▪ Identify XOR and XNOR logic symbols.</li> <li>▪ Identify XOR and XNOR logic schematic representation.</li> <li>▪ Construct truth tables for XOR and XNOR gates.</li> <li>▪ Identify input and output waveforms of XOR and XNOR gates.</li> <li>▪ Measure the input and output waveforms of an XOR gate and an XNOR gate.</li> </ul>	
5022-714-310 Digital and Analog Switches . . . . .	2424
<ul style="list-style-type: none"> <li>▪ Compare the digital and analog switch to other switching methods.</li> <li>▪ Discuss the theory of digital and analog switch operation.</li> <li>▪ Identify the operation parameters of the digital and analog switch.</li> <li>▪ Analyze the digital and analog switch in SPST, SPDT, DPST, and DPDT configurations.</li> <li>▪ Review practical applications for the digital and analog switch.</li> <li>▪ Reinforce the operation of digital and analog switches through experimentation.</li> <li>▪ Probe and confirm all test points in the digital and analog switch circuit.</li> <li>▪ Troubleshoot the digital and analog switch circuit.</li> </ul>	
5022-714-920 Digital Logic Circuits Post-Test (Theory) . . . . .	---

#### **Combinational Logic Circuits**

5022-716-130 Introduction to Combinational Circuits . . . . .	---
<ul style="list-style-type: none"> <li>▪ Define combinational logic.</li> <li>▪ Describe the uses of combinational logic.</li> <li>▪ Trace inputs through a combinational logic circuit.</li> <li>▪ Describe the universal property of the NAND gate.</li> <li>▪ Describe the universal property of the NOR gate.</li> </ul>	
5022-716-160 Logic Families . . . . .	---
<ul style="list-style-type: none"> <li>▪ Describe TTL logic.</li> <li>▪ Identify supply voltage.</li> </ul>	



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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Combinational Logic Circuits (cont.)**

5022-716-160 Logic Families (cont.)

- Define fan-in and fan-out.
- Define propagation delay.
- Describe CMOS logic.
- Describe ECL logic.
- Describe IIL logic.

5022-716-190 Number Systems . . . . . ---

- Recognize the decimal number system.
- Recognize the binary number system.
- Recognize the octal number system.
- Recognize the hexadecimal number system.
- Convert decimal numbers to binary numbers.
- Convert binary numbers to decimal numbers.
- Convert octal numbers to binary numbers.
- Convert hexadecimal numbers to binary numbers.
- Add binary numbers.
- Subtract binary numbers.
- Multiply binary numbers.
- Divide binary numbers.

5022-716-220 Base 10 to Binary Conversion . . . . . 2416

- Identify the purpose of a decimal encoder.
- Identify a decimal-to-binary encoder circuit.
- Predict the outputs of a decimal encoder.
- Probe the outputs of a decimal encoder.
- Recognize normal operation of a decimal encoder.

5022-716-250 Binary to Decimal Conversion . . . . . 2418, 2420

- Identify the purpose of a binary decoder.
- Describe a seven segment display.
- Describe a binary to LED decimal decoder circuit.
- Describe a binary to decimal seven segment decoder circuit.
- Predict the inputs and outputs of a BCD to discrete decimal decoder.
- Examine the inputs and outputs of a BCD to discrete decimal decoder.
- Recognize normal operation of a BCD to discrete decimal decoder.
- Predict the inputs and outputs of a BCD to 7 segment decoder.
- Examine the inputs and outputs of a BCD to 7 segment decoder.
- Recognize normal operation of a BCD to 7 segment decoder.

5022-716-920 Combinational Logic Circuits Post-Test (Theory) . . . . . ---

#### **Flip-Flop Circuits**

5022-718-130 Introduction to Latches and Flip-Flops . . . . . ---

- Identify the difference between a sequential circuit and a combinational circuit.
- Recognize SET and RESET conditions.
- Understand basic flip-flop operation.
- Describe the operation of RS and  $\sim R\sim S$  latches.
- Identify the RS and  $\sim R\sim S$  latch truth tables.
- Describe the race condition in the RS and  $\sim R\sim S$  latches.

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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Flip-Flop Circuits (cont.)**

5022-718-160 RS Flip-Flops . . . . .	2408
<ul style="list-style-type: none"><li>▪ Identify the purpose of an RS flip-flop.</li><li>▪ Describe an RS flip-flop circuit.</li><li>▪ Predict the outputs of the RS and <math>\sim R\sim S</math> flip-flop.</li><li>▪ Verify the inputs and outputs of the RS and <math>\sim R\sim S</math> flip-flops.</li><li>▪ Understand the basic principles of the RS and <math>\sim R\sim S</math> flip-flops.</li></ul>	
5022-718-220 D-Type Flip-Flops . . . . .	2410
<ul style="list-style-type: none"><li>▪ Identify the purpose of a D-type flip-flop.</li><li>▪ Describe a D-type flip-flop circuit.</li><li>▪ Predict inputs and outputs of a D-type flip-flop.</li><li>▪ Probe the inputs and outputs of a D-type flip-flop.</li><li>▪ Recognize outputs of a D-type flip-flop.</li></ul>	
5022-718-250 JK Flip-Flops . . . . .	2410
<ul style="list-style-type: none"><li>▪ Describe the JK flip-flop symbol and truth table.</li><li>▪ Explain the operation of a JK flip-flop.</li><li>▪ Develop a timing diagram for a JK flip-flop.</li><li>▪ Predict the inputs and outputs of a JK flip-flop.</li><li>▪ Probe inputs and outputs of a JK flip-flop.</li><li>▪ Recognize outputs of a JK flip-flop.</li></ul>	
5022-718-920 Flip-Flop Circuits Post-Test (Theory) . . . . .	---

#### **Register Memory Circuits**

5022-720-130 Introduction to Registers and Memory . . . . .	---
<ul style="list-style-type: none"><li>▪ Describe the terms data, bit, and byte.</li><li>▪ Describe serial data transfer.</li><li>▪ Describe parallel data transfer.</li><li>▪ Identify the purpose of a register.</li><li>▪ Describe storage and shift registers.</li></ul>	
5022-720-160 Serial Shift Registers . . . . .	2422
<ul style="list-style-type: none"><li>▪ Identify the purpose of a 4-bit shift register.</li><li>▪ Recognize 4-bit shift register circuits.</li><li>▪ Predict the output of a serial shift register.</li><li>▪ Examine inputs and outputs of a serial shift register.</li><li>▪ Recognize normal operation of a serial shift register.</li></ul>	
5022-720-190 Parallel Shift Registers . . . . .	2422
<ul style="list-style-type: none"><li>▪ Identify the purpose of a 4-bit shift register.</li><li>▪ Describe shift right and shift left.</li><li>▪ Recognize 4-bit shift register circuits.</li><li>▪ Predict the output of a parallel shift register.</li><li>▪ Probe the inputs and outputs of a parallel shift register.</li><li>▪ Recognize normal operation of a parallel shift register.</li></ul>	
5022-720-220 64-Bit Memory Circuit . . . . .	2428
<ul style="list-style-type: none"><li>▪ Identify the purpose of a 64-bit memory circuit.</li><li>▪ Define terms as they apply to memory circuits: word, address, read, write, RAM, ROM, volatile, and nonvolatile.</li><li>▪ Recognize 64-bit memory circuits.</li><li>▪ Reinforce the understanding of memory operation through experimentation.</li></ul>	

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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Register Memory Circuits (cont.)**

5022-720-220 64-Bit Memory Circuit (cont.)

- Probe all test points in the memory circuit.
- Troubleshoot the memory circuit.

5022-720-920 Register Memory Circuits Post-Test (Theory) . . . . . ---

#### **Arithmetic Counting Circuits**

5022-722-130 Introduction to Arithmetic Counting Circuits . . . . . ---

- Identify the purpose of a counter.
- Describe modulus.
- Recognize basic synchronous and asynchronous counter circuits.
- Describe how a counter divides and is used as a timing circuit.
- Identify the purpose of an adder.
- Describe how adders are used in addition, multiplication, subtraction, and division.

5022-722-160 Ripple Counter . . . . . 2414

- Identify the purpose of a ripple counter.
- Describe a basic ripple counter circuit.
- Recognize ripple counter circuits with different moduli.
- Predict the inputs and outputs of ripple and decade counters.
- Probe the inputs and outputs of ripple and decade counters.
- Recognize normal operation of ripple and decade counters.

5022-722-190 Up Counter . . . . . 2412

- Identify the purpose of an up counter.
- Describe a basic up counter circuit.
- Recognize free run and single step circuits of an up counter.
- Understand the operation of the up counter.
- Predict the inputs and outputs of the up counter.

5022-722-220 Down Counter . . . . . 2412

- Identify the purpose of a down counter.
- Describe a basic down counter circuit.
- Recognize free run and single step circuits of a down counter.
- Predict the inputs and outputs of a down counter.
- Recognize normal operation of a down counter.

5022-722-250 4-Bit Adder . . . . . 2426

- Identify the purpose of a 4-bit adder.
- Describe adder circuits.
- Recognize serial and parallel full adder circuits.
- Recognize the normal operation of the 4-bit adder circuit.
- Predict the output of the 4-bit adder.
- Confirm the output of the 4-bit adder circuit.

5022-722-280 4-Bit Subtractor . . . . . 2426

- Identify the purpose of a 4-bit subtractor.
- Describe two's complement.
- Recognize serial and parallel full subtractor circuits.
- Predict the outputs of a 4-bit subtractor circuit.
- Probe the outputs of a 4-bit subtractor circuit.
- Recognize normal operation of a 4-bit subtractor circuit.

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### **DIGITAL CIRCUITS (MODEL 2105) (cont.)**

#### **Arithmetic Counting Circuits (cont.)**

5022-722-920 Arithmetic Counting Circuits Post-Test (Theory) . . . . . ---

#### **Conversion and Data Circuits**

5022-724-130 Introduction to Conversion and Data Circuits . . . . . ---

- Identify the purpose of conversion circuits.
- Recognize basic A/D and D/A circuits.
- Identify the purpose of data circuits.
- Recognize basic data selector and data distributor circuits.

5022-724-160 D/A Conversion . . . . . 2430, 2432

- Identify the D/A conversion process.
- Understand tri-state device functions.
- Analyze an 8-bit D/A circuit.
- Observe operation of an 8-bit D/A circuit.
- Observe operation of an A/D - D/A circuit.
- Troubleshoot an A/D - D/A circuit.

5022-724-190 A/D Conversion . . . . . 2432

- Identify the A/D conversion process.
- Analyze 8-bit A/D circuitry.
- Troubleshoot the A/D circuit.

5022-724-920 Conversion and Data Circuits Post-Test (Theory) . . . . . ---

### **DIGITAL CIRCUITS (MODEL 2404)**

#### **Introduction to Digital Circuits**

5021-712-130 Introduction to Digital Electronics . . . . . 101

- Identify developments of digital electronics.
- Describe the growth of computing equipment.
- Identify uses of digital electronics.
- Describe input and output conditions for digital circuits.
- Identify the AND, OR, and NOT functions.
- Recognize the digital truth table.
- Recognize the AND, OR, and NOT Boolean equations.
- Observe the operation of various digital gates.
- Read a truth table.
- Recognize HIGH and LOW outputs.

5021-712-160 Digital Electronics Hardware . . . . . ---

- Define integrated circuit.
- Identify three forms of integrated circuit packaging.
- Identify markings associated with integrated circuits.
- Identify integrated circuit functions.
- Describe the purpose of a data book.

5021-712-190 Buffers and Inverters . . . . . 106

- Describe the purpose of a buffer.
- Describe the purpose of an inverter.
- Describe input threshold voltages.
- Describe output threshold voltages.
- Measure threshold voltages.

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Introduction to Digital Circuits (cont.)**

5021-712-220 Digital Test Equipment .....	112
▪ Describe the purpose of a clock generator circuit.	
▪ Identify the signals produced by the clock generator.	
▪ Identify the basic components of a clock generator.	
▪ Describe the purpose of a logic probe.	
▪ Describe basic operation of a logic probe.	
▪ Operate a simple clock generator circuit.	
▪ Operate a logic probe.	
5021-712-250 555 Timer .....	153
▪ Describe the purpose of the 555 timer.	
▪ Describe the internal operation of the 555 timer.	
▪ Describe the operation of a 555 timer used as an astable multivibrator.	
▪ Describe the operation of a 555 timer used as a monostable multivibrator.	
▪ Observe the operation of a 555 timer circuit.	
▪ Operate a 555 timer in astable and monostable multivibrator configurations.	
5021-712-280 Introduction to Integrated Circuits .....	---
▪ Identify the different IC construction classifications.	
▪ Identify integration classifications.	
▪ Explain the construction of a basic IC.	
▪ Understand the various IC packaging arrays.	
▪ Identify basic IC packaging materials.	
▪ Identify various integrated components.	
▪ Interpret basic IC numbers.	
▪ Locate information on an IC using an IC data book.	
5022-712-921 Introduction to Digital Circuits Post-Test (Theory) .....	---

#### **Digital Logic Functions**

5021-714-130 AND Gates .....	102, 112
▪ Identify AND operation.	
▪ Identify AND logic symbols.	
▪ Identify AND logic schematic representation.	
▪ Construct an AND gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-160 OR Gates .....	104, 112
▪ Identify OR operation.	
▪ Identify OR logic symbols.	
▪ Identify OR logic schematic representation.	
▪ Construct an OR gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-190 NOT Gates .....	106, 112
▪ Identify NOT operation.	
▪ Identify NOT logic symbols.	
▪ Identify NOT logic schematic representation.	
▪ Construct a NOT gate truth table.	
▪ Identify input and output waveforms.	

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Digital Logic Functions (cont.)**

5021-714-190 NOT Gates (cont.)	103, 112
▪ Measure input and output waveforms.	
5021-714-220 NAND Gates	103, 112
▪ Identify NAND operation.	
▪ Identify NAND logic symbols.	
▪ Identify NAND logic schematic representation.	
▪ Construct a NAND gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-250 NOR Gates	105, 112
▪ Identify NOR operation.	
▪ Identify NOR logic symbols.	
▪ Identify NOR logic schematic representation.	
▪ Construct a NOR gate truth table.	
▪ Identify input and output waveforms.	
▪ Measure input and output waveforms.	
5021-714-280 XOR and XNOR Gates	107, 112
▪ Identify XOR and XNOR operation.	
▪ Identify XOR and XNOR logic symbols.	
▪ Identify XOR and XNOR logic schematic representation.	
▪ Construct truth tables for XOR and XNOR gates.	
▪ Identify input and output waveforms of XOR and XNOR gates.	
▪ Measure the input and output waveforms of an XOR gate.	
5022-714-310 Digital and Analog Switches	2424
▪ Compare the digital and analog switch to other switching methods.	
▪ Discuss the theory of digital and analog switch operation.	
▪ Identify the operation parameters of the digital and analog switch.	
▪ Analyze the digital and analog switch in SPST, SPDT, DPST, and DPDT configurations.	
▪ Review practical applications for the digital and analog switch.	
▪ Reinforce the operation of digital and analog switches through experimentation.	
▪ Probe and confirm all test points in the digital and analog switch circuit.	
▪ Troubleshoot the digital and analog switch circuit.	
5021-714-310 Introduction to Logic Functions	---
▪ Identify AND operation.	
▪ Identify AND logic symbols.	
▪ Construct an AND gate truth table.	
▪ Identify input and output waveforms.	
▪ Identify OR operation.	
▪ Identify OR logic symbols.	
▪ Construct an OR gate truth table.	
▪ Identify input and output waveforms.	
5022-714-921 Digital Logic Circuits Post-Test (Theory)	---
<b><u>Combinational Logic Circuits</u></b>	
5021-716-130 Introduction to Combinational Circuits	103, 112
▪ Define combinational logic.	
▪ Describe the uses of combinational logic.	

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Combinational Logic Circuits (cont.)**

- 5021-716-130 Introduction to Combinational Circuits (cont.)
- Trace inputs through a combinational logic circuit.
  - Describe the universal property of the NAND gate.
  - Describe the universal property of the NOR gate.
  - Measure outputs in a combinational logic circuit.
  - Verify NAND gates performing AND, OR, and NOR functions.
- 5021-716-160 Logic Families ..... ---
- Describe TTL logic.
  - Identify supply voltage.
  - Define fan-in and fan-out.
  - Define propagation delay.
  - Describe CMOS logic.
  - Describe ECL logic.
  - Describe IIL logic.
- 5021-716-190 Number Systems ..... 111, 124
- Recognize the decimal number system.
  - Recognize the binary number system.
  - Recognize the octal number system.
  - Recognize the hexadecimal number system.
  - Convert decimal numbers to binary numbers.
  - Convert binary numbers to decimal numbers.
  - Convert octal numbers to binary numbers.
  - Convert hexadecimal numbers to binary numbers.
  - Add binary numbers.
  - Subtract binary numbers.
  - Multiply binary numbers.
  - Divide binary numbers.
  - Observe binary to octal conversion.
  - Observe binary to decimal conversion.
  - Observe binary to hexadecimal conversion.
- 5021-716-220 Base 10 to Binary Conversion ..... 108
- Identify the purpose of a decimal encoder.
  - Identify a decimal-to-binary encoder circuit.
  - Predict the outputs of a decimal encoder.
  - Probe the outputs of a decimal encoder.
  - Recognize normal operation of a decimal encoder.
- 5021-716-250 Binary to 7 Segment Conversion ..... 109
- Identify the purpose of a binary decoder.
  - Describe a seven segment display.
  - Describe a binary to decimal seven segment decoder circuit.
  - Predict the outputs of a binary decoder.
  - Probe the outputs of a binary decoder.
  - Recognize normal operation of a binary decoder.
- 5021-716-280 4-Bit Comparator ..... 110
- Identify the purpose of a comparator.
  - Describe a comparator circuit.

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Combinational Logic Circuits (cont.)**

5021-716-280 4-Bit Comparator (cont.)

- Apply binary codes to a 4-bit comparator.
- Measure outputs from a 4-bit comparator.

5022-716-921 Combinational Logic Circuits Post-Test (Theory) . . . . . ---

#### **Flip-Flop Circuits**

5021-718-130 Introduction to Latches and Flip-Flops . . . . . ---

- Identify the difference between a sequential circuit and a combinational circuit.
- Recognize SET and RESET conditions.
- Understand basic flip-flop operation.
- Describe the operation of RS and  $\sim R\sim S$  latches.
- Identify the RS and  $\sim R\sim S$  latch truth tables.
- Describe the race condition in the RS and  $\sim R\sim S$  latches.

5021-718-160 RS Flip-Flops . . . . . 113

- Identify the purpose of an RS flip-flop.
- Describe an RS flip-flop circuit.
- Predict the outputs of an RS flip-flop.
- Probe the inputs and outputs of an RS flip-flop.
- Recognize normal operation of an RS flip-flop.

5021-718-190 Clocked RS Flip-Flops . . . . . 111, 128

- Identify the purpose of a clocked RS flip-flop.
- Describe a clocked RS flip-flop circuit.
- Predict outputs of an RS flip-flop.
- Probe the inputs and outputs of a clocked RS flip-flop.
- Recognize normal operations of a clocked RS flip-flop.

5021-718-220 D-Type Flip-Flops . . . . . 111, 114

- Identify the purpose of a D-type flip-flop.
- Describe a D-type flip-flop circuit.
- Predict inputs and outputs of a D-type flip-flop.
- Probe the normal operation of a D-type flip-flop.
- Recognize outputs of a D-type flip-flop.

5021-718-250 JK Flip-Flops . . . . . 111, 115

- Describe the JK flip-flop symbol and truth table.
- Explain the operation of a JK flip-flop.
- Develop a timing diagram for a JK flip-flop.
- Predict the output of a JK flip-flop.
- Probe inputs and outputs of a JK flip-flop.
- Recognize normal operation of a JK flip-flop.

5021-718-280 Master-Slave Flip-Flops . . . . . 111, 137

- Describe flip-flop level triggering.
- Describe flip-flop edge triggering.
- Describe flip-flop pulse triggering.
- Identify the purpose of a master slave flip-flop.
- Recognize master slave flip-flop circuits.
- Predict the outputs of a master-slave flip-flop.
- Probe the inputs and outputs of a master-slave flip-flop.
- Recognize normal operation of a master-slave flip-flop.



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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Flip-Flop Circuits (cont.)**

5022-718-921 Flip-Flop Circuits Post-Test (Theory) . . . . . ---

#### **Register Memory Circuits**

5021-720-130 Introduction to Registers and Memory . . . . . ---

- Describe the terms data, bit, and byte.
- Describe serial data transfer.
- Describe parallel data transfer.
- Identify the purpose of a register.
- Describe storage and shift registers.

5021-720-160 4-Bit Storage Register . . . . . 111, 118

- Identify the purpose of a 4-bit storage register.
- Recognize 4-bit storage register circuits.
- Predict the outputs of a 4-bit storage register.
- Probe the inputs and outputs of a 4-bit storage register.
- Recognize normal operation of a 4-bit storage register.

5022-720-160 Serial Shift Registers . . . . . 2422

- Identify the purpose of a 4-bit shift register.
- Recognize 4-bit shift register circuits.
- Predict the output of a serial shift register.
- Examine inputs and outputs of a serial shift register.
- Recognize normal operation of a serial shift register.

5022-720-190 Parallel Shift Registers . . . . . 2422

- Identify the purpose of a 4-bit shift register.
- Describe shift right and shift left.
- Recognize 4-bit shift register circuits.
- Predict the output of a parallel shift register.
- Probe the inputs and outputs of a parallel shift register.
- Recognize normal operation of a parallel shift register.

5022-720-220 64-Bit Memory Circuit . . . . . 2428

- Identify the purpose of a 64-bit memory circuit.
- Define terms as they apply to memory circuits: word, address, read, write, RAM, ROM, volatile, and nonvolatile.
- Recognize 64-bit memory circuits.
- Reinforce the understanding of memory operation through experimentation.
- Probe all test points in the memory circuit.
- Troubleshoot the memory circuit.

5022-720-921 Register Memory Circuits Post-Test (Theory) . . . . . ---

#### **Arithmetic Counting Circuits**

5021-722-130 Introduction to Arithmetic Counting Circuits . . . . . ---

- Identify the purpose of a counter.
- Describe modulus.
- Recognize basic synchronous and asynchronous counter circuits.
- Describe how a counter divides and is used as a timing circuit.
- Identify the purpose of an adder.
- Describe how adders are used in addition, multiplication, subtraction, and division.

5021-722-160 Ripple Counter . . . . . 111, 116

- Identify the purpose of a ripple counter.

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Arithmetic Counting Circuits (cont.)**

- 5021-722-160 Ripple Counter (cont.)
- Describe a basic ripple counter circuit.
  - Recognize ripple counter circuits with different moduli.
  - Predict the outputs of a ripple counter.
  - Probe the outputs of a ripple counter.
  - Recognize normal operation of a ripple counter.
- 5021-722-190 Up Counter . . . . . 111, 131
- Identify the purpose of an up counter.
  - Describe a basic up counter circuit.
  - Recognize free run and single step circuits of an up counter.
  - Predict the outputs of an up counter.
  - Probe the outputs of an up counter.
  - Recognize normal operation of an up counter.
- 5021-722-220 Down Counter . . . . . 111, 132
- Identify the purpose of a down counter.
  - Describe a basic down counter circuit.
  - Recognize free run and single step circuits of a down counter.
  - Predict the outputs of a down counter.
  - Probe the outputs of a down counter.
  - Recognize normal operation of a down counter.
- 5021-722-250 4-Bit Adder . . . . . 111, 121
- Identify the purpose of a 4-bit adder.
  - Describe adder circuits.
  - Recognize serial and parallel full adder circuits.
  - Predict the outputs of a 4-bit adder.
  - Probe the outputs of a 4-bit adder.
  - Recognize normal operation of a 4-bit adder.
- 5021-722-280 4-Bit Subtractor . . . . . 111, 122
- Identify the purpose of a 4-bit subtractor.
  - Describe two's complement.
  - Recognize serial and parallel full subtractor circuits.
  - Predict the outputs of a 4-bit subtractor.
  - Probe the outputs of a 4-bit subtractor.
  - Recognize normal operation of a 4-bit subtractor.
- 5022-722-921 Arithmetic Counting Circuits Post-Test (Theory) . . . . . ---

#### **Conversion and Data Circuits**

- 5021-724-130 Introduction to Conversion and Data Circuits . . . . . ---
- Identify the purpose of conversion circuits.
  - Recognize basic A/D and D/A circuits.
  - Identify the purpose of data circuits.
  - Recognize basic data selector and data distributor circuits.
- 5022-724-160 D/A Conversion . . . . . 2430, 2432
- Identify the D/A conversion process.
  - Understand tri-state device functions.
  - Analyze an 8-bit D/A circuit.
  - Observe operation of an 8-bit D/A circuit.

## OBJECTIVE LISTING - HTML Lessons

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### **DIGITAL CIRCUITS (MODEL 2404) (cont.)**

#### **Conversion and Data Circuits (cont.)**

5022-724-160 D/A Conversion (cont.)

- Observe operation of an A/D - D/A circuit.
- Troubleshoot an A/D - D/A circuit.

5022-724-190 A/D Conversion ..... 2432

- Identify the A/D conversion process.
- Analyze 8-bit A/D circuitry.
- Troubleshoot the A/D circuit.

5021-724-190 Data Selector Circuits ..... 112, 133

- Identify the purpose of data selector circuits.
- Recognize data selector circuits.
- Predict the outputs of a data selector circuit.
- Measure the outputs of a data selector circuit.
- Recognize normal operation of a data selector circuit.

5021-724-220 Data Distributor Circuits ..... 112, 133, 134

- Identify the purpose of data distributor circuits.
- Recognize data distributor circuits.
- Predict the outputs of a data distributor circuit.
- Measure the outputs of a data distributor circuit.
- Recognize normal operation of a data distributor circuit.

5022-724-921 Conversion and Data Circuits Post-Test (Theory) ..... ---

#### **Troubleshooting**

5021-726-130 Troubleshooting Digital Systems ..... ---

- Understand a basic troubleshooting method for ICs.
- Identify common internal digital IC faults and their symptoms.
- Identify common external digital IC faults and their symptoms.
- Understand basic procedures used to troubleshoot digital systems.

### **WIRING (MODEL 1449)**

5021-214-130 PCB Component Insertion/Extraction Techniques ..... ---

- Identify the general characteristics of PC boards.
- Identify several connection methods used on PC boards.
- Identify the general techniques for inserting components into PC boards.
- Identify common faults which may occur when installing components on PC boards.
- Identify the general techniques for extracting components from PC boards.
- Identify general techniques for repairing PC board traces and pads.

5021-214-160 Basic Soldering Techniques ..... ---

- Identify different types of solder and flux.
- Select the correct soldering iron for a particular task.
- Know how to properly prepare a wire for soldering.
- Understand how to make a "Western Union" splice.
- Identify different types of wire terminals and their connection methods.
- Know how to make reliable solder connections.
- Understand how to correct poor solder connections.

5021-214-190 Basic Connector Termination Techniques ..... ---

- Identify standard wire gauges.

## OBJECTIVE LISTING - HTML Lessons

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### **WIRING (MODEL 1449) (cont.)**

- 5021-214-190 Basic Connector Termination Techniques (cont.)
- Identify types of wire and cable.
  - Understand how cables and wires are typically used
  - Understand basic connector termination techniques.
  - Understand the correct method of terminating banana plugs, crimp connectors and BNC connections.
  - Know which skills are required to make routine repairs to electronic equipment
- 5021-214-220 Basic Wire Wrapping Techniques . . . . . ---
- Understand wire wrapping terminology.
  - Identify common types of wire wraps.
  - Identify common wire wrap tools.
  - Recognize the characteristics of good wire wrap.
  - Understand the procedure for making good wire wrap connections.
  - Recognize common wire wrapping faults.
- 5021-214-250 Basic Wiring and Connector Troubleshooting Theory . . . . . ---
- Follow a logical troubleshooting procedure
  - Describe open circuit measurements.
  - Describe short circuit measurements.
  - Describe changed value measurements.
  - Understand cable and connector labeling.
  - Describe how to make continuity checks of shielded and unshielded cables
- 5021-214-280 Wire Troubleshooting . . . . . W1, W2, W3
- Determine if a wire is open and identify which wire is open using continuity checks.
  - Determine if a wire is shorted and identify which wire is shorted using continuity checks.
  - Determine if a wiring circuit has a changed value and identify the component that has changed value using continuity checks.
  - Find an open and short using voltage and current measurements
- 5021-214-920 Wiring Post-Test (Theory) . . . . . ---

### **DC PERFORMANCE TESTS (MODEL 1451)**

#### **DC Circuits**

- 5021-114-960 Multimeter Use Post-Test (Performance) . . . . . 2W, 4AW
- Demonstrate the ability to properly set up a circuit and follow safety precautions
  - Demonstrate the ability to use a multimeter to measure voltage, current, and resistance.
- 5021-116-960 Basic DC Circuits Post-Test (Performance) . . . . . 9AW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a circuit is working properly using voltage, current, and resistance measurements.
  - Demonstrate the ability to troubleshoot a circuit using voltage, current, and resistance measurements.
- 5021-118-960 Complex DC Circuits Post-Test (Performance) . . . . . 9CW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a voltage divider circuit is working properly using voltage and resistance measurements.

## OBJECTIVE LISTING - HTML Lessons

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CARDS/KITS

### **DC PERFORMANCE TESTS (MODEL 1451) (cont.)**

#### **Wiring**

- 5021-214-960 Wiring Post-Test (Performance) . . . . . W1W, W2W, W3W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a wiring harness is working properly using voltage and resistance measurements.

### **AC PERFORMANCE TESTS (MODEL 1452)**

- 5020-314-960 AC Test Equipment Post-Test (Performance) . . . . . 10W, 804W
- Demonstrate the ability to properly set up a circuit and follow safety precautions
  - Demonstrate the ability to use an oscilloscope to make voltage and frequency measurements.
- 5021-316-960 Inductance and RL Circuits Post-Test (Performance) . . . . . 16BW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if an RL circuit is working properly using voltage measurements made using an oscilloscope.
- 5021-318-960 Capacitance and RC Circuits Post-Test (Performance) . . . . . 14AW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if an RC circuit is working properly using voltage measurements made using an oscilloscope.
- 5021-320-960 RC Time Constants and Transients Post-Test (Performance) . . . . . 14BW, 804W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to make charge time and period measurements in an RC circuit using an oscilloscope.
  - Demonstrate the ability to determine if an RC circuit is working properly using charge time and period measurements.
  - Demonstrate the ability to troubleshoot an RC circuit using voltage and frequency measurements.
- 5021-322-960 Resonance Post-Test (Performance) . . . . . 18AW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a resonant circuit is working properly using voltage and frequency measurements made with an oscilloscope.
  - Demonstrate the ability to troubleshoot a resonant circuit using voltage and frequency measurements.
- 5021-324-960 Transformers Post-Test (Performance) . . . . . 21W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a transformer circuit is working properly using voltage measurements made using a multimeter.
  - Demonstrate the ability to determine the type of transformer circuit (step up, step down, 1:1) using voltage measurements.
  - Demonstrate the ability to troubleshoot a transformer circuit using voltage measurements.

## OBJECTIVE LISTING - HTML Lessons

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CARDS/KITS

### **AC PERFORMANCE TESTS (MODEL 1452) (cont.)**

- 5021-326-960 Relays and Switches Post-Test (Performance) . . . . . 84BW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a relay logic circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a relay logic circuit using voltage measurements.

### **ANALOG PERFORMANCE TESTS (MODEL 1453)**

- 5021-514-960 Diodes and Diode Circuits Post-Test (Performance) . . . . . 22AW, 77AW, 77BW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a diode switching circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a diode switching circuit using voltage measurements.
  - Demonstrate the ability to troubleshoot a diode clamping circuit using voltage measurements.
  - Demonstrate the ability to troubleshoot a diode limiting circuit using voltage measurements.
- 5021-516-960 Transistor Circuits Post-Test (Performance) . . . . . 30AW, 31W, 32W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a common emitter amplifier is working properly using voltage measurements.
  - Demonstrate the ability to determine if a common collector amplifier is working properly using voltage measurements.
  - Demonstrate the ability to determine if a common base amplifier is working properly using voltage measurements.
- 5021-518-960 Power Supplies Post-Test (Performance) . . . . . 23W, 25W, 26W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a rectifier circuit is working properly using voltage measurements.
  - Demonstrate the ability to determine if a voltage regulator circuit is working properly using voltage measurements.
  - Demonstrate the ability to determine if a zener reference regulator circuit is working properly using voltage measurements.
- 5021-520-960 Transistor Amplifiers Post-Test (Performance) . . . . . 30AW, 31W, 32W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a three-stage transistor amplifier circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a three-stage transistor amplifier circuit using voltage measurements.
- 5021-522-960 Transistor Oscillators Post-Test (Performance) . . . . . 42W, 43AW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions

## OBJECTIVE LISTING - HTML Lessons

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CARDS/KITS

### **ANALOG PERFORMANCE TESTS (MODEL 1453) (cont.)**

- 5021-522-960 Transistor Oscillators Post-Test (Performance) (cont.)
- Demonstrate the ability to determine if a transistor oscillator circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a transistor oscillator circuit using voltage measurements.
- 5021-524-960 Transistor Pulse Circuits Post-Test (Performance) . . . . . 44W, 45W, 46W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a transistor pulse circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a transistor pulse circuit using voltage measurements.
- 5021-526-960 Trigger Device Circuits Post-Test (Performance) . . . . . 52AW, 52BW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a trigger device power control circuit is working properly using voltage measurements.
  - Demonstrate the ability to determine if a DC control circuit is working properly using voltage measurements.
- 5021-528-960 Operational Amplifiers Post-Test (Performance) . . . . . 54W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a summing/difference operational amplifier is working properly using voltage measurements.
  - Demonstrate the ability to determine if an inverting/non-inverting operational amplifier is working properly using voltage measurements.
- 5021-530-960 RF Electronics Post-Test (Performance) . . . . . 38W, 39W, 40W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to align an AM receiver and determine if receiver is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot an AM receiver using voltage measurements.

### **DIGITAL PERFORMANCE TESTS (MODEL 1454)**

- 5021-712-960 Introduction to Digital Circuits Post-Test (Performance) . . . . . 101W, 105W, 112W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a basic logic gate is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a basic logic gate using voltage measurements.
- 5021-714-960 Digital Logic Circuits Post-Test (Performance) . . . . . 102W, 105W, 112W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if logic gate circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a logic gate circuit using voltage measurements.

## OBJECTIVE LISTING - HTML Lessons

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### **DIGITAL PERFORMANCE TESTS (MODEL 1454) (cont.)**

- 5021-716-960 Combinational Logic Circuits Post-Test (Performance) . . . . . 108W, 109W, 110W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a base 10 to binary conversion circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a binary to 7-segment driver circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a 4-bit comparator circuit using voltage measurements.
- 5021-718-960 Flip-Flop Circuits Post-Test (Performance) . . . . . 111W, 113W, 115W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot an RS flip-flop circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a JK flip-flop circuit using voltage measurements.
- 5021-720-960 Register Memory Circuits Post-Test (Performance) . . . . . 111W, 118W, 126W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a register timing circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a register memory circuit using voltage measurements.
- 5021-722-960 Arithmetic Counting Circuits Post-Test (Performance) . . . . . 111W, 116W, 121W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a serial counter circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a register loading and adder circuit using voltage measurements.
- 5021-724-960 Conversion and Data Circuits Post-Test (Performance) . . . . . 112W, 133W, 134W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a data selector is working properly using voltage measurements.
  - Demonstrate the ability to determine if a data distributor is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a data conversion circuit using voltage measurements.

### **PERFORMANCE TESTS (MODEL 1456)**

#### **DC Circuits**

- 5021-114-960 Multimeter Use Post-Test (Performance) . . . . . 2W, 4AW
- Demonstrate the ability to properly set up a circuit and follow safety precautions
  - Demonstrate the ability to use a multimeter to measure voltage, current, and resistance.



## OBJECTIVE LISTING - HTML Lessons

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### **PERFORMANCE TESTS (MODEL 1456) (cont.)**

#### **DC Circuits (cont.)**

5021-116-960 Basic DC Circuits Post-Test (Performance) . . . . . 9AW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a circuit is working properly using voltage, current, and resistance measurements.
- Demonstrate the ability to troubleshoot a circuit using voltage, current, and resistance measurements.

5021-118-960 Complex DC Circuits Post-Test (Performance) . . . . . 9CW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a voltage divider circuit is working properly using voltage and resistance measurements.

#### **Wiring**

5021-214-960 Wiring Post-Test (Performance) . . . . . W1W, W2W, W3W

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a wiring harness is working properly using voltage and resistance measurements.

#### **AC Circuits**

5020-314-960 AC Test Equipment Post-Test (Performance) . . . . . 10W, 804W

- Demonstrate the ability to properly set up a circuit and follow safety precautions
- Demonstrate the ability to use an oscilloscope to make voltage and frequency measurements.

5021-316-960 Inductance and RL Circuits Post-Test (Performance) . . . . . 16BW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if an RL circuit is working properly using voltage measurements made using an oscilloscope.

5021-318-960 Capacitance and RC Circuits Post-Test (Performance) . . . . . 14AW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if an RC circuit is working properly using voltage measurements made using an oscilloscope.

5021-320-960 RC Time Constants and Transients Post-Test (Performance) . . . . . 14BW, 804W

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to make charge time and period measurements in an RC circuit using an oscilloscope.
- Demonstrate the ability to determine if an RC circuit is working properly using charge time and period measurements.
- Demonstrate the ability to troubleshoot an RC circuit using voltage and frequency measurements.

5021-322-960 Resonance Post-Test (Performance) . . . . . 18AW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions

## OBJECTIVE LISTING - HTML Lessons

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### **PERFORMANCE TESTS (MODEL 1456) (cont.)**

#### **AC Circuits (cont.)**

5021-322-960 Resonance Post-Test (Performance) (cont.)

- Demonstrate the ability to determine if a resonant circuit is working properly using voltage and frequency measurements made with an oscilloscope.
- Demonstrate the ability to troubleshoot a resonant circuit using voltage and frequency measurements.

5021-324-960 Transformers Post-Test (Performance) . . . . . 21W

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a transformer circuit is working properly using voltage measurements made using a multimeter.
- Demonstrate the ability to determine the type of transformer circuit (step up, step down, 1:1) using voltage measurements.
- Demonstrate the ability to troubleshoot a transformer circuit using voltage measurements.

5021-326-960 Relays and Switches Post-Test (Performance) . . . . . 84BW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a relay logic circuit is working properly using voltage measurements.
- Demonstrate the ability to troubleshoot a relay logic circuit using voltage measurements.

#### **Analog Circuits**

5021-514-960 Diodes and Diode Circuits Post-Test (Performance) . . . . . 22AW, 77AW, 77BW

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a diode switching circuit is working properly using voltage measurements.
- Demonstrate the ability to troubleshoot a diode switching circuit using voltage measurements.
- Demonstrate the ability to troubleshoot a diode clamping circuit using voltage measurements.
- Demonstrate the ability to troubleshoot a diode limiting circuit using voltage measurements.

5021-516-960 Transistor Circuits Post-Test (Performance) . . . . . 30AW, 31W, 32W

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a common emitter amplifier is working properly using voltage measurements.
- Demonstrate the ability to determine if a common collector amplifier is working properly using voltage measurements.
- Demonstrate the ability to determine if a common base amplifier is working properly using voltage measurements.

5021-518-960 Power Supplies Post-Test (Performance) . . . . . 23W, 25W, 26W

- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
- Demonstrate the ability to determine if a rectifier circuit is working properly using voltage measurements.
- Demonstrate the ability to determine if a voltage regulator circuit is working properly using voltage measurements.

## OBJECTIVE LISTING - HTML Lessons

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CARDS/KITS

### **PERFORMANCE TESTS (MODEL 1456) (cont.)**

#### **Analog Circuits (cont.)**

- 5021-518-960 Power Supplies Post-Test (Performance) (cont.)
- Demonstrate the ability to determine if a zener reference regulator circuit is working properly using voltage measurements.
- 5021-520-960 Transistor Amplifiers Post-Test (Performance) . . . . . 30AW, 31W, 32W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a three-stage transistor amplifier circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a three-stage transistor amplifier circuit using voltage measurements.
- 5021-522-960 Transistor Oscillators Post-Test (Performance) . . . . . 42W, 43AW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a transistor oscillator circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a transistor oscillator circuit using voltage measurements.
- 5021-524-960 Transistor Pulse Circuits Post-Test (Performance) . . . . . 44W, 45W, 46W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a transistor pulse circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a transistor pulse circuit using voltage measurements.
- 5021-526-960 Trigger Device Circuits Post-Test (Performance) . . . . . 52AW, 52BW
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a trigger device power control circuit is working properly using voltage measurements.
  - Demonstrate the ability to determine if a DC control circuit is working properly using voltage measurements.
- 5021-528-960 Operational Amplifiers Post-Test (Performance) . . . . . 54W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a summing/difference operational amplifier is working properly using voltage measurements.
  - Demonstrate the ability to determine if an inverting/non-inverting operational amplifier is working properly using voltage measurements.
- 5021-530-960 RF Electronics Post-Test (Performance) . . . . . 38W, 39W, 40W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to align an AM receiver and determine if receiver is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot an AM receiver using voltage measurements.

## OBJECTIVE LISTING - HTML Lessons

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### **PERFORMANCE TESTS (MODEL 1456) (cont.)**

#### **Digital Circuits**

- 5021-712-960 Introduction to Digital Circuits Post-Test (Performance) . . . . . 101W, 105W, 112W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if a basic logic gate is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a basic logic gate using voltage measurements.
- 5021-714-960 Digital Logic Circuits Post-Test (Performance) . . . . . 102W, 105W, 112W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to determine if logic gate circuit is working properly using voltage measurements.
  - Demonstrate the ability to troubleshoot a logic gate circuit using voltage measurements.
- 5021-716-960 Combinational Logic Circuits Post-Test (Performance) . . . . . 108W, 109W, 110W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a base 10 to binary conversion circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a binary to 7-segment driver circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a 4-bit comparator circuit using voltage measurements.
- 5021-718-960 Flip-Flop Circuits Post-Test (Performance) . . . . . 111W, 113W, 115W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot an RS flip-flop circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a JK flip-flop circuit using voltage measurements.
- 5021-720-960 Register Memory Circuits Post-Test (Performance) . . . . . 111W, 118W, 126W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a register timing circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a register memory circuit using voltage measurements.
- 5021-722-960 Arithmetic Counting Circuits Post-Test (Performance) . . . . . 111W, 116W, 121W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions
  - Demonstrate the ability to verify operation and troubleshoot a serial counter circuit using voltage measurements.
  - Demonstrate the ability to verify operation and troubleshoot a register loading and adder circuit using voltage measurements.
- 5021-724-960 Conversion and Data Circuits Post-Test (Performance) . . . . . 112W, 133W, 134W
- Demonstrate the ability to properly set up a circuit, correctly use test equipment, and follow safety precautions

## OBJECTIVE LISTING - HTML Lessons

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### **PERFORMANCE TESTS (MODEL 1456) (cont.)**

#### **Digital Circuits (cont.)**

5021-724-960 Conversion and Data Circuits Post-Test (Performance) (cont.)

- Demonstrate the ability to determine if a data selector is working properly using voltage measurements.
- Demonstrate the ability to determine if a data distributor is working properly using voltage measurements.
- Demonstrate the ability to troubleshoot a data conversion circuit using voltage measurements.

### **CABLES AND CONNECTORS (MODEL 1459)**

5021-216-130 Cables, Connectors, and Tools ..... ---

- Define wire.
- Define cable.
- Define harness.
- Identify solid and stranded wires.
- Understand the purpose of a connector.
- Determine the difference between a plug and jack.
- Understand connector terminology.
- Understand the purpose of cutters.
- Understand the purpose of crimpers.
- Understand the purpose of a multimeter.
- Understand the purpose of a cable tester.

5021-216-160 Single Wire Assemblies ..... W7

- Identify the steps used to prepare, build, and test single wire assemblies.
- Assemble a FASTON type connector.
- Assemble a butt splice.
- Assemble a 0.156 KK Series connector.
- Build and test single wire assemblies without guidance.

5021-216-190 Flat Satin Cable and RJ Connectors ..... W6

- Describe flat satin cable.
- Understand flat satin cable applications.
- Describe the RJ11 connector.
- Describe the RJ45 connector.
- Understand RJ11 and RJ45 applications.
- Assemble an RJ14 cable.
- Assemble an RJ45 cable.
- Build and test flat satin cable assemblies without guidance.

5021-216-220 Cabling Standards and Categories of Performance ..... ---

- Understand the origin of cabling standards.
- Know the agencies responsible for establishing standards.
- Define Universal Service Ordering Codes.
- Understand the types of serial data connections.
- Describe characteristics of a multi-conductor cable.
- Describe characteristics of a flat satin cable.
- Describe characteristics of a twisted pair cable.
- Describe characteristics of a coaxial cable.

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### **CABLES AND CONNECTORS (MODEL 1459) (cont.)**

- 5021-216-220 Cabling Standards and Categories of Performance (cont.)
- Identify UTP, SFTP, and STP cable.
  - Understand Cat 1 through Cat 7 cable properties.
- 5021-216-250 Twisted Pair Cable ..... W6
- Identify and describe how a modular RJ45 plug is used.
  - Identify and describe how a keystone jack is used.
  - Identify the difference between an ATT 110 punchdown type jack and a CAT 5 TIA/EIA-568-A/B keystone type jack.
  - Identify and describe how CAT 5 UTP cable is used.
  - Understand T568A, T568B, and 10BASE-T wiring standards.
  - Understand straight-through and cross-over wiring methods.
  - Understand how to prepare CAT 5 UTP cable for assembly with an RJ45 modular plug and CAT 5 TIA/EIA-568-A/B keystone type jack.
  - Identify the tools used to attach a modular RJ45 plug and CAT 5 TIA/EIA-568-A/B keystone type jack to CAT 5 UTP.
  - Understand how to attach a CAT 5 TIA/EIA-568-A/B keystone type jack to a UTP cable following T568A standards.
  - Prepare, build, and test a CAT 5 UTP cable with RJ45 plugs following T568A standards and the straight-through wiring method without guidance.
  - Prepare, build, and test CAT 5 UTP cable with a CAT 5 TIA/EIA-568-A/B keystone type jack following T568A standards and the straight-through wiring method.
- 5021-216-280 Multi-Wire Cable ..... W7
- Describe a multi-wire cable.
  - Identify a D-Sub connector.
  - Understand how a D-Sub connector is used.
  - Understand the purpose of DCE and DTE devices.
  - Identify DCE and DTE cable configurations.
  - Identify and examine the parts and types of D-Sub connectors.
  - Examine the RS-232 wiring standard.
  - Prepare, build, and test a multi-wire cable assembly using a D-Sub connector and RS-232 standards.
  - Prepare, build, and test multi-wire cable assemblies without guidance.
- 5021-216-310 Coaxial Cable ..... W6
- Describe the parts of a coaxial cable.
  - Recognize types of coaxial cable.
  - Identify coaxial cable applications.
  - Recognize an F-type coaxial connector.
  - Recognize a BNC coaxial connector.
  - Understand how to prepare a coaxial cable for assembly with an F-type connector and a BNC connector.
  - Identify the tools used to construct a coaxial cable assembly.
  - Understand how to test a coaxial cable assembly with a multimeter.
  - Prepare, build, and test a coaxial cable assembly with F-type connectors.
  - Prepare, build, and test a coaxial cable assembly with BNC type connectors.

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### **CIRCUIT CONSTRUCTION (MODEL 1413)**

- 5021-912-130 Circuit Construction ..... 130X
- Describe soldering and breadboarding methods of circuit construction.
  - Describe the Nida Series PC130X.
  - Describe how to construct a simple series circuit using PC130X.
  - Insert and remove a component from the PC130X breadboard card.
- 5021-912-160 DC Circuit Construction ..... 130X
- Construct a series circuit.
  - Verify series circuit operation.
  - Construct a parallel circuit.
  - Verify parallel circuit operation.
  - Construct a series-parallel circuit.
  - Verify series-parallel circuit operation.
  - Construct a circuit using various components.
  - Verify circuit operation.
- 5021-912-190 AC Circuit Construction ..... 130X
- Construct an AC circuit.
  - Verify AC circuit operation.
- 5021-912-220 Analog Circuit Construction ..... 130X
- Construct an analog circuit.
  - Verify analog circuit operation.
- 5021-912-250 Digital Circuit Construction ..... 130X
- Construct a digital circuit.
  - Verify digital circuit operation.

### **SOLDERING (MODEL 1410)**

- 5021-914-130 Soldering Safety and Electrostatic Sensitive Devices ..... ---
- Understand the safety requirements of soldering chemicals and supplies.
  - Describe the procedure for use of an eyewash station.
  - Define an electrostatic sensitive device.
  - Describe the sources of electrostatic discharge and list its hazards to electronic components.
  - Identify the static-producing materials in the work area.
  - Explain the principles of static control and methods employed in developing static control facilities.
  - Describe the special handling, identification, packaging, and protection requirements for electrostatic sensitive devices.
- 5021-914-160 Solder and Soldering Equipment ..... ---
- Identify different types of solder.
  - Identify proper solder flux.
  - Understand how to handle a soldering iron properly.
  - Understand how and why a soldering iron tip is tinned.
  - Understand correct use of safety equipment.
  - Identify hand tools used to aid soldering.
  - Describe proper use of heat sinks and wire forming tools.
  - Use safety equipment properly.
  - Demonstrate how to tin a soldering iron tip properly.

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### **SOLDERING (MODEL 1410) (cont.)**

- 5021-914-170 Solder and Soldering Equipment Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to tin a soldering iron tip properly.
- 5021-914-190 Wire Stripping, Tinning, and Splicing ..... ---
- Identify different types of wire strippers and trimmers.
  - Identify the proper tools used to strip various wires.
  - Understand how to strip wires using wire strippers.
  - Identify methods of wire tinning.
  - Understand how and when to tin a wire.
  - Identify methods of wire splicing.
  - Understand how and when to splice a wire.
  - Strip wires using the available wire strippers.
  - Demonstrate wire tinning.
  - Demonstrate wire splicing.
- 5021-914-200 Wire Stripping, Tinning, and Splicing Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to properly the strip and tin the end of a wire.
  - Demonstrate how to properly make a wire splice.
- 5021-914-220 Terminal Types and Connections ..... ---
- Understand the IPC/EIA J-STD-001C standards used for turret, bifurcated, and hook terminals.
  - Identify turret, bifurcated, and hook terminals.
  - Describe the application of turret, bifurcated, and hook terminals.
  - Understand the IPC/EIA J-STD-001C standards used for pierced and cup turrets.
  - Identify pierced and cup turrets.
  - Describe the application of pierced and cup turrets terminals.
  - Solder connections to a turret terminal.
  - Solder connections to a bifurcated terminal.
  - Solder connections to a hook terminal.
  - Solder connections to a pierced terminal.
  - Solder a connection to a cup terminal.
- 5021-914-230 Terminal Types and Connections Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to properly solder a wire to a turret terminal.
  - Demonstrate how to properly solder a wire to a bifurcated terminal.
  - Demonstrate how to properly solder a wire to a hook terminal.
  - Demonstrate how to properly solder a wire to a pierced terminal.
  - Demonstrate how to properly solder a wire to a cup terminal.
- 5021-914-250 Printed Circuit Board Types and Manufacturing Methods ..... 1410K1
- Identify the general characteristics of PC boards.
  - Identify several connection methods used on PC boards.
  - Identify the options and procedures available for repairing broken circuit board copper lands.
  - Prepare a circuit board for repair using a surface mount jumper.
  - Repair a circuit board using a surface mount jumper.
- 5021-914-260 Printed Circuit Board Types and Manufacturing Methods Practical Exam ..... 1410K1
- Use safety equipment properly.



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### **SOLDERING (MODEL 1410) (cont.)**

- 5021-914-260 Printed Circuit Board Types and Manufacturing Methods Practical Exam (cont.)
- Demonstrate how to properly prepare a PC board for installation of a surface mount jumper wire.
  - Demonstrate how to properly solder a surface mount jumper wire.
- 5021-914-280 Through-Hole Non-Polarized Component Soldering and Desoldering . . . . . 1410K1
- Understand the soldering process.
  - Identify good, cold, flux, and disturbed solder connections.
  - Identify common non-polarized components.
  - Identify tools used to form leads.
  - Understand lead forming methods.
  - Identify the methods used to mount components on a PCB.
  - Understand desoldering methods.
  - Understand how to correct poor solder connections.
  - Form component leads.
  - Mount and solder components to a PCB.
  - Desolder components from a PCB.
- 5021-914-290 Through-Hole Non-Polarized Component Soldering and Desoldering Practical Exam . . . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly form the leads of a thru-hole component.
  - Demonstrate how to properly solder non-polarized thru-hole components.
  - Demonstrate how to properly desolder non-polarized thru-hole components.
- 5021-914-310 Through-Hole Polarized Component Soldering . . . . . 1410K1
- Identify common polarized components.
  - Identify orientation of components.
  - Explain heat fragility of some components.
  - Form leads of polarized components.
  - Mount polarized components on a PCB.
  - Solder heat-sensitive components on a PCB.
  - Solder polarized components on a PCB.
- 5021-914-320 Through-Hole Polarized Component Soldering Practical Exam . . . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly solder polarized thru-hole components.
  - Demonstrate how to properly desolder polarized thru-hole components.
- 5021-914-340 Soldering Surface Mount Devices . . . . . 1410K1
- Explain differences between through-hole and SMD technologies.
  - Identify common SMD components.
  - Understand SMD soldering and desoldering techniques.
  - Prepare surface mount pads for soldering of a component.
  - Solder a surface mount resistor to a PCB.
  - Solder a surface mount IC to a PCB.
- 5021-914-350 Soldering Surface Mount Devices Practical Exam . . . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly tin a PC board in preparation for installation of surface mount components.
  - Demonstrate how to properly solder surface mount components.
  - Demonstrate how to properly desolder surface mount components.

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### **SOLDERING (MODEL 1410) (cont.)**

- 5021-914-370 Coax Cable Connectors ..... ---
- Review BNC connector history, advantages, and limitations.
  - Review RG-58 cable history, advantages, and limitations.
  - Understand the assembly of the UG-88C/U BNC connector.
  - Understand how a UG-88C/U BNC connector is attached to a coaxial cable.
  - Install a UG-88C/U BNC connector on the RG-58 A/U cable.
- 5021-914-380 Coax Cable Connectors Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to properly a BNC connector on a cable.

### **LEAD-FREE SOLDERING (MODEL 1410LF)**

- 5021-916-130 Soldering Safety and Electrostatic Sensitive Devices ..... ---
- Understand the safety requirements of soldering chemicals and supplies.
  - Describe the procedure for use of an eyewash station.
  - Define an electrostatic sensitive device.
  - Describe the sources of electrostatic discharge and list its hazards to electronic components.
  - Identify the static-producing materials in the work area.
  - Explain the principles of static control and methods employed in developing static control facilities.
  - Describe the special handling, identification, packaging, and protection requirements for electrostatic sensitive devices.
- 5021-916-160 Solder and Soldering Equipment ..... ---
- Identify different types of solder.
  - Identify proper solder flux.
  - Understand how to handle a soldering iron properly.
  - Understand how and why a soldering iron tip is tinned.
  - Understand correct use of safety equipment.
  - Identify hand tools used to aid soldering.
  - Describe proper use of heat sinks and wire forming tools.
  - Use safety equipment properly.
  - Demonstrate how to tin a soldering iron tip properly.
- 5021-916-170 Solder and Soldering Equipment Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to tin a soldering iron tip properly.
- 5021-916-190 Wire Stripping, Tinning, and Splicing ..... ---
- Identify different types of wire strippers and trimmers.
  - Identify the proper tools used to strip various wires.
  - Understand how to strip wires using wire strippers.
  - Identify methods of wire tinning.
  - Understand how and when to tin a wire.
  - Identify methods of wire splicing.
  - Understand how and when to splice a wire.
  - Strip wires using the available wire strippers.
  - Demonstrate wire tinning.
  - Demonstrate wire splicing.

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### **LEAD-FREE SOLDERING (MODEL 1410LF) (cont.)**

- 5021-916-200 Wire Stripping, Tinning, and Splicing Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to properly strip and tin the end of a wire.
  - Demonstrate how to properly make a wire splice.
- 5021-916-220 Terminal Types and Connections ..... ---
- Understand the IPC/EIA J-STD-001C standards used for turret, bifurcated, and hook terminals.
  - Identify turret, bifurcated, and hook terminals.
  - Describe the application of turret, bifurcated, and hook terminals.
  - Understand the IPC/EIA J-STD-001C standards used for pierced and cup turrets.
  - Identify pierced and cup turrets.
  - Describe the application of pierced and cup turrets terminals.
  - Solder connections to a turret terminal.
  - Solder connections to a bifurcated terminal.
  - Solder connections to a hook terminal.
  - Solder connections to a pierced terminal.
  - Solder a connection to a cup terminal.
- 5021-916-230 Terminal Types and Connections Practical Exam ..... ---
- Use safety equipment properly.
  - Demonstrate how to properly solder a wire to a turret terminal.
  - Demonstrate how to properly solder a wire to a bifurcated terminal.
  - Demonstrate how to properly solder a wire to a hook terminal.
  - Demonstrate how to properly solder a wire to a pierced terminal.
  - Demonstrate how to properly solder a wire to a cup terminal.
- 5021-916-250 Printed Circuit Board Types and Manufacturing Methods ..... 1410K1
- Identify the general characteristics of PC boards.
  - Identify several connection methods used on PC boards.
  - Identify the options and procedures available for repairing broken circuit board copper lands.
  - Prepare a circuit board for repair using a surface mount jumper.
  - Repair a circuit board using a surface mount jumper.
- 5021-916-260 Printed Circuit Board Types and Manufacturing Methods Practical Exam ..... 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly prepare a PC board for installation of a surface mount jumper wire.
  - Demonstrate how to properly solder a surface mount jumper wire.
- 5021-916-280 Through-Hole Non-Polarized Component Soldering and Desoldering ..... 1410K1
- Understand the soldering process.
  - Identify good, cold, flux, and disturbed solder connections.
  - Identify common non-polarized components.
  - Identify tools used to form leads.
  - Understand lead forming methods.
  - Identify the methods used to mount components on a PCB.
  - Understand desoldering methods.
  - Understand how to correct poor solder connections.
  - Form component leads.
  - Mount and solder components to a PCB.
  - Desolder components from a PCB.

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### **LEAD-FREE SOLDERING (MODEL 1410LF) (cont.)**

- 5021-916-290 Through-Hole Non-Polarized Component Soldering and Desoldering Practical Exam . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly form the leads of a thru-hole component.
  - Demonstrate how to properly solder non-polarized thru-hole components.
  - Demonstrate how to properly desolder non-polarized thru-hole components.
- 5021-916-310 Through-Hole Polarized Component Soldering . . . . . 1410K1
- Identify common polarized components.
  - Identify orientation of components.
  - Explain heat fragility of some components.
  - Form leads of polarized components.
  - Mount polarized components on a PCB.
  - Solder heat-sensitive components on a PCB.
  - Solder polarized components on a PCB.
- 5021-916-320 Through-Hole Polarized Component Soldering Practical Exam . . . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly solder polarized thru-hole components.
  - Demonstrate how to properly desolder polarized thru-hole components.
- 5021-916-340 Soldering Surface Mount Devices . . . . . 1410K1
- Explain differences between through-hole and SMD technologies.
  - Identify common SMD components.
  - Understand SMD soldering and desoldering techniques.
  - Prepare surface mount pads for soldering of a component.
  - Solder a surface mount resistor to a PCB.
  - Solder a surface mount IC to a PCB.
- 5021-916-350 Soldering Surface Mount Devices Practical Exam . . . . . 1410K1
- Use safety equipment properly.
  - Demonstrate how to properly tin a PC board in preparation for installation of surface mount components.
  - Demonstrate how to properly solder surface mount components.
  - Demonstrate how to properly desolder surface mount components.
- 5021-916-370 Coax Cable Connectors . . . . . ---
- Review BNC connector history, advantages, and limitations.
  - Review RG-58 cable history, advantages, and limitations.
  - Understand the assembly of the UG-88C/U BNC connector.
  - Understand how a UG-88C/U BNC connector is attached to a coaxial cable.
  - Install a UG-88C/U BNC connector on the RG-58 A/U cable.
- 5021-916-380 Coax Cable Connectors Practical Exam . . . . . ---
- Use safety equipment properly.
  - Demonstrate how to properly a BNC connector on a cable.

### **PHASE LOCK LOOP (MODEL 1411)**

- 5041-112-130 Phase Lock Loop . . . . . 86, 224, 225
- Describe phase lock loop circuits to the block diagram level.
  - Describe phase lock loop FM demodulators.
  - Define phase lock loop circuitry.

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### **PHASE LOCK LOOP (MODEL 1411) (cont.)**

5041-112-130 Phase Lock Loop (cont.)

- Describe the operation of a phase lock loop detector circuit.
- Describe the operation of a phase lock loop error amplifier circuit.
- Observe the operation of a phase lock loop system configured as a band pass filter, FM demodulator, and frequency synthesizer.

### **RADAR (MODEL 1415)**

5061-212-130 Introduction to Radar . . . . . ---

- Define terms, abbreviations, and symbols used in conjunction with radar principles.
- Convert decibel and power ratio into standardized reference power (dBm).
- Describe the composition of a basic radar system.
- Identify the blocks of a basic radar system.
- Define abbreviations, terms, symbols, and characteristics used in conjunction with radar systems.
- State the purpose and use of the surface search, air search, and targeting radar systems.
- Explain the basic operation of a pulse, continuous wave (CW), and Doppler radar system.
- Describe a block diagram of a pulse radar system.
- Understand pulse radar circuit functions.
- Describe basic radar antennas.

5061-212-160 Basic Radar Operation . . . . . 231

- Examine a typical radar timing circuit.
- Examine both a sweep and video amplifier.
- Examine typical radar characteristics.

5061-212-190 Radar Transmitters and Receivers . . . . . ---

- Define radar transmitter abbreviations, terms, and symbols.
- Describe the function, operational characteristics, and major subsections of a typical radar transmitter.
- Define radar receiver abbreviations, terms, and symbols.
- Describe the function, operational characteristics, and major subsections of a typical radar receiver.

5061-212-220 Transmission Lines . . . . . ---

- Identify transmission line operating characteristics.
- Identify the different types of transmission lines.

5061-212-250 Waveguide Theory . . . . . ---

- Describe a waveguide and explain the advantages and disadvantages of waveguides over other means of transferring RF energy.
- Explain how waveguides are developed from parallel transmission lines.
- Describe waveguide impedance matching terminations.
- Describe waveguide components.
- Describe waveguide plumbing.

5061-212-280 Antennas . . . . . ---

- Understand antenna characteristics.
- Explain the propagation of energy in antennas.

5061-212-310 Cavity Resonators and Tube Microwave Devices . . . . . ---

- Describe the purpose of cavity resonators.
- Describe the basic theory and operation of cavity resonators.

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### **RADAR (MODEL 1415) (cont.)**

- 5061-212-310 Cavity Resonators and Tube Microwave Devices (cont.)
- Describe the basic principle of microwave tubes and their limitations.
  - Describe the basic theory and operation of klystrons and magnetrons.
- 5061-212-340 Semiconductor Microwave Devices . . . . . ---
- Describe the limitations of bipolar and field effect transistors at microwave frequencies.
  - Describe methods to minimize limitations in bipolar and field effect transistors at microwave frequencies.
  - Describe the basic theory of operation of varactor diodes, tunnel diodes, gunn diodes, and DROs.
- 5061-212-370 Electromagnetic Compatibility and Countermeasures . . . . . ---
- Define terms, abbreviations, and symbols associated with electromagnetic compatibility.
  - Describe the function and operational characteristics of electromagnetic compatibility (EMC), electronic countermeasures (ECM), and electronic counter-countermeasures (ECCM).
- 5061-212-400 Radar Auxiliary Systems . . . . . ---
- Define terms, abbreviations, and symbols used with radar dry air systems.
  - Describe the function and operational characteristics of radar dry air systems.
  - Define terms, abbreviations, and symbols used with radar cooling systems.
  - Describe the function and operational characteristics of radar cooling systems.

### **INTRODUCTION TO FILTERS (MODEL 1418)**

- 5041-116-130 Introduction to Filters . . . . . ---
- Define an active and passive filter.
  - Define inductive and capacitive reactance.
  - Define a low-pass filter.
  - Define a high-pass filter.
  - Define a band pass filter.
  - Define a band reject filter.
- 5041-116-160 High-Pass Filters . . . . . 145
- Describe the operation of high-pass filters.
  - Describe the types of high-pass filters.
  - Calculate high-pass filter circuit values.
  - Observe the normal operation of a high-pass filter.
  - Verify correct operation of a high-pass filter circuit.
  - Determine if a high-pass filter circuit is faulted.
  - Identify a faulted component in a high-pass filter circuit.
- 5041-116-190 Low-Pass Filters . . . . . 146
- Describe the theory of operation of a low-pass filter.
  - Identify low-pass filter circuits.
  - Discuss the cutoff frequency of a low pass RC filter circuit.
  - Verify proper low-pass filter operation.
  - Determine the cutoff frequency of a low pass RC filter circuit.
- 5041-116-220 Bandpass Filters . . . . . 147
- Describe the theory of operation of a band-pass filter.
  - Discuss the upper and lower cutoff frequencies of a band-pass filter.
  - Identify a band-pass filter circuit.
  - Verify proper band-pass filter operation.

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### **INTRODUCTION TO FILTERS (MODEL 1418) (cont.)**

- 5041-116-220 Bandpass Filters (cont.)
- Determine the bandwidth of a band-pass filter.
- 5041-116-250 Band-Reject Filters ..... 148
- Discuss the theory of operation of a band-reject filter.
  - Identify a typical band-reject filter circuit.
  - Verify proper band-reject filter circuit operation.
  - Determine the bandwidth of a typical band-reject filter.

### **OPERATIONAL AMPLIFIERS (MODEL 1419)**

- 5041-118-130 Operational Amplifiers ..... ---
- Describe the operational amplifier and how it is used.
  - Describe the schematic symbol and packaging of operational amplifiers.
  - Describe the basic operation of operational amplifiers.
  - Describe operational amplifier characteristics.
  - Describe linear operational amplifiers.
  - Describe arithmetic operational amplifiers.
  - Describe wave shaping operational amplifiers.
- 5041-118-160 Operational Amplifier Experiment ..... 161, 162, 163
- Observe the operation of inverting and non-inverting amplifiers.
  - Measure signals in inverting and non-inverting amplifiers.
  - Locate faults in inverting and non-inverting amplifiers.
  - Observe the operation of summing and difference amplifiers.
  - Measure signals in summing and difference amplifiers.
  - Locate faults in summing and difference amplifiers.
  - Observe the operation of integrator and differentiator amplifiers.
  - Measure signals in integrator and differentiator amplifiers.
  - Locate faults in integrator and differentiator amplifiers.

### **8051 MICROCONTROLLER (MODEL 1439)**

#### **Introduction to Microprocessors**

- 5082-212-130 Introduction to Microprocessors ..... ---
- Describe a brief development of microprocessors.
  - Identify the major parts of a microprocessor system.
  - Define common terms associated with microprocessors.
- 5082-212-160 Basic Microprocessor Operations ..... ---
- Identify parts of a microprocessor and describe microprocessor operation.
  - Define and describe internal registers and counters.
  - Understand the physical characteristics of RAM and ROM.
  - Describe the difference between RAM and ROM.
  - Understand the configuration caches, conventional, extended, upper, high, and expanded memory.
  - Know the purpose of caches, conventional, extended, upper, high, and expanded memory.
  - Explain the evolution of caches, conventional, extended, upper, high, and expanded memory.
- 5082-212-190 Microprocessor Number Systems ..... ---
- Identify different mathematical numbering systems.

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### **8051 MICROCONTROLLER (MODEL 1439) (cont.)**

#### **Introduction to Microprocessors (cont.)**

5082-212-190 Microprocessor Number Systems (cont.)

- Describe and perform number system conversions.
- Describe and perform binary addition and subtraction.
- Describe and perform multiplication and division.

#### **8051 Microcontroller Circuits**

5082-222-130 8051 Microcontroller Circuit . . . . . 405, 406, 407

- Describe the internal structure of the 8051 microcontroller.
- Describe the timed operations of the 8051 microcontroller.
- Observe signals from the 8051 microcontroller circuit.
- Enter a simple program to observe system operation.

5082-222-160 Operation of the 8051 Microcontroller . . . . . 405, 406, 407

- Describe external timing and control connections to the 8051 microcontroller.
- Describe the memory connections to the 8051 microcontroller.
- Observe the various signals generated by the 8051 microcontroller.
- Observe the operation of external memory.

5082-222-190 Interfacing with the 8051 Microcontroller . . . . . 405, 406, 407

- Describe the connection of input/output devices attached to the 8051.
- Understand the different types of input/output devices connected to a microcontroller.
- Observe signals of the keyboard circuitry in the microcontroller system.

5082-222-220 Troubleshooting the 8051 Microcontroller . . . . . 405, 406, 407

- Describe the techniques required to troubleshoot a defective microcontroller system.
- Describe preventive maintenance.
- Describe the basic tool used to troubleshoot a microcontroller system.
- Perform successful troubleshooting with the 8051 microcontroller trainer.
- Understand basic fault types in a microcontroller system.

### **8085 MICROPROCESSOR (MODEL 1440)**

#### **Introduction to Microprocessors**

5082-212-130 Introduction to Microprocessors . . . . . ---

- Describe a brief development of microprocessors.
- Identify the major parts of a microprocessor system.
- Define common terms associated with microprocessors.

5082-212-160 Basic Microprocessor Operations . . . . . ---

- Identify parts of a microprocessor and describe microprocessor operation.
- Define and describe internal registers and counters.
- Understand the physical characteristics of RAM and ROM,
- Describe the difference between RAM and ROM.
- Understand the configuration caches, conventional, extended, upper, high, and expanded memory.
- Know the purpose of caches, conventional, extended, upper, high, and expanded memory.
- Explain the evolution of caches, conventional, extended, upper, high, and expanded memory.

5082-212-190 Microprocessor Number Systems . . . . . ---

- Identify different mathematical numbering systems.
- Describe and perform number system conversions.



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### **8085 MICROPROCESSOR (MODEL 1440) (cont.)**

#### **Introduction to Microprocessors (cont.)**

5082-212-190 Microprocessor Number Systems (cont.)

- Describe and perform binary addition and subtraction.
- Describe and perform multiplication and division.

#### **8085 Microprocessor Circuits**

5082-224-130 8085 Microprocessor Circuits . . . . . 400, 401, 402, 485

- Describe the internal structure of the 8085 microprocessor.
- Describe the timed operations of the 8085 microprocessor.
- Observe signals from the 8085 microprocessor circuit.
- Enter a simple program to observe system operation.

5082-224-160 Operation of the 8085 Microprocessor . . . . . 400, 401, 402, 485

- Describe timing and control connections to the 8085 microprocessor.
- Describe the memory connections to the 8085 microprocessor.
- Observe the operation of timing and control signals in an 8085 microprocessor system.
- Observe memory interface signals during actual microprocessor operation.

5082-224-190 Interfacing with the 8085 Microprocessor . . . . . 400, 401, 402, 485

- Describe the connection of input/output devices attached to the 8085.
- Understand the different types of input/output devices connected to a microprocessor.
- Observe the operation of an input/output device as it is used in a microprocessor system.

5082-224-220 Troubleshooting the 8085 Microprocessor . . . . . 400, 401, 402, 485

- Describe the techniques required to troubleshoot a defective microprocessor system.
- Describe preventive maintenance.
- Describe the basic tools used to troubleshoot a microprocessor system.
- Perform successful troubleshooting with the 8085 microprocessor trainer.
- Understand basic fault types in a microprocessor system.

### **8086 MICROPROCESSOR (MODEL 1441)**

#### **Introduction to Microprocessors**

5082-212-130 Introduction to Microprocessors . . . . . ---

- Describe a brief development of microprocessors.
- Identify the major parts of a microprocessor system.
- Define common terms associated with microprocessors.

5082-212-160 Basic Microprocessor Operations . . . . . ---

- Identify parts of a microprocessor and describe microprocessor operation.
- Define and describe internal registers and counters.
- Understand the physical characteristics of RAM and ROM,
- Describe the difference between RAM and ROM.
- Understand the configuration caches, conventional, extended, upper, high, and expanded memory.
- Know the purpose of caches, conventional, extended, upper, high, and expanded memory.
- Explain the evolution of caches, conventional, extended, upper, high, and expanded memory.

5082-212-190 Microprocessor Number Systems . . . . . ---

- Identify different mathematical numbering systems.
- Describe and perform number system conversions.
- Describe and perform binary addition and subtraction.

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### **8086 MICROPROCESSOR (MODEL 1441) (cont.)**

#### **Introduction to Microprocessors (cont.)**

5082-212-190 Microprocessor Number Systems (cont.)

- Describe and perform multiplication and division.

#### **8086 Microprocessor Circuits**

5082-226-130 8086 Microprocessor Circuit ..... 401, 404, 410, 411

- Describe the internal structure of the 8086 microprocessor.
- Understand the various internal components.
- Understand the external connections to the 8086.
- Demonstrate the ability to examine signal conditions of the 8086.
- Demonstrate the ability to enter a program into the 8086.

5082-226-160 Operation of the 8086 Microprocessor ..... 401, 404, 410, 411

- Describe external timing and control connections to the 8086 microprocessor.
- Describe the memory connections to the 8086 microprocessor.
- Observe the various signals generated by the 8086 microprocessor.
- Observe memory interface signals during actual microprocessor operation.

5082-226-190 Interfacing with the 8086 Microprocessor ..... 401, 404, 410, 411

- Describe the connection of input/output devices attached to the 8086.
- Understand the different types of input/output devices connected to a microprocessor.
- Observe the operation of an input/output device as it is used in a microprocessor system.

5082-226-220 Troubleshooting the 8086 Microprocessor ..... 401, 404, 410, 411

- Describe the techniques required to troubleshoot a defective microprocessor system.
- Describe preventive maintenance.
- Describe the basic tools used to troubleshoot a microprocessor system.
- Perform successful troubleshooting with the 8086 microprocessor trainer.
- Understand basic fault types in a microprocessor system.

5082-226-250 8086 Data Transfer Instructions ..... 401, 404, 410, 411

- Describe immediate data transfers.
- Describe direct data transfers.
- Describe indirect data transfers.
- Perform immediate data transfers in an 8086 microprocessor.
- Perform direct data transfers in an 8086 microprocessor.
- Perform indirect data transfers in an 8086 microprocessor.

5082-226-280 8086 Addition and Subtraction ..... 401, 404, 410, 411

- Describe computer addition.
- Describe computer subtraction.
- Perform computer addition.
- Perform computer subtraction.

5082-226-310 8086 Logic Instructions ..... 401, 404, 410, 411

- Describe logic instructions.
- Perform operations using logic instructions.

5082-226-340 8086 Jump Instructions ..... 401, 404, 410, 411

- Describe jump instructions.
- Perform jump instructions.

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### **68000 MICROPROCESSOR (MODEL 1468)**

#### **Introduction to Microprocessors**

- 5082-212-130 Introduction to Microprocessors . . . . . ---
- Describe a brief development of microprocessors.
  - Identify the major parts of a microprocessor system.
  - Define common terms associated with microprocessors.
- 5082-212-160 Basic Microprocessor Operations . . . . . ---
- Identify parts of a microprocessor and describe microprocessor operation.
  - Define and describe internal registers and counters.
  - Understand the physical characteristics of RAM and ROM,
  - Describe the difference between RAM and ROM.
  - Understand the configuration caches, conventional, extended, upper, high, and expanded memory.
  - Know the purpose of caches, conventional, extended, upper, high, and expanded memory.
  - Explain the evolution of caches, conventional, extended, upper, high, and expanded memory.
- 5082-212-190 Microprocessor Number Systems . . . . . ---
- Identify different mathematical numbering systems.
  - Describe and perform number system conversions.
  - Describe and perform binary addition and subtraction.
  - Describe and perform multiplication and division.

#### **68000 Microprocessor Circuits**

- 5082-228-130 Introduction to 68000 Microprocessors . . . . . ---
- Identify the major sections of a microprocessor system.
  - Define the buses used by the 68000 for addressing, data, and control.
  - Define the modes of operation for the 68000.
  - Understand the use and manipulation of binary, hexadecimal, and decimal numbering systems.
  - Understand ASCII and BCD data encoding.
- 5082-228-160 The 68000 Microprocessor . . . . . 401, 403, 404, 468
- Define the different package styles of the 68000 microprocessor.
  - Understand label identification on the 68000 microprocessor.
  - Identify the address, data and control buses of the 68000 microprocessor.
  - Identify the operation of the clock and reset circuits of the 68000 microprocessor.
  - Identify the operation of the microprocessor interrupts.
  - Observe the operation of the 68000 buses.
- 5082-228-190 Registers and Memory . . . . . 401, 403, 404, 468
- Define the purpose and usage of the internal registers.
  - Understand the operation of the user and supervisor stacks.
  - Define the types of external memory.
  - Explain the connections and control of memory in the 68000 microprocessor.
  - Observe the contents of registers in the 68000.
  - Observe the contents of external memory to the 68000.
- 5082-228-220 I/O Circuits . . . . . 401, 403, 404, 468
- Understand the purpose and usage of I/O circuits.
  - Understand the operation of the 68000 keyboard.
  - Understand the operation of the 68000 LCD.
  - Understand the operation of the serial and parallel ports.

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### **68000 MICROPROCESSOR (MODEL 1468) (cont.)**

#### **68000 Microprocessor Circuits (cont.)**

5082-228-220 I/O Circuits (cont.)

- Observe data communications through the parallel port.

5082-228-250 Operation of the 68000 ..... 401, 403, 404, 468

- Explain the vector addressing of the 68000 microprocessor.
- Understand the different states of microprocessor operation.
- Describe the different types of exceptions recognized by the 68000 microprocessor.
- Observe the occurrence of exceptions in manually entered code.
- Explain and observe the results of the exceptions caused by the manually entered code.

5082-228-280 Introduction to Programming ..... 401, 403, 404, 468

- Explain the purpose and usage of programming in a microprocessor system.
- Understand the different types of programming and the type used by the Nida 68000 microprocessor trainer.
- Define the different groups of instructions and which instructions are in those groups.
- Observe and understand all of the instruction code of a simple program.
- Observe the effects of executing the simple program.

5082-228-310 Move and Branch Commands ..... 401, 403, 404, 468

- Define, understand, and use the different types of move instructions.
- Define, understand, and use the different types of branch instructions.
- Demonstrate the usage of move and branch commands.

5082-228-340 Arithmetic and Logic Commands ..... 401, 403, 404, 468

- Understand the different types and use of arithmetic instructions.
- Understand the different types and use of logic instructions.
- Demonstrate the use of both arithmetic and logic instructions.

5082-228-370 Test and Additional Commands ..... 401, 403, 404, 468

- Understand the different types of test instructions.
- Understand the different uses of test instructions.
- Understand the different types of additional instructions.
- Understand the different uses of additional instructions.
- Demonstrate the use of a test instruction.
- Demonstrate the use of an additional instruction.

5082-228-400 Debugging and Compatibility ..... 401, 403, 404, 468

- Understand debugging programs and tools.
- Identify other Motorola processors compatible with the 68000, and understand their characteristics.
- Demonstrate the ability to debug a small program.

5082-228-430 Troubleshooting the 68000 ..... 401, 403, 404, 468

- Define the techniques required to troubleshoot a defective microprocessor system.
- Describe preventive maintenance.
- Describe the basic tools used to troubleshoot microprocessor systems.
- Perform successful troubleshooting with the 68000 microprocessor trainer.

### **FIBEROPTIC CIRCUITS (MODEL 1406)**

5102-114-130 Introduction to Fiber Optics ..... 251, 301, 302, 323

- Explain what light is and how it is produced.
- Identify the components of the visible spectrum and the optical spectrum.

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### **FIBEROPTIC CIRCUITS (MODEL 1406) (cont.)**

- 5102-114-130 Introduction to Fiber Optics (cont.)
- Describe the difference between reflection and refraction.
  - Identify the law of reflection and Snell's law.
  - Explain total internal reflection.
  - Explain the operation of a fiberoptic system.
  - Describe the three sections of a fiberoptic system.
  - Identify some optical light sources and optical detectors.
  - Describe the construction of a fiberoptic cable.
  - Identify some of the advantages and disadvantages of fiberoptic systems.
  - Become familiar with fiberoptic cables.
  - Observe the operation of a fiberoptic system.
- 5102-114-160 Fiberoptic Components ..... 251
- Define attenuation and bandwidth.
  - Identify the primary causes of attenuation.
  - Describe single mode and multimode optical fibers.
  - Understand the numerical aperture rating.
  - Identify some of the characteristics for optical sources.
  - Describe the difference between homojunction and heterojunction LEDs.
  - Describe the differences between LEDs and lasers.
  - Identify some of the characteristics for optical detectors.
  - Describe the differences between PIN photodiodes and APDs.
  - Compare the operation of different optical sources to different optical detectors.
  - Experimentally demonstrate certain limiting characteristics of some fiberoptic components.
- 5102-114-190 Signal Transmission ..... 301, 302, 303, 305, 306, 322
- Describe the five areas of signal processing.
  - Explain AM, FM, PCM, and intensity modulation.
  - Explain TDM, FDM, and WDM.
  - Define SNR and BER.
  - Construct and set up a fiberoptic system utilizing time division multiplexing.
  - Demonstrate the operational characteristics of time division multiplexing.
- 5102-114-220 Fiberoptic Cable Connections ..... 301, 302
- Explain losses due to the different types of misalignment and waveguide geometry.
  - Describe the basic steps for splicing waveguides properly.
  - Identify the six requirements for a good connector.
  - Connectorize a fiberoptic cable properly.
  - Determine the losses of adding a non-permanent mechanical splice to a fiberoptic cable.
- 5102-114-250 Fiberoptic System Troubleshooting ..... 301, 302
- Identify a faulted fiberoptic system.
  - Develop an organized troubleshooting strategy.
  - Understand how to isolate a faulted section of a fiberoptic system.
  - Demonstrate the steps involved in using a troubleshooting flowchart to properly troubleshoot a fiberoptic system .
  - Examine the characteristics of a faulty transmission circuit, transmission medium, and receiver circuit.
  - Troubleshoot random fiberoptic system faults.

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### **SIGNAL PROCESSING (MODEL 1407)**

#### **Introduction to Signal Processing**

- 5101-112-130 Communications Systems and Signal Processing . . . . . ---
- Describe the basic elements that compose a communications system.
  - State the two fundamental limiting factors in a communications system.
  - Describe the basic differences between analog and digital signals.
  - Describe signal processing.
  - Identify various signal processing techniques.
- 5101-112-160 Amplitude Modulation . . . . . ---
- Describe amplitude modulation (AM).
  - Describe the characteristics of amplitude modulation.
  - Generate amplitude modulation signals using a function generator.
  - Observe and measure the characteristics of an amplitude modulated signal.
- 5101-112-190 Frequency Modulation . . . . . ---
- Describe frequency modulation (FM).
  - Describe the characteristics of frequency modulation.
  - Generate frequency modulation signals using a function generator.
  - Observe and measure the characteristics of a frequency modulated signal.
- 5101-112-220 Single Sideband and Transmission Lines . . . . . ---
- Identify the Single Sideband operating principle.
  - Identify the operation of a Single Sideband transmitter and receiver.
  - Identify transmission line operating characteristics.
  - Identify the different types of transmission lines.

#### **AM/FM Circuits**

- 5101-114-130 AM Circuits . . . . . ---
- Describe a diode AM modulator circuit.
  - Describe a transistor collector AM modulator circuit.
  - Describe a transistor series AM modulator circuit.
  - Describe a diode AM demodulator circuit.
  - Describe a transistor AM demodulator circuit.
- 5101-114-160 Basic AM Circuit Construction . . . . . 130X, 322
- Construct an AM diode modulator circuit.
  - Measure signals in an AM diode modulator circuit.
  - Construct an AM diode demodulator circuit.
  - Measure signals in an AM diode demodulator circuit.
- 5101-114-190 AM Circuit Operation . . . . . 91, 92
- Observe the operation of a transistor collector modulator transmitter.
  - Measure signals in a transistor collector modulator transmitter.
  - Observe the operation of a diode demodulator receiver.
  - Measure signals in a diode demodulator receiver.
- 5101-114-220 AM Circuit Troubleshooting . . . . . 91, 92
- Determine if an AM transmitter and receiver system is operating correctly.
  - Identify the faulted circuit in a malfunctioning AM transmitter and receiver system.
- 5101-116-130 FM Circuits . . . . . ---
- Describe a reactance modulator circuit.
  - Describe a varactor modulator circuit.
  - Describe an IC voltage controlled oscillator modulator circuit.
  - Describe a slope demodulator circuit.

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### **SIGNAL PROCESSING (MODEL 1407) (cont.)**

#### **AM/FM Circuits (cont.)**

5101-116-130 FM Circuits (cont.)

- Describe a discriminator demodulator circuit.
- Describe a ratio demodulator circuit.
- Describe phase lock loop circuits to the block diagram level.
- Describe phase lock loop FM demodulators.

5101-116-160 Basic FM Circuit Construction . . . . . 130X

- Construct an FM reactance modulator circuit.
- Measure signals in an FM reactance modulator circuit.
- Construct an FM slope demodulator circuit.
- Measure signals in an FM slope demodulator circuit.

5101-116-220 IC FM Circuit Operation . . . . . 336

- Observe the operation of an integrated circuit transmitter and receiver.
- Measure signals in an integrated circuit transmitter and receiver.

5101-116-280 Analog Pulse Modulation . . . . . ---

- Define analog pulse modulation.
- Describe pulse amplitude modulation.
- Describe pulse width modulation.
- Describe pulse position modulation.

#### **Modulation Techniques**

5101-122-130 Pulse Code Modulation (PCM) . . . . . ---

- Describe pulse code modulation (PCM).
- Describe the characteristics of PCM signals.
- Describe the block diagram of a PCM modulator.
- Describe a typical PCM modulator circuit.
- Describe the block diagram of a PCM demodulator.
- Describe a typical PCM demodulator circuit.

5101-122-160 PCM Circuit Operation . . . . . 284, 326, 327

- Observe the operation of a typical PCM modulator.
- Measure signals in a typical PCM modulator.
- Observe the operation of a typical PCM demodulator.
- Measure signals in a typical PCM demodulator.

5101-122-190 PCM Circuit Troubleshooting . . . . . 326, 327

- Determine if a PCM transmitter and receiver system is operating correctly.
- Identify the faulted component in a malfunctioning PCM transmitter and receiver system.

5101-124-130 Delta Modulation (DM) . . . . . ---

- Describe Delta Modulation.
- Describe the characteristics of DM signals.
- Describe a typical DM modulator circuit.
- Describe the CVSD DM modulator integrated circuit.
- Describe a typical DM demodulator circuit.
- Describe the CVSD DM demodulator integrated circuit.

5101-124-160 Delta Modulation (DM) Circuit Operation . . . . . 332, 333

- Observe the operation of a typical DM modulator.
- Measure signals in a typical DM modulator.
- Observe the operation of a typical DM demodulator.
- Measure signals in a typical DM demodulator.

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### **SIGNAL PROCESSING (MODEL 1407) (cont.)**

#### **Modulation Techniques (cont.)**

- 5101-124-190 DM Circuit Troubleshooting . . . . . 332, 333
- Determine if a DM transmitter and receiver system is operating correctly.
  - Identify the faulted component in a malfunctioning DM transmitter and receiver system.
- 5101-126-130 Frequency Shift Keying (FSK) . . . . . ---
- Describe Frequency Shift Keying.
  - Describe the characteristics of FSK signals.
  - Describe a typical FSK modulator circuit.
  - Describe the MC14066 analog switch and ICL8038 VCO integrated circuits.
  - Describe a typical FSK demodulator circuit.
  - Describe the NE565 and NE567 PLL integrated circuits.
- 5101-126-160 Frequency Shift Keying Circuit Operation . . . . . 328, 329
- Observe the operation of a typical FSK modulator.
  - Measure signals in a typical FSK modulator.
  - Observe the operation of a typical FSK demodulator.
  - Measure signals in a typical FSK demodulator.
- 5101-126-190 FSK Circuit Troubleshooting . . . . . 328, 329
- Determine if an FSK transmitter and receiver system is operating correctly.
  - Identify the faulted component in a malfunctioning FSK transmitter and receiver system.
- 5101-128-130 Phase Shift Keying (PSK) . . . . . ---
- Describe Phase Shift Keying.
  - Describe the characteristics of PSK signals.
  - Describe a typical PSK modulator circuit.
  - Describe a typical PSK demodulator circuit.
- 5101-128-160 Phase Shift Keying Circuit Operation . . . . . 323, 330, 331
- Observe the operation of a typical PSK modulator.
  - Measure signals in a typical PSK modulator.
  - Observe the operation of a typical PSK demodulator.
  - Measure signals in a typical PSK demodulator.
- 5101-128-190 PSK Circuit Troubleshooting . . . . . 323, 330, 331
- Determine if a PSK/QPSK transmitter and receiver system is operating correctly.
  - Identify the faulted component in a malfunctioning PSK/QPSK transmitter and receiver system.

#### **Multiplexing Techniques**

- 5101-132-130 Time Division Multiplexing (TDM) . . . . . ---
- Describe Time Division Multiplexing.
  - Describe the characteristics of TDM signals.
  - Describe a typical TDM multiplexer circuit.
  - Describe the MC14051 circuit used as a TDM multiplexer.
  - Describe a typical TDM demultiplexer circuit.
  - Describe the MC14051 circuit used as a TDM demultiplexer.
- 5101-132-160 Time Division Multiplexing Circuit Operation . . . . . 305, 306, 322
- Observe the operation of a typical TDM multiplexer.
  - Measure signals in a typical TDM multiplexer.
  - Observe the operation of a typical TDM demultiplexer.
  - Measure signals in a typical TDM demultiplexer.



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### **SIGNAL PROCESSING (MODEL 1407) (cont.)**

#### **Multiplexing Techniques (cont.)**

- 5101-132-190 TDM Circuit Troubleshooting . . . . . 305, 306, 322
- Determine if a TDM transmitter and receiver system is operating correctly.
  - Identify the faulted component in a malfunctioning TDM transmitter and receiver system.
- 5101-134-130 Frequency Division Multiplexing (FDM) . . . . . ---
- Describe Frequency Division Multiplexing.
  - Describe the characteristics of FDM signals.
  - Describe a typical FDM multiplexer circuit.
  - Describe the NE564 PLL circuit used as an FM modulator.
  - Describe a typical FDM demultiplexer circuit.
  - Describe the NE564 PLL circuit used as an FM demodulator.
- 5101-134-160 FDM Circuit Operation . . . . . 322, 324, 325
- Observe the operation of a typical FDM multiplexer.
  - Measure signals in a typical FDM multiplexer.
  - Observe the operation of a typical FDM demultiplexer.
  - Measure signals in a typical FDM demultiplexer.
- 5101-134-190 FDM Circuit Troubleshooting . . . . . 322, 324, 325
- Determine if an FDM transmitter and receiver system is operating correctly.
  - Identify the faulted component in a malfunctioning FDM transmitter and receiver system.

### **BASIC TELEPHONE (MODEL 1429)**

- 5102-312-130 Introduction to Communications Systems . . . . . ---
- Define the basic elements that make up communications systems.
  - Describe common circuits and components that are contained in the elements of communications systems.
  - Describe bandwidth as a limiting factor in communications systems.
  - Describe noise as a limiting factor in communications systems.
- 5102-312-160 Telephone Systems . . . . . ---
- Define the construction of a basic telephone system.
  - Describe the local area telephone network.
  - Describe local area telephone calling.
  - Describe the local loop.
  - Describe the long distance telephone network.
  - Describe a typical long distance hierarchy telephone system.
- 5102-312-190 Telephone Equipment . . . . . 337(2)
- Describe the operation of the mechanical telephone set.
  - Describe the operation of the electronic telephone set.
  - Observe the operation of an electronic telephone set and local loop.
  - Measure signals in the local loop of an electronic telephone set.

### **TELECOMMUNICATIONS**

- 5102-314-130 Fundamentals of Telecommunications . . . . . ---
- Define telecommunications.
  - Identify a basic telecommunications system.
  - Recognize the difference between wired and wireless.
  - Describe the mission of the Federal Communications Commission (FCC).

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### **TELECOMMUNICATIONS (cont.)**

- 5102-314-130 Fundamentals of Telecommunications (cont.)  
▪ Identify the types of telecommunications systems.
- 5102-314-160 Telecommunications Careers ..... ---  
▪ Identify the types of telecommunications careers.  
▪ Identify the educational requirements of telecommunications careers.  
▪ Describe the certification requirements of the telecommunications industry.
- 5102-314-190 History of Telecommunications ..... ---  
▪ Identify innovators in the telecommunications industry.  
▪ Describe a brief history of telecommunications.
- 5102-314-220 Special Interest Groups ..... ---  
▪ Describe special interest groups in the telecommunications industry.
- 5102-314-250 Telecommunications Terminology ..... ---  
▪ Recognize terms, jargon, and acronyms associated with the telecommunications industry.  
▪ Define telecommunications terms using the appropriate jargon and acronyms.  
▪ Identify symbols/flowcharts related to the telecommunications industry.
- 5102-314-310 Connection Links ..... ---  
▪ Define a connection link, a physical link, and an atmospheric link.  
▪ Understand the purpose of a connection link.  
▪ Understand the effects of bandwidth, attenuation, and EMI.  
▪ Define a metallic link.  
▪ Define a non-metallic link.  
▪ Identify a fiberoptic link.  
▪ State the advantages of a fiberoptic link.  
▪ Identify a radio link.  
▪ Identify a microwave link.  
▪ Identify a satellite link.
- 5102-314-340 Introduction to Network Switching ..... ---  
▪ Define and identify the purpose of switching in a telecommunications network.  
▪ Describe the four major methods and variations of switching in a telecommunications network.
- 5102-314-370 Broadcast Systems ..... ---  
▪ Identify and discuss the different types of broadcast systems.  
▪ Define and explain the role of broadcast systems in telecommunications.  
▪ Explain the purpose and use of the Global Positioning System.
- 5102-314-400 Spread Spectrum Modulation ..... ---  
▪ Identify the different techniques of spread spectrum modulation.  
▪ Define and explain the purpose of spread spectrum modulation.  
▪ Describe the PN sequence generation in spread spectrum systems.  
▪ Describe the need and process for synchronization and preamble in spread spectrum systems.
- 5102-314-430 Cellular Telephony ..... ---  
▪ Describe the theoretical and physical structures of a cellular telephone system and discuss the different multiplexing techniques used.  
▪ Define cellular telephony and associated terminology.  
▪ Explain the process of a cellular telephone call and state the difference between the original mobile telephone and cellular telephone.

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### **TELECOMMUNICATIONS (cont.)**

- 5102-314-460 Information Systems ..... ---
- Describe LAN, WAN, and MAN computer networks.
  - Identify the topologies and common components of the various types of networks.
  - Define the term network and associated terminology.
  - Understand the RF and IR wireless networks and explain the benefits they provide.
  - Describe the use of spread spectrum in wireless networks.
- 5102-314-490 Satellite Systems ..... ---
- Describe satellite telecommunications systems including satellite types and capabilities.
  - Understand the advantages and disadvantages of satellite radio.
  - List multiple access techniques and common satellite electronic circuits.

### **BASIC MICROWAVE (MODEL 3301)**

- 5121-112-130 Introduction to Microwaves ..... ---
- Provide a brief history of microwave inception and explain how microwave communications were initiated.
  - Identify basic microwave principles and recognize the Radio Frequency spectrum.
  - Identify microwave frequencies and factors affecting communications.
  - Identify metric prefixes.
  - Perform conversions between different metric prefixes.
- 5121-112-160 Introduction to Microwave Systems ..... 307, 308
- Identify various stages in a basic microwave communications system.
  - Describe the basic principle of multiplexing.
  - Describe the purpose of microwave repeater stations.
  - Identify basic microwave components and devices.
  - Observe the effects of blocked microwave transmission signals and misaligned microwave antennas.
  - Become familiar with the Nida Model 330 Microwave Trainer.
- 5121-112-190 Microwave Transmitters ..... 307, 308
- Describe the operation of typical microwave transmitters.
  - Describe the operation of the transmitter in the Nida Model 330 Microwave Trainer.
  - Observe and trace signals through a basic microwave transmitter.
- 5121-112-220 Microwave Receivers ..... 307, 308
- Describe the operation of a typical microwave receiver.
  - Describe the operation of the receiver in the Nida Model 330 Microwave Trainer.
  - Observe the trace signals through a basic microwave receiver.
- 5121-112-250 Waveguide Theory ..... ---
- Describe a waveguide and explain the advantages and disadvantages of waveguides over other means of transferring RF energy.
  - Explain how waveguides are developed from parallel to wire transmission lines.
  - Describe waveguide plumbing.
- 5121-112-280 Antennas ..... 307, 308
- Describe the basic construction and theory of operation of various types of antennas.
  - Verify that microwave signals can be reflected.
- 5121-112-310 Cavity Resonators and Tube Microwave Devices ..... ---
- Describe the purpose of cavity resonators.
  - Describe the basic theory and operation of cavity resonators.

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### **BASIC MICROWAVE (MODEL 3301) (cont.)**

- 5121-112-310 Cavity Resonators and Tube Microwave Devices (cont.)
- Describe the basic principle of microwave tubes and their limitations.
  - Describe the basic theory and operation of Klystrons and Magnetrons.
- 5121-112-340 Semiconductor Microwave Devices . . . . . ---
- Describe the limitations of Bipolar and Field Effect Transistors at microwave frequencies.
  - Describe methods to minimize limitations in Bipolar and Field Effect Transistors at microwave frequencies.
  - Describe the basic theory of operation of Varactor Diodes, Tunnel Diodes, Gunn Diodes and DROs.

### **ELECTROMAGNETICS (MODEL 1435)**

- 5142-310-130 Magnetism and Electromagnetic Principles . . . . . 182, 183
- Define magnetism.
  - Describe different types of magnetism.
  - Describe relays, motors, transformers, and generators.
  - Observe magnetic poles.
  - Demonstrate temporary magnets.
  - Examine electromagnetic operation.
  - Demonstrate an application of magnetism.
- 5142-310-160 Magnetic Calculations . . . . . ---
- Describe properties of magnetic lines of force.
  - Identify magnetic and non-magnetic materials.
  - Identify the characteristics of electromagnetism.
  - Calculate magnetomotive force.
  - Calculate magnetic field strength.
  - Determine force.
  - Determine torque.

### **INTRODUCTION TO MOTORS (MODEL 1432)**

- 5142-312-130 Introduction to Rotating Machinery . . . . . ---
- Describe the various devices that are called rotating machinery.
  - Describe Speed, Torque, Counter Electromotive Force (CEMF), Loads, Power, and Efficiency in rotating machinery.
- 5142-312-160 DC Motors and Generators . . . . . 180
- Describe the operation of DC motors.
  - Describe the operation of DC generators.
  - Observe the normal operation of a DC motor-generator set.
  - Measure signals in the control circuits for a DC motor-generator set.
  - Troubleshoot a DC motor-generator set.
- 5142-312-190 Stepper Motors . . . . . 181
- Describe the operation of stepper motors.
  - Describe the characteristics of stepper motors.
  - Observe the normal operation of stepper motors.
  - Measure signals in the control circuits for stepper motors.
  - Troubleshoot stepper motors.

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### **INTRODUCTION TO MOTORS (MODEL 1432) (cont.)**

- 5142-312-220 AC Motors and Generators ..... ---
- Describe motor theory of operation.
  - Describe AC motor construction.
  - Discuss terms and types of AC motors.
  - Discuss the equivalent model of an induction motor transformer.
  - Discuss general AC generator theory.
  - Describe generator construction.
  - Describe generator characteristics.

### **MOTOR CONTROL SYSTEMS (MODEL 170)**

#### **DC Motor Systems**

- 5142-314-130 DC Series Field Motors ..... ---
- Identify the principles and types of rotating machinery (motors).
  - Describe basic DC motor action.
  - Describe the DC series field motor.
  - Identify the principles of circular force and torque.
  - Describe the characteristics of a DC series field motor.
  - Identify the loaded characteristics of a DC series field motor.
- 5142-314-160 Brushless DC Motors ..... ---
- Identify the physical characteristics of BLDC motors.
  - Describe the advantages of BLDC over other types.
  - Understand basic BLDC types, applications, and configurations.
  - Describe motor drive, position sensing, and other controller functions.
- 5142-314-190 Troubleshooting AC Motors ..... ---
- Describe safety issues related to motor troubleshooting.
  - Describe routine maintenance on motors.
  - Describe a visual check of a motor.
  - Describe an operational check and a performance test.
- 5142-314-220 Pulse Width Modulation and Amplification ..... 178, 179
- Identify the principles of pulse width modulation.
  - Describe the operation of PWM motor control.
  - Describe the operation of a PWM amplifier/driver.
  - Measure signals at various points throughout a PWM circuit.
  - Measure and compare pulse width vs. current output of a PWM amplifier.
  - Recognize normal operation of a PWM motor driver.
- 5142-314-250 Open Loop Motor System Experiment ..... 178, 179
- Describe an open loop motor system.
  - Examine simple block diagrams of open loop systems.
  - List the terminal characteristics of an armature-controlled motor.
  - Measure circuit frequency and calculate rpm.
  - Measure armature voltages.
  - Measure armature current under locked and unlocked rotor conditions.

#### **Motor Control Systems**

- 5142-318-130 Motion Detection ..... 177, 178, 179
- Identify the characteristics of linear motion.
  - Identify the characteristics of circular motion and motion transducers.

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### **MOTOR CONTROL SYSTEMS (MODEL 170) (cont.)**

#### **Motor Control Systems (cont.)**

- 5142-318-130 Motion Detection (cont.)
- Compute linear and rotary motion rates based on system mechanical and electrical parameters.
  - Analyze motion to frequency for rpm and velocity.
  - Analyze motion to analog DC for rpm and velocity.
- 5142-318-160 Error Detection and Feedback . . . . . 177, 178, 179
- Describe a closed loop feedback controlled motor system.
  - Identify simple block diagrams of closed loop systems.
  - List the functions that a closed loop feedback system performs.
  - Measure the error and feedback signals in a closed loop DC motor system.
- 5142-318-190 Troubleshooting Closed Loop Systems . . . . . 177, 178, 179
- Describe the four-step process of basic troubleshooting.
  - Describe component isolation, signal tracing, and signal injection.
  - Trace signal flow through a closed loop feedback system.
  - Troubleshoot and fault isolate to the circuit level of a closed loop feedback system.
- 5142-318-220 Position Detection . . . . . 177, 178, 179
- Define position.
  - Describe positional devices.
  - Describe the characteristics of prime movers.
  - Calculate various output quantities of prime movers.
  - Describe analog angular position sensors.
  - Describe analog linear position sensors.
  - Describe digital angular position sensors.
  - Describe digital linear position sensors.
  - Compute linear and rotary position based on electrical and mechanical circuit parameters.
  - Analyze the position detection operation of an encoder wheel with CCW/CW sensing.
- 5142-318-250 Proportional, Integral, and Derivative Control System . . . . . ---
- Identify the principles of proportional and derivative control.
  - Identify the principles of proportional and integral control.
  - Identify the principles of proportional, integral, and derivative control.
- 5142-318-280 PID Control System Experiment . . . . . 177, 178, 179
- Identify the proportional, integral, and derivative circuits.
  - Adjust the PID proportional gain.
  - Adjust the PID integral reset control.
  - Adjust the PID derivative rate control.

### **HYDRAULIC AND PNEUMATIC SYSTEMS**

- 5142-412-130 Introduction to Hydraulic Systems . . . . . ---
- Describe hydraulics.
  - Understand the concept of hydraulics.
  - Realize hydraulic applications.
  - Understand basic hydraulic safety.
  - Describe a basic hydraulic system and its components.
  - Describe different system components and their schematic symbols.

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### **HYDRAULIC AND PNEUMATIC SYSTEMS (cont.)**

- 5142-412-160 Introduction to Pneumatic Systems ..... ---
- Describe pneumatics.
  - Understand the concept of pneumatics.
  - Realize pneumatic applications.
  - Understand basic pneumatic applications.
  - Describe a basic pneumatic system and its components.
  - Describe different system components and their schematic symbols.
- 5142-412-190 Fluid System Valve Operation ..... ---
- Recognize valves used in hydraulics and pneumatics.
  - Demonstrate the knowledge of the theory and applications of valves used in hydraulics and pneumatics.
- 5142-412-220 Hydraulic and Pneumatic Pumps ..... ---
- Recognize the types of pumps used in hydraulic systems.
  - Demonstrate the knowledge of pump operation and application.
  - Understand the causes of common pump failures.
  - Describe the basic repairs needed to restore pump operation.
  - Recognize the types of pumps used in pneumatic systems.
  - Demonstrate the knowledge of pump operation and application.
  - Understand the causes of common pump failures.
  - Describe the basic repairs needed to restore pump operation.
- 5142-412-250 Troubleshooting Hydraulic and Pneumatic Systems ..... ---
- Recognize the symptoms of common hydraulic and pneumatic component failures.
  - Demonstrate component troubleshooting procedures.

### **SYSTEMS - BASIC (MODEL 3600)**

#### **Introduction to Systems**

- 7211-112-130 Systems Familiarization ..... ST101, ST102, ST103, ST104, ST105, ST106
- Define a system.
  - Define structure, interconnectivity, and behavior.
  - Define input, process, and output.
  - Define feedback and system control.
  - Identify types of feedback and system control.
  - Define interface.
  - Apply a systems thinking approach.
  - Set up a system.
  - Follow setup instructions.
  - Initialize, align, and operate a system.
  - Perform a system E-Stop.
  - Perform a system restart.
  - Perform a system shutdown.
- 7211-112-160 Systems Safety ..... ---
- Define a hazard.
  - Identify a hazard as physical, chemical, ergonomic, radiation, psychological, or biological.
  - Perform a safety risk assessment.
  - Apply the hierarchy of risk controls.
  - Select the correct fire extinguisher to put out a class A, B, C, D, and combination fires.

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### **SYSTEMS - BASIC (MODEL 3600) (cont.)**

#### **Introduction to Systems (cont.)**

7211-112-160 Systems Safety (cont.)

- Read emergency evacuation route diagrams.
- Practice standard safety rules while working around and with electricity.
- Correlate OSHA safety code colors used in manufacturing to situations and devices.
- Read material safety data sheets (MSDS).
- Implement the 5-point eye safety checklist.
- Recognize the hazards of confined spaces.

7211-112-190 Multimeter Familiarization . . . . . ST101, ST102, ST103, ST104, ST105, ST106

- Define a digital multimeter's purpose.
- Identify quantities measured with a digital multimeter.
- Identify the sections of a digital multimeter.
- List the IEC Measurement Categories.
- List safe measurement techniques.
- Set up a DMM to measure DC and AC voltages.
- Measure and read DC and AC voltages.
- Apply safe voltage measurement techniques.
- Set up a DMM to measure DC current.
- Measure and read DC current.
- Apply safe current measurement techniques.
- Set up a DMM to measure resistance.
- Measure and read resistance.
- Set up a DMM to measure continuity.
- Measure and read continuity.
- Apply safe resistance and continuity measurement techniques.

7211-112-220 Oscilloscope Familiarization . . . . . ST101, ST102, ST103, ST104, ST105, ST106

- Define the purpose of an oscilloscope.
- Identify quantities measured with an oscilloscope.
- Identify the sections of an oscilloscope.
- Set up an oscilloscope.
- Zero a trace.
- Perform probe compensation.
- Use an oscilloscope to measure waveforms for determining DC voltage, AC voltage ( $V_{pk}$  and  $V_{pp}$ ), and period.
- Calculate frequency,  $V_{rms}$ , phase, and pulse width using an oscilloscope.
- Define and measure duty cycle.

#### **System Structure and Behavior**

7211-114-130 System Input and Output Devices . . . . . ST101, ST102, ST103, ST104, ST105, ST106

- Define a system input.
- Identify system input devices.
- Define a system output.
- Identify system output devices.
- Trace input and output subsystem connections using a composite diagram.
- Perform an alignment procedure to adjust sensor sensitivity.
- Verify normal operation of speed, position, and direction sensors using displays, monitors, and a multimeter.



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### **SYSTEMS - BASIC (MODEL 3600) (cont.)**

#### **System Structure and Behavior (cont.)**

7211-114-160 System Control and Interface . . . . . ST101, ST102, ST103, ST104, ST105, ST106

- Define process control
- Identify open loop control
- Identify closed loop control
- Read a control loop block diagram
- Recognize control station devices
- Define interface
- Identify hardware interface
- Identify software interface
- Identify user interface
- Examine various control signals.
- Control a system using GUI, HCI and HMI.
- Trace a control signal using a composite diagram.
- Analyze normal control signals using a multimeter and oscilloscope.

7211-114-190 System Indicator, Display, and Monitor Devices . . . . . ST101, ST102, ST103, ST104,  
ST105, ST106

- Recognize the difference between data and information
- Define the parts of a data acquisition system
- Recognize the difference between passive and active data collection
- Define the purpose of system monitoring
- Identify monitoring devices
- Define the purpose of system displays
- Identify display devices
- Read a display
- Manually monitor system operation
- Recognize a system malfunction using the display

#### **System Testing and Troubleshooting**

7211-116-190 System Malfunctions and Troubleshooting . . . . ST101, ST102, ST103, ST104, ST105,  
ST106

- Examine the systems troubleshooting process.
- Set up and initialize a system following a given procedure.
- Validate system operation using sensors, displays, and monitoring devices.
- Verify symptoms of subsystem malfunctions.
- Use a digital multimeter and oscilloscope to take measurements.
- Troubleshoot malfunctioning subsystems in a system.

### **SYSTEMS - RENEWABLE ENERGY - HOME (MODEL 3601)**

#### **Introduction**

7231-112-130 Introduction to Renewable Energy Systems . . . . . ---

- Express the need for renewable energy.
- Explain the four interdependent elements of renewable energy systems.
- Understand renewable energy sources.
- Describe energy conversion technologies.

7231-112-160 Energy Sources and Site Surveys . . . . . ---

- Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).

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### **SYSTEMS - RENEWABLE ENERGY - HOME (MODEL 3601) (cont.)**

#### **Introduction (cont.)**

7231-112-160 Energy Sources and Site Surveys (cont.)

- Illustrate energy resources (wind, solar).
- Explain the use of a site survey.
- Describe how to perform a site survey.

#### **Home Energy Systems**

7231-114-130 Home Solar Energy System Fundamentals . . . ES101, ES102, ES104, ES105, ES106, ES107

- Explain home solar energy operation.
- Describe solar resources and their uses for home energy.
- Recognize safe home solar energy maintenance methods.
- Recognize home solar energy common tools.
- Read a home solar energy block diagram to identify the major subsystems.
- Operate a home solar energy system using a block diagram.
- Verify the operation of the home solar energy system using sensors, monitors and display devices.
- Examine the operation of the home solar energy system.

7231-114-160 Home Wind Energy System Fundamentals . . . ES101, ES102, ES104, ES105, ES106, ES107, ES182

- Explain home wind energy operation.
- Describe the effects of wind speed and wind obstructions.
- Describe tilt-up tower operation.
- Recognize safe home wind energy maintenance methods.
- Recognize home wind energy common tools.
- Read a home wind energy block diagram to identify the major subsystems.
- Operate a home wind energy system using a block diagram.
- Verify the operation of the home wind energy system using sensors, monitors and display devices.
- Examine the operation of a home wind energy system.

7231-114-190 Home Hybrid Energy System Fundamentals . . . . . ES101, ES102, ES104, ES105, ES106, ES107, ES182

- Explain home backup power generation.
- Explain home inverter and grid-tied interface operation.
- Describe hybrid home energy system integration.
- Recognize safe home hybrid energy maintenance methods.
- Recognize home hybrid energy common tools.
- Read a home hybrid energy block diagram to identify the major subsystems.
- Operate a home hybrid energy system using a block diagram.
- Verify the operation of the home hybrid energy system using sensors, monitors, and display devices.
- Examine the operation of each home hybrid energy subsystem.

7231-114-220 Home Energy System Maintenance and Diagnostics . . ES101, ES102, ES104, ES105, ES106, ES107, ES182

- Recognize typical home energy preventive, scheduled, and unscheduled maintenance routines.
- Describe general inspection techniques for home energy systems.
- Recognize unscheduled maintenance routines.

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### **SYSTEMS - RENEWABLE ENERGY - HOME (MODEL 3601) (cont.)**

#### **Home Energy Systems (cont.)**

7231-114-220 Home Energy System Maintenance and Diagnostics (cont.)

- Describe when unscheduled maintenance is necessary.
- Set up and initialize a home energy system following a given procedure.
- Perform a home energy operational check.
- Show proper use of measurement devices.
- Examine home energy system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a home energy system using fault isolation procedures.

7231-114-250 Home Energy System Malfunctions and Troubleshooting . . . . . ES101, ES102, ES104, ES105, ES106, ES107

- Examine the troubleshooting process for home energy systems.
- Describe the basic tools used to troubleshoot home energy systems.
- Set up and initialize a home energy system following a given procedure.
- Validate system operation using sensors, displays, and monitoring devices.
- Verify symptoms of home energy subsystem malfunctions.
- Use a digital multimeter to take measurements.
- Troubleshoot malfunctioning subsystems in a home energy system.

7231-114-920 Home Energy Systems Post-Test (Theory) . . . . . ---

### **SYSTEMS - RENEWABLE ENERGY - COMMERCIAL WIND (MODEL 3602)**

#### **Introduction**

7231-112-130 Introduction to Renewable Energy Systems . . . . . ---

- Express the need for renewable energy.
- Explain the four interdependent elements of renewable energy systems.
- Understand renewable energy sources.
- Describe energy conversion technologies.

7231-112-160 Energy Sources and Site Surveys . . . . . ---

- Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).
- Illustrate energy resources (wind, solar).
- Explain the use of a site survey.
- Describe how to perform a site survey.

#### **Wind Energy Systems**

7231-116-130 Wind Turbine System Fundamentals . . . . . ES101, ES102, ES103, ES110, ES111, ES112, ES181

- Describe the types of wind turbines (HAWT and VAWT).
- Describe the differences between commercial and residential wind generation.
- Recognize safe wind turbine maintenance methods.
- Explain commercial wind power subsystem operation (generator, gearing, cooling, control, yaw, pitch, brake).
- Read a wind turbine block diagram to identify major subsystems.
- Set up and initialize a wind turbine system following a given procedure.
- Operate a wind turbine system using a block diagram.
- Verify the operation of a wind turbine system using sensors, monitors, and display devices.
- Examine the operation of each wind turbine subsystem.

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### **SYSTEMS - RENEWABLE ENERGY - COMMERCIAL WIND (MODEL 3602) (cont.)**

#### **Wind Energy Systems (cont.)**

7231-116-160 3-Phase Power Fundamentals . . . . . ES101, ES102, ES103, ES110, ES111, ES112, ES181

- Describe 3-phase power.
- Describe the operation of an AC generator.
- Describe the operation of inverters.
- Describe the difference between 50 Hz and 60 Hz power.
- Read a wind turbine block diagram.
- Operate a wind turbine system using a block diagram.
- Verify the presence of 3-phase power using an oscilloscope.

7231-116-190 Wind Turbine System Maintenance and Diagnostics . . ES101, ES102, ES103, ES110, ES111, ES112, ES181

- Recognize wind turbine preventive/scheduled and unscheduled maintenance routines.
- Describe physical inspection techniques for a wind turbine system.
- Recognize unscheduled maintenance routines.
- Describe when unscheduled maintenance is necessary.
- Set up and initialize a wind turbine system following a given procedure.
- Perform a wind turbine system operational check.
- Show proper use of measurement devices.
- Examine wind turbine system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a wind turbine system using fault isolation procedures.

7231-116-220 Wind Turbine System Malfunctions and Troubleshooting . . . . . ES101, ES102, ES103, ES110, ES111, ES112, ES181

- Examine the troubleshooting process for wind turbine systems.
- Describe the basic tools used to troubleshoot commercial wind turbine systems.
- Initialize a wind turbine system.
- Validate a wind turbine system operation.
- Recognize symptoms of wind turbine subsystem malfunctions.
- Use a digital multimeter and oscilloscope to take measurements.
- Identify a malfunctioning subsystem in a wind turbine power system.

7231-116-920 Commercial Wind Energy Systems Post-Test (Theory) . . . . . ---

### **SYSTEMS - RENEWABLE ENERGY - COMMERCIAL SOLAR (MODEL 3603)**

#### **Introduction**

7231-112-130 Introduction to Renewable Energy Systems . . . . . ---

- Express the need for renewable energy.
- Explain the four interdependent elements of renewable energy systems.
- Understand renewable energy sources.
- Describe energy conversion technologies.

7231-112-160 Energy Sources and Site Surveys . . . . . ---

- Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).
- Illustrate energy resources (wind, solar).
- Explain the use of a site survey.

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### **SYSTEMS - RENEWABLE ENERGY - COMMERCIAL SOLAR (MODEL 3603) (cont.)**

#### **Introduction (cont.)**

7231-112-160 Energy Sources and Site Surveys (cont.)

- Describe how to perform a site survey.

#### **Solar Energy Systems**

7231-118-130 Solar Thermal System Fundamentals . . . . . ---

- Express the need for solar thermal power as a renewable energy.
- Differentiate non-concentrating and concentrating thermal collectors.
- Explain the three main classes of solar thermal collectors.
- Examine solar pool heating systems.
- Examine solar water heating systems.
- Examine solar space heating systems.
- Examine parabolic trough systems.
- Examine solar dish (Stirling engine) systems.
- Examine solar power tower systems.

7231-118-160 Solar Photovoltaic System Fundamentals . . . . ES101, ES102, ES104, ES107, ES108, ES109

- Express the need for solar photovoltaic power as a renewable energy.
- Explain the photovoltaic (PV) effect and construction.
- Describe solar resources.
- Describe general solar photovoltaic personal protective equipment.
- Explain proper installation procedures.
- Recognize safe installation and maintenance methods.
- Recognize solar PV system common tools.
- Read a solar photovoltaic system block diagram to identify the major subsystems.
- Set up and initialize a solar PV system following a given procedure.
- Operate a solar photovoltaic system using a block diagram.
- Verify the operation of a solar photovoltaic system using sensors, monitors, and display devices.
- Examine the operation of each solar photovoltaic subsystem.

7231-118-190 Solar Photovoltaic System Maintenance and Diagnostics . . . . . ES101, ES102, ES104, ES107, ES108, ES109

- Recognize solar photovoltaic preventive/scheduled and unscheduled maintenance routines.
- Describe physical inspection techniques for solar photovoltaic systems.
- Recognize unscheduled maintenance routines.
- Describe when unscheduled maintenance is necessary.
- Set up and initialize a solar PV system following a given procedure.
- Perform a solar photovoltaic system operational check.
- Show proper use of measurement devices.
- Examine solar photovoltaic system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a solar photovoltaic system using fault isolation procedures.

7231-118-220 Solar Photovoltaic System Malfunctions and Troubleshooting . . . . . ES101, ES102, ES104, ES107, ES108, ES109

- Examine the troubleshooting process for solar photovoltaic systems.
- Describe the basic tools used to troubleshoot solar photovoltaic systems.
- Set up and initialize a solar PV system following a given procedure.
- Validate system operation using sensors, displays, and monitoring devices.

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### **SYSTEMS - RENEWABLE ENERGY - COMMERCIAL SOLAR (MODEL 3603) (cont.)**

#### **Solar Energy Systems (cont.)**

7231-118-220 Solar Photovoltaic System Malfunctions and Troubleshooting (cont.)

- Verify symptoms of solar photovoltaic subsystem malfunctions.
- Use a digital multimeter and oscilloscope to take measurements.
- Troubleshoot malfunctioning subsystems in a solar photovoltaic system.

7231-118-920 Commercial Solar Energy Systems Post-Test (Theory) . . . . . ---

### **SONAR (MODEL 3650)**

7811-614-130 Introduction to Sonar . . . . . ---

- Describe acoustic waves.
- Describe frequency and wavelength.
- Describe the Doppler effect.
- Define sonar.
- Describe acoustic wave propagation speed and sound pressure level.
- Define sound intensity.
- Describe decibel and signal-to-noise ratio.
- Define ambient noise as related to sonar performance.

7811-614-160 Principles of Sonar . . . . . MS101, MS102, MS103, MS104, MS105, MS106, MS113

- State the different roles of sonar, including: search, attack, noisemaking, navigation, bottom search, communication, oceanographic, active intercept, torpedo warning, classification, self noise monitoring, and laser depth.
- State and describe the principles of sound transmission, including: transmission speed, discrimination, and penetration.
- Describe the different methods of submarine detection including: magnetic anomaly detection, electromagnetic action, sniffing, infrared buoys, seabed hydrophones, towed array, and sonar.
- Define the terms active and passive, and relate to the detection methods.
- Read an active sonar block diagram to identify major subsystems.
- Operate and observe an active sonar system.
- Observe distance measuring on an active sonar system.

7811-614-190 Oceanography . . . . . MS107, MS108, MS109, MS110, MS111, MS112, MS114(2)

- State and define the three main factors of temperature, depth, and salinity that affect the speed of sound through water.
- State and describe the following terms: refraction, velocity gradients (positive, negative, and zero), surface layers, thermocline (seasonal and permanent), isothermal.
- Describe the purpose of variable depth sonar.
- Explain the operation of a typical shipborne bathythermograph (XBT) installation.
- State and define the following propagation losses: spreading, absorption, scattering, Doppler distortion, reverberation, target size, target inclination, and noise (ambient and ship).
- List and explain the methods employed to minimize ship noise including: radiated noise, self noise (masker), propeller noise (agouti), crew noise, ship quiet states (cruising, quiet state, ultra quiet state, noise reduction organization), and noise ranging.
- Observe the display outputs of a passive sonar system operation.

7811-614-220 Basic Sonar Transmitter, Receiver, and Processing . MS101, MS102, MS103, MS104,  
MS105, MS106, MS113, MS107,  
MS108, MS109, MS110, MS111,  
MS112, MS114(2)

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### **SONAR (MODEL 3650) (cont.)**

- 7811-614-220 Basic Sonar Transmitter, Receiver, and Processing (cont.)
- List and state the function of each block in a typical sonar transmitter: Timing, oscillator, PFN, BFN, TX power amplifier, T/R switch, transducer (line, planar, spherical, cylindrical, and conformal arrays), RX amplifier, system interface, own Doppler nullifier, control/display, and headset.
  - State the principles of beam-forming.
  - List and explain typical sonar active (sector, ripple, omni) and passive operating modes.
  - State the advantages/disadvantages of active and passive modes, of hull mounted and towed arrays, and of multistatic and bistatic sonars.
  - Using a block diagram as a reference, observe signal flow and measure input and output signals between modules of an active sonar system.
  - Given an active sonar system, align the system for maximum performance, perform subsystem operational checks, and detect a malfunctioning subsystem.
  - Using a block diagram as a reference, observe signal flow and measure input and output signals between modules of a passive sonar system.
  - Given a passive sonar system, align the system for maximum performance, perform subsystem operational checks, and detect a malfunctioning subsystem.
- 7811-614-250 Active Sonar System Troubleshooting . . . . . MS101, MS102, MS103, MS104, MS105, MS106, MS113
- Examine the troubleshooting process for active sonar systems.
  - Set up and initialize an active sonar system following a given procedure.
  - Validate system operation using sensors, displays, and monitoring devices.
  - Verify symptoms of active sonar subsystem malfunctions.
  - Use a digital oscilloscope to take measurements.
  - Troubleshoot malfunctioning subsystems in an active sonar system.
- 7811-614-280 Passive Sonar System Experiments . . . . . MS107, MS108, MS109, MS110, MS111, MS112, MS114(2)
- Set up and initialize a passive sonar system following a given procedure.
  - Validate system operation using sensors, displays, and monitoring devices.
  - Verify symptoms of passive sonar subsystem malfunctions.
  - Use a digital oscilloscope to take measurements.
  - Troubleshoot malfunctioning subsystems in a passive sonar system.
- 7811-614-310 Ships Fitted Sonar Equipment - Royal Australian Navy Vessels . . . . . ---
- Identify FFG (Adelaide class) sonar equipment.
  - Identify FFH (Anzac class) sonar equipment.
  - Identify SSG (Collins class) sonar equipment.
  - Describe sonar equipment used on FFG, FFH, and SSG vessels.
  - Identify MHC sonar equipment.
  - Identify AGS sonar equipment
  - Identify SMB sonar equipment.
  - Identify AGSC sonar equipment.
  - Describe MHC, HS, SMB, and SML sonar equipment.
- 7811-614-940 Sonar Post-Test (Theory) . . . . . ---
- 7811-614-940AU Sonar Post-Test (Theory) . . . . . ---

## OBJECTIVE LISTING - HTML Lessons

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### **FUNDAMENTALS OF AVIATION TECHNOLOGY**

#### **Introduction to Aviation Maintenance Technology**

- 7121-114-190 Introduction to Aviation Technology . . . . . ---
- Identify the types of careers that support the aviation industry.
  - Describe a brief history of aviation maintenance.
  - Describe the certification process of the Aviation Maintenance Technician.
  - Describe the certification process of the Avionics Technician.
- 7121-114-250 General Aircraft Principles . . . . . ---
- Describe the major sections of a typical aircraft.
  - Define and describe the physics principles that affect thrust, drag, lift, and gravity.
  - Define and describe the three axes of flight.
  - Define and describe the primary flight controls of an aircraft.
  - Define and describe the secondary flight controls of an aircraft.
  - Define and describe the auxiliary flight controls of an aircraft.
- 7121-114-310 Aircraft Structures . . . . . ---
- Describe the types of materials used in aircraft construction.
  - Describe the advantages and disadvantages of using metals in aircraft construction.
  - Describe the advantages and disadvantages of using composites in aircraft construction.
  - Describe fuselage shapes and construction, and their effect on aircraft flight.
  - Describe wing shapes and construction, and their effect on aircraft flight.
  - Describe tail shapes and construction, and their effect on aircraft flight.
- 7121-114-370 Aircraft Power Plants . . . . . ---
- Describe the principles and operation of internal combustion engines.
  - Describe the principles and operation of jet propulsion engines.
  - Understand the fundamentals of propellers.
- 7121-114-490 FOE (Foreign Object Elimination) . . . . . ---
- Define terminology and acronyms associated with FOD.
  - Identify the types of FOD.
  - Describe the potential damage or harm to aircraft and humans by foreign objects found in the aviation community.
  - Identify good housekeeping practices to reduce and eliminate FOD.
  - Define control methods for eliminating FOD in the hangar and ramp areas.
  - Describe the methods of protecting parts from FOD.
  - Define the components of an FOE (Foreign Object Elimination) program.
  - Describe the process followed when tools or material are missing during aircraft maintenance.
  - Detail a brief history of Nida Corporation.
  - Describe the various aviation technical training programs that Nida offers.

#### **Math for Aircraft Technicians**

- 7121-118-160 Fractions . . . . . ---
- Describe fractions.
  - Describe proper and improper fractions.
  - Change improper fractions to whole numbers or mixed numbers.
  - Change mixed numbers to improper fractions.
  - Reduce fractions to the lowest terms.
- 7121-118-190 Fraction Operations . . . . . ---
- Add fractions.
  - Subtract fractions.



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### **FUNDAMENTALS OF AVIATION TECHNOLOGY (cont.)**

#### **Math for Aircraft Technicians (cont.)**

7121-118-190 Fraction Operations (cont.)

- Multiply fractions.
- Divide fractions.

7121-118-220 Decimal Fractions ..... ---

- Describe decimal fractions.
- Recognize positional values in decimal fractions.
- Convert decimal fractions to standard fractions.
- Convert standard fractions to decimal.
- Add decimal fractions.
- Subtract decimal fractions.
- Multiply decimal fractions.
- Divide decimal fractions.

7121-118-250 Percents ..... ---

- Describe percents.
- Change percents to decimal numbers.
- Change decimal numbers to percents.
- Calculate the percentage part.
- Calculate the percentage rate.
- Calculate the percentage base.

7121-118-280 Signed Numbers ..... ---

- Describe signed numbers.
- Describe the signed number line.
- Determine the relationship between two signed numbers.
- Add signed numbers.
- Subtract signed numbers.
- Multiply signed numbers.
- Divide signed numbers.

7121-118-310 Exponents and Square Roots ..... ---

- Describe exponents.
- Calculate the result of numbers that use exponents.
- Describe square roots.
- Calculate square roots.

7121-118-340 Metric Notation ..... ---

- Convert decimal numbers to powers of ten and vice versa.
- Convert decimal numbers to metric prefixes and vice versa.
- Add, subtract, multiply, and divide powers of ten.
- Add, subtract, multiply, and divide metric prefixes.

7121-118-370 Ratio and Proportion ..... ---

- Compare two numbers or quantities in ratio form.
- Determine ratios pertaining to technical industry applications.
- Solve proportion problems.

7121-118-520 Fundamentals of Algebra ..... ---

- Describe real numbers.
- Describe the four fundamental operations of real numbers.
- Describe real number variables.
- Describe the order of operations.

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### **FUNDAMENTALS OF AVIATION TECHNOLOGY (cont.)**

#### **Math for Aircraft Technicians (cont.)**

7121-118-520 Fundamentals of Algebra (cont.)

- Combine variables.
- Describe real number properties - closure, commutative, associative, identity, inverse, distributive.

7121-118-550 Linear Equations . . . . . ---

- Describe addition and subtraction laws.
- Solve  $X + A = B$  type of equations.
- Solve  $X - A = B$  type of equations.
- Describe multiplication and division laws.
- Solve  $X \times A = B$  type of equations.
- Solve  $X \div A = B$  type of equations.
- Describe a formula.
- Place a word problem in an equation.
- Solve for the unknown quantity.

7121-118-580 Solving Linear Equations . . . . . ---

- Use the basic laws of equations to solve linear equations.
- Solve problems in the format of  $ax + b = c$  and  $ax - b = c$ .
- Solve problems in the format of  $x/a + b = c$ .
- Use the four-step process to solve word problems.
- Solve word problems in the format of linear equations.

7121-118-640 Angular and Circular Measurements . . . . . ---

- Become familiar with some basic concepts of angular and circular characteristics including: angle, diameter, and radius.
- Describe angular measurement using: try square, carpenter's square, protractor, sliding T-bevel, and combination square.
- Describe diameter and radius measurements using calipers, micrometers, and vernier calipers.

7121-118-670 Area Measurements . . . . . ---

- Define rectangles and squares.
- Determine the difference between the two.
- Use the area formula for squares and rectangles.
- Define parallelograms and triangles.
- Determine the relationship between the two.
- Use the area formula for parallelograms and triangles.
- Define a trapezoid.
- Differentiate trapezoids from parallelograms.
- Define the dimensions of a circle: radius, diameter, and circumference.
- Use the formulas for area and circumference.

7121-118-700 Volume Measurements . . . . . ---

- Define volume and describe how it relates to area.
- Differentiate between liter, centimeter, and meter.
- Solve problems of volume measurement in a solid rectangle.
- Define and be able to recognize a prism.
- Define and be able to recognize a pyramid.
- Using the formulas for each, solve problems of prism and pyramid volume.
- Define and be able to recognize a cylinder.

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### **FUNDAMENTALS OF AVIATION TECHNOLOGY (cont.)**

#### **Math for Aircraft Technicians (cont.)**

- 7121-118-700 Volume Measurements (cont.)
- Define and be able to recognize a cone.
  - Define and be able to recognize a sphere.
  - Using the formulas for each, solve problems of cylinder, cone, and sphere volume.
- 7121-118-730 Velocity and Acceleration Measurements . . . . . ---
- Define vector and scalar quantities and be able to differentiate between the two.
  - Define and be able to solve problems of velocity.
  - Define and be able to solve problems of acceleration.
- 7121-118-760 Force Measurements . . . . . ---
- Describe force as it relates to inertia and Newton's First Law of Motion.
  - Describe force as it relates to acceleration and Newton's Second Law of Motion.
  - Describe force as it relates to interaction and Newton's Third Law of Motion.
- 7121-118-790 Work and Power Measurements . . . . . ---
- Define work and be able to solve problems using the standard measure of work, the newton (N).
  - Define power and be able to solve problems using the standard measure of power, the joule (J).

#### **Science for Aircraft Technicians**

- 7121-122-130 Introduction to Chemistry . . . . . ---
- Define chemistry.
  - Describe the history of chemistry.
  - Recognize chemistry's impact on everyday life.
- 7121-122-160 Matter and Energy . . . . . ---
- Define Matter and Energy.
  - Name the three states of matter.
  - Distinguish classes of matter.
  - Differentiate between physical changes and chemical reactions.
- 7121-122-190 Solids, Liquids, and Gases . . . . . ---
- Identify the three physical states of matter.
  - Define the properties of the three states of matter.
  - Understand how matter changes from one state to another.
- 7121-122-730 Simple Machines . . . . . ---
- Identify types of simple machines.
  - Identify the three classes of levers.
  - Determine ratio and proportion outcomes of levers.
  - Identify the wheel and axle.
  - Determine mechanical advantage of a wheel and axle.
  - Identify a pulley.
  - Determine mechanical advantage of a block and tackle.
  - Identify inclined plane, wedge, and screw.
  - Identify how the inclined plane, wedge, and screw are used.
  - Determine the mechanical advantage of an inclined plane, wedge, and screw.
  - Determine threads per inch (TPI) and pitch of a screw.

#### **Aircraft Publications**

- 7121-126-130 Aircraft Regulatory Publications . . . . . FAR/AMT Book
- Identify the FAR Parts that apply to the Airframe and Power Plant Technician.

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### **FUNDAMENTALS OF AVIATION TECHNOLOGY (cont.)**

#### **Aircraft Publications (cont.)**

7121-126-130 Aircraft Regulatory Publications (cont.)

- Identify the FAR Part titles that apply to the Airframe and Power Plant Technician.
- Define selected Part 1 abbreviations.
- Describe the purpose of FAA Regulatory Publications.
- Identify the correct publication to locate aircraft maintenance requirements.

7121-126-190 Aircraft Drawings . . . . . ---

- Identify types of aircraft drawings.
- Understand symbols, markings, and lines on aircraft drawings.
- Describe the ways information is presented in an aircraft drawing.
- Prepare drawing in accordance with instructor provided specifications.

7121-126-250 Aircraft Technical Publications . . . . . ---

- Identify technical information using the Air Transport Association Specification 100 (ATA Spec 100) numbering system.
- Describe the purpose and identify the information in the Aircraft Maintenance, Overhaul, Structural Repair, Service, and Component manuals.
- Identify the purpose of Service Bulletins and describe their use.
- Describe the purpose of the Illustrated Parts Catalog/Breakdown Manual.
- Identify the layout, structure, and sections of the Illustrated Parts Catalog/Breakdown Manual.
- Utilizing aircraft technical publications, identify the proper procedures for given tasks.
- Utilizing an aircraft IPC/IPB, locate information on assemblies, subassemblies, and parts.

#### **Line Maintenance**

7121-130-130 Flight Line Safety . . . . . ---

- Describe the personal protection required when working on an aircraft flight line.
- Describe and identify flight line ground support equipment.
- Demonstrate the procedures and safety precautions on an aircraft flight line.
- Identify the danger zones associated with aircraft movement and operations.

7121-130-190 Flight Line Fire Protection . . . . . ---

- Define the elements of fire.
- Understand fire classifications.
- Identify the correct fire extinguishing agent for a given fire classification.
- Identify and describe the fire-prone areas and fire fighting areas on an aircraft.
- Describe the duties of an aircraft fireguard.
- Understand how to use a portable fire extinguisher.

7121-130-250 Aircraft Ground Operations . . . . . ---

- Understand how aircraft ground operations are performed.
- Explain the proper procedures for towing and taxiing an aircraft.
- Identify the types of aircraft tie-down equipment.
- Identify the proper tie-down method for various weather conditions.
- Describe the procedures for de-icing an aircraft.

### **AIRCRAFT ELECTRICAL (MODEL 1438P)**

#### **Aircraft Wiring**

7121-314-190 Cables, Connectors, and Tools . . . . . ---

- Define wire.

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### **AIRCRAFT ELECTRICAL (MODEL 1438P) (cont.)**

#### **Aircraft Wiring (cont.)**

7121-314-190 Cables, Connectors, and Tools (cont.)

- Define cable.
- Define harness.
- Identify solid and stranded wires.
- Understand the purpose of a connector.
- Determine the difference between a plug and jack.
- Understand connector terminology.
- Understand the purpose of cutters.
- Understand the purpose of crimpers.
- Understand the purpose of a multimeter.
- Understand the purpose of a cable tester.

7121-314-220 Single Wire Assemblies . . . . . W7

- Identify the steps used to prepare, build, and test single wire assemblies.
- Assemble a FASTON type connector.
- Assemble a butt splice.
- Assemble a 0.156 KK Series connector.
- Build and test single wire assemblies without guidance.

7121-314-250 Cabling Standards and Categories of Performance . . . . . ---

- Understand the origin of cabling standards.
- Know the agencies responsible for establishing standards.
- Define Universal Service Ordering Codes.
- Understand the types of serial data connections.
- Describe characteristics of a multi-conductor cable.
- Describe characteristics of a flat satin cable.
- Describe characteristics of a twisted pair cable.
- Describe characteristics of a coaxial cable.
- Identify UTP, SCTP, and STP cable.
- Understand Cat 1 through Cat 7 cable properties.

7121-314-280 Twisted Pair Cable . . . . . W6

- Identify and describe how a modular RJ45 plug is used.
- Identify and describe how a keystone jack is used.
- Identify the difference between an ATT 110 punchdown type jack and a CAT 5 TIA/EIA-568-A/B keystone type jack.
- Identify and describe how CAT 5 UTP cable is used.
- Understand T568A, T568B, and 10BASE-T wiring standards.
- Understand straight-through and cross-over wiring methods.
- Understand how to prepare CAT 5 UTP cable for assembly with an RJ45 modular plug and CAT 5 TIA/EIA-568-A/B keystone type jack.
- Identify the tools used to attach a modular RJ45 plug and CAT 5 TIA/EIA-568-A/B keystone type jack to CAT 5 UTP.
- Understand how to attach a CAT 5 TIA/EIA-568-A/B keystone type jack to a UTP cable following T568A standards.
- Prepare, build, and test a CAT 5 UTP cable with RJ45 plugs following T568A standards and the straight-through wiring method without guidance.
- Prepare, build, and test CAT 5 UTP cable with a CAT 5 TIA/EIA-568-A/B keystone type jack following T568A standards and the straight-through wiring method.

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### AIRCRAFT ELECTRICAL (MODEL 1438P) (cont.)

#### Aircraft Wiring (cont.)

- 7121-314-310 Coaxial Cable . . . . . W6
- Describe the parts of a coaxial cable.
  - Recognize types of coaxial cable.
  - Identify coaxial cable applications.
  - Recognize an F-type coaxial connector.
  - Recognize a BNC coaxial connector.
  - Understand how to prepare a coaxial cable for assembly with an F-type connector and a BNC connector.
  - Identify the tools used to construct a coaxial cable assembly.
  - Understand how to test a coaxial cable assembly with a multimeter.
  - Prepare, build, and test a coaxial cable assembly with F-type connectors.
  - Prepare, build, and test a coaxial cable assembly with BNC type connectors.
- 7121-314-400 Soldering Safety and Electrostatic Sensitive Devices . . . . . ---
- Understand the safety requirements of soldering chemicals and supplies.
  - Describe the procedure for use of an eyewash station.
  - Define an electrostatic sensitive device.
  - Describe the sources of electrostatic discharge and list its hazards to electronic components.
  - Identify the static-producing materials in the work area.
  - Explain the principles of static control and methods employed in developing static control facilities.
  - Describe the special handling, identification, packaging, and protection requirements for electrostatic sensitive devices.
- 7121-314-430 Solder and Soldering Equipment . . . . . ---
- Identify different types of solder.
  - Identify proper solder flux.
  - Understand how to handle a soldering iron properly.
  - Understand how and why a soldering iron tip is tinned.
  - Understand correct use of safety equipment.
  - Identify hand tools used to aid soldering.
  - Describe proper use of heat sinks and wire forming tools.
  - Use safety equipment properly.
  - Demonstrate how to tin a soldering iron tip properly.
- 7121-314-460 Wire Stripping, Tinning, and Splicing . . . . . ---
- Identify different types of wire strippers and trimmers.
  - Identify the proper tools used to strip various wires.
  - Understand how to strip wires using wire strippers.
  - Identify methods of wire tinning.
  - Understand how and when to tin a wire.
  - Identify methods of wire splicing.
  - Understand how and when to splice a wire.
  - Strip wires using the available wire strippers.
  - Demonstrate wire tinning.
  - Demonstrate wire splicing.
- 7121-314-490 Terminal Types and Connections . . . . . ---
- Understand the IPC/EIA J-STD-001C standards used for turret, bifurcated, and hook terminals.

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### **AIRCRAFT ELECTRICAL (MODEL 1438P) (cont.)**

#### **Aircraft Wiring (cont.)**

7121-314-490 Terminal Types and Connections (cont.)

- Identify turret, bifurcated, and hook terminals.
- Describe the application of turret, bifurcated, and hook terminals.
- Understand the IPC/EIA J-STD-001C standards used for pierced and cup turrets.
- Identify pierced and cup turrets.
- Describe the application of pierced and cup turrets terminals.
- Solder connections to a turret terminal.
- Solder connections to a bifurcated terminal.
- Solder connections to a hook terminal.
- Solder connections to a pierced terminal.
- Solder a connection to a cup terminal.

7121-314-520 Printed Circuit Board Types and Manufacturing Methods . . . . . 1410K1

- Identify the general characteristics of PC boards.
- Identify several connection methods used on PC boards.
- Identify the options and procedures available for repairing broken circuit board copper lands.
- Prepare a circuit board for repair using a surface mount jumper.
- Repair a circuit board using a surface mount jumper.

7121-314-700 Aircraft Wires and Connectors . . . . . ---

- Identify the common types of wire and cable and their uses.
- Identify each element of a wire identification number.
- Describe the purpose of wire bundle lacing, spot tying, grommets, Adel clamps, and wrapping.
- Identify the types and purpose of aircraft wiring splices, terminal lugs, and connectors.
- Identify the types of tools utilized in maintaining aircraft wiring connections.

7121-314-730 Aircraft Wire Repair and Troubleshooting . . . . . 746, 747, 748

- Identify parts of a wire harness assembly.
- Understand how a wire harness assembly is constructed using screw-on and twist and lock connectors.
- Identify tools required to build a wire and connector harness assembly that has screw-on and twist and lock connectors.
- Understand how wire and harness assembly tools are used.
- Build and install a simple aircraft wiring system.
- Analyze a simple aircraft wiring system.
- Identify faults in a wire and connector assembly.
- Repair a fault in a wire and connector assembly.
- Modify the simple aircraft wiring system according to a sample FAA Airworthiness Directive and Manufacturer's Service Bulletin.
- Remove the wiring and connectors from the Cockpit Wiring circuit card.
- Disassemble the wiring harness on the Aircraft Wiring circuit card.
- Remove the wire harness from the Bulkhead Harness circuit card.
- Restore circuit card soldered wire connections, plugs, and jacks to reusable conditions.

#### **Aircraft Power**

7121-318-130 Introduction to Aircraft Systems Troubleshooting . . . . . 739, 740, 741, 742

- Describe the types of aircraft systems and their purpose.
- Describe the steps in a typical troubleshooting process.

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### **AIRCRAFT ELECTRICAL (MODEL 1438P) (cont.)**

#### **Aircraft Power (cont.)**

- 7121-318-130 Introduction to Aircraft Systems Troubleshooting (cont.)
- Use the basic troubleshooting process to identify probable faults in a generic operational circuit card system.
- 7121-318-190 Aircraft Batteries . . . . . ---
- Explain the theory of chemical batteries.
  - Identify types and construction of aircraft batteries.
  - Identify battery shop safety features and precautions when servicing various types of batteries.
  - Explain the process of servicing a lead-acid battery.
  - Explain the process of servicing a nickel-cadmium battery.
  - Service an aircraft battery in accordance with published procedures.
- 7121-318-250 Aircraft DC Generation Systems . . . . . 180, 734, 735, 736
- Identify the types of DC generation devices.
  - Describe the operation of a DC generator, DC alternator, turbine engine starter-generator, converter, and transformer rectifier.
  - Describe the purpose and operation of current limiters, DC regulators, reverse current relays (RCRs), generator control units (GCUs), and alternator control units (ACUs).
  - Identify common problems encountered in a DC generation system and their typical fixes.
  - Describe the operation of a twin-engine alternator system.
  - Describe the purpose and operation of alternator load balancing.
  - Balance an alternator paralleling system.
- 7121-318-310 Aircraft AC Generation Systems . . . . . ---
- Identify the types of AC generation devices.
  - Describe the operation of an AC generator/inverter.
  - Describe the operation of an AC generation system.
  - Identify common inspection and maintenance practices of an AC generation system.
  - Given AC generation fault scenarios, use a schematic to identify the probable cause.
- 7121-318-370 Basic Aircraft Power Distribution Systems . . . . . 734, 735
- Describe the operation of a basic power distribution system.
  - Identify the basic requirements for a power distribution system.
  - Identify the various components of basic power distribution systems.
  - Observe the operation of a basic power distribution system.
  - Observe faults in a basic power distribution system.
- 7121-318-430 Multi-Engine Aircraft Power Distribution Systems . . . . . 735, 736
- Describe the operation of a split-bus power distribution system.
  - Identify the components of a split-bus power distribution system.
  - Describe the operation of a parallel bus power distribution system.
  - Identify the components of a parallel bus power distribution system.
  - Observe the operation of a split-bus distribution system.
  - Identify faults in a basic split-bus distribution system.

### **AIRCRAFT ELECTRICAL SYSTEMS (MODEL 1438S)**

#### **Aircraft Airframe Systems**

- 7121-514-190 Aircraft Lighting Systems . . . . . 749, 750, 751, 752
- Identify the types of light bulbs used on aircraft.



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### **AIRCRAFT ELECTRICAL SYSTEMS (MODEL 1438S) (cont.)**

#### **Aircraft Airframe Systems (cont.)**

##### 7121-514-190 Aircraft Lighting Systems (cont.)

- Given a list of light bulb characteristics, identify the correct bulb for a given condition.
- Describe the configuration, purpose, and operation of typical aircraft interior and emergency lighting system circuits.
- Describe exterior navigation lighting locations and configuration.
- Identify typical exterior lighting used for landing, taxiing, and safety.
- Observe and troubleshoot an incandescent lighting circuit.
- Observe and troubleshoot a strobe lighting system.
- Observe and troubleshoot malfunctions in interior lighting and emergency exit systems.

##### 7121-514-250 Aircraft Ice and Rain Protection Systems . . . . . ---

- Describe the dangers of aircraft icing.
- Describe the types and operation of aircraft ice detection systems.
- Identify the components and function of the pitot-static ice protection system.
- Identify the types and operation of aircraft anti-ice systems.
- Identify the types and operation of aircraft de-icing systems.
- Describe the types and purpose of the aircraft windshield wiper/washer systems.
- Understand the operation of the aircraft windshield wiper/washer systems.
- Understand maintenance precautions for the windshield wiper/washer systems.

##### 7121-514-310 Environmental Control Systems . . . . . 731, 732, 733

- Describe a typical pneumatic system.
- Describe a typical air conditioning system.
- Describe a typical pressure control system.
- Observe the operation of a typical thermostat and trim valve in an air conditioning system.
- Isolate a fault in a typical thermostat and trim valve of an air conditioning system.

##### 7121-514-370 Landing Gear Systems . . . . . 743, 744, 745

- Identify the components associated with a landing gear shock strut assembly.
- Describe the function of each landing gear component.
- Describe the operation of the landing gear shock strut.
- Describe the flow through the landing gear hydraulic system.
- Describe the function of the landing gear electrical system.
- Identify typical landing gear hydraulic and electrical malfunctions.
- Observe the normal operation of a typical landing gear system.
- Troubleshoot and isolate the cause of landing gear system faults.

##### 7121-514-430 Aircraft Braking Systems . . . . . ---

- Define the types of wheel assemblies.
- Identify the key components of an aircraft wheel assembly.
- Identify the parts of an aircraft tire and describe their purpose.
- Describe the safety precautions associated with aircraft wheel assemblies.
- Describe tire inspection and maintenance processes.
- Define the distinguishing properties of expander tube, independent, power boost brake, and power control brake systems.
- Identify the components of expander tube, independent, power boost brake, and power control brake systems.
- Describe the safety precautions associated with brake systems.
- Describe the brake system inspection and maintenance process.
- Describe the purpose of the Anti-Skid System

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### **AIRCRAFT ELECTRICAL SYSTEMS (MODEL 1438S) (cont.)**

#### **Aircraft Airframe Systems (cont.)**

7121-514-430 Aircraft Braking Systems (cont.)

- Given a list of anti-skid components, identify and describe the function of each component.
- Given a schematic of a generic anti-skid system, describe the corrective action for various system malfunctions.

7121-514-490 Fire Warning and Extinguishing Systems ..... 738

- Identify different types of fire warning systems.
- Explain the basic operation of each type of system.
- Describe the different types of fire extinguishing agents.
- Explain the basic operation of the fire extinguishing system.
- Identify a normal operating fire warning system.
- Identify a faulty operating fire warning system.

7121-514-550 Aircraft Fuel Systems ..... ---

- Describe the characteristics and properties of aviation fuels.
- Identify the effects of fuel contamination.
- Describe the gravity type fuel system.
- Describe the pump type fuel system.
- Describe the operational characteristics of the fuel system components.
- Describe the operation of a carburetor.
- Describe the operation of fuel injection.

#### **Aircraft Engine Systems**

7121-518-190 Aircraft Ignition Systems ..... ---

- Identify the types of ignition systems.
- Describe the principles of spark discharge and coil ignition systems.
- Describe the types of magneto ignition systems.
- Describe the principles of gas turbine ignition systems.
- Describe the principles of operation of ignition systems.
- State the advantages and disadvantages of high and low tension magneto systems.

### **AIRCRAFT ELECTRONIC SYSTEMS (MODEL 1438E)**

#### **Aircraft Instrument Systems**

7121-714-130 Introduction to Aircraft Instruments ..... ---

- Identify the classifications of aircraft instruments.
- Define and describe basic aircraft instruments.
- Describe the various operating principles of aircraft instruments.

7121-714-190 Tachometer, Torque, and Position-Indicating Systems ..... ---

- Recognize the operating principles and characteristics of the tachometer and position-indicating systems.
- Recognize the operating principles and characteristics of torque systems.
- Identify the basic procedures used in maintaining aircraft instruments.

7121-714-250 Temperature and Fuel Flow Indicating Systems ..... 189, 190

- Identify the types and describe the function of the Exhaust Gas Temperature (EGT), Cylinder Head Temperature (CHT), and Carburetor Air Temperature (CAT) sensing systems instruments.
- Identify the types and describe the function of fuel flow indicating systems instruments.
- Identify the principles of temperature transducers.

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### **AIRCRAFT ELECTRONIC SYSTEMS (MODEL 1438E) (cont.)**

#### **Aircraft Instrument Systems (cont.)**

- 7121-714-250 Temperature and Fuel Flow Indicating Systems (cont.)
- Analyze the operation of solid-state temperature transducers.
- 7121-714-310 Pressure Sensing and Chip Detection Systems ..... 241, 242
- Identify the types and describe the function of pressure sensing and chip detection indicating systems instruments.
  - Identify the principles of pressure transducers.
  - Analyze the operation of solid-state pressure transducers.
- 7121-714-370 Aircraft Electronic Flight Instrument Systems ..... ---
- Describe the systems and components of the aircraft monitoring and alerting system.
  - Describe the different types of aircraft built-in fault and maintenance test equipment.
- 7121-714-430 Aircraft Master Warning and Annunciator Systems ..... 735, 737
- Describe the operation of the master warning and annunciator system.
  - Identify annunciator system applications.
  - Observe master warning and annunciator system operation.
  - Observe normal system operation.
  - Identify faulty system operation.

#### **Aircraft Communications Systems**

- 7121-722-130 Introduction to Aircraft Communications ..... ---
- Define a typical communications system.
  - Identify the types of radios and their uses.
  - Identify and describe aircraft internal communications systems.
  - Identify common radio communications failures and describe typical repairs for each failure.
  - Identify the letters of the phonetic alphabet.
  - Describe the procedures and regulations for transmitting a radio communications check.
- 7121-722-250 Aircraft Antenna Systems ..... ---
- Understand antenna characteristics.
  - Explain the propagation of electromagnetic energy in antennas.
  - Identify the correct antenna for associated aircraft COM/NAV system.
  - Describe the general location of each type of aircraft antenna.

#### **Aircraft Navigation Systems**

- 7121-726-130 Introduction to Aircraft Navigation ..... ---
- Define the purpose of an air navigation system
  - Describe the types of air navigation systems
  - Define the terms associated with air navigation
  - Plot latitude and longitude positions on an air navigation chart.
  - Identify types of air navigation information display indicators
  - Describe the purpose of ADI, BDI, HSI, and MFD air navigation indicators.
  - Identify and describe the information displayed by the ADI, BDI, HSI, and MFD air navigation indicator.

### **AUTOMOTIVE TECHNOLOGY (MODEL 1431)**

#### **Introduction to Vehicle Technology**

- 7021-112-130 Introduction to the Automobile ..... ---
- Understand the history of the automobile.
  - Identify 9 of the many automobile systems.

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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Introduction to Vehicle Technology (cont.)**

- 7021-112-130 Introduction to the Automobile (cont.)  
▪ Identify careers associated with the automobile.
- 7021-112-160 Electrical Systems ..... ---  
▪ Identify an automobile battery.  
▪ Identify devices of the automobile.  
▪ Understand how the devices get electrical energy from the battery.  
▪ Understand that a computer can control some systems of the automobile.
- 7021-112-190 Charging and Ignition Systems ..... ---  
▪ Understand how the alternator works to recharge the battery.  
▪ Understand how the ignition coil works to ignite the fuel in the engine.
- 7021-112-220 Fuel Systems ..... ---  
▪ Understand how a carburetor functions.  
▪ Understand how fuel injection functions.  
▪ Understand how a turbocharger functions.
- 7021-112-250 Engines ..... ---  
▪ Identify basic engine parts.  
▪ Understand how the engine functions.  
▪ Understand how engines are classified.
- 7021-112-280 Cooling Systems ..... ---  
▪ Identify the parts of the automobile's cooling system.  
▪ Understand the function of the cooling system.
- 7021-112-310 Hydraulic Systems ..... ---  
▪ Understand the automobile's braking system.  
▪ Understand the automobile's power steering system.
- 7021-112-340 Air Conditioning and Heating Systems ..... ---  
▪ Identify the major parts of the air conditioning system.  
▪ Understand how the air conditioning system functions.  
▪ Identify the parts of the heating system.  
▪ Understand how the heating system functions.
- 7021-112-370 Drive Train and Suspension ..... ---  
▪ Identify the parts of the drive train.  
▪ Understand the function of the drive train.  
▪ Identify the parts of the suspension.  
▪ Understand the function of the suspension.
- 7021-112-400 Body Design ..... ---  
▪ Identify the automobile body parts.  
▪ Understand the function of the automobile body parts.  
▪ Identify the different options of an automobile.  
▪ Understand the capabilities of each option.

#### **Introduction to Automotive Electricity**

- 7021-212-130 Automotive Safety ..... ---  
▪ Identify safety habits associated with electrical and other equipment.  
▪ Identify hazards associated with the automobile.
- 5021-112-130 Metric Notation ..... ---  
▪ Convert decimal numbers to powers of ten and vice versa.  
▪ Convert decimal numbers to metric prefixes and vice versa.

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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Introduction to Automotive Electricity (cont.)**

5021-112-130 Metric Notation (cont.)

- Add, subtract, multiply, and divide powers of ten.
- Add, subtract, multiply, and divide metric prefixes.

7021-212-190 Voltage, Current, and Resistance . . . . . ---

- Describe an atom and its structure.
- Define electric charge as it relates to electrons and protons.
- Describe the law of electrostatic forces.
- Define voltage and the volt as a unit of voltage.
- Define the relationship between voltage and potential difference.
- Define current and the ampere as the unit of current.
- Describe a conductor and the behavior of electrons within a conductor.
- Describe an insulator and the behavior of electrons within an insulator.
- Identify the purpose of a resistor.
- Identify the unit of resistance as the ohm.

7021-212-220 Switches and Protective Devices . . . . . ---

- Identify the purpose of a switch.
- Identify switch schematic symbols.
- Describe single and double pole.
- Describe single and double throw.
- Identify the purpose of protection devices.
- Identify a fuse and a circuit breaker.
- Identify schematic symbols for fuses and circuit breakers.
- Identify a fusible link.

#### **Automotive Test Equipment**

7021-214-130 Introduction to Multimeters . . . . . ---

- Describe the purpose of a multimeter.
- Identify the quantities measured by multimeters.
- Identify two types of multimeter displays.
- Describe the four functional sections of the multimeter.
- Describe the purpose of each functional section.

7021-214-160 Multimeter Use . . . . . 701

- Understand the operation of a digital multimeter.
- Understand the steps to make a proper measurement using a digital multimeter.

7021-214-190 Voltage Measurements . . . . . 701

- Describe how to set up a multimeter to measure voltage.
- Describe how to read a multimeter's display when measuring voltage.
- Identify the precautions to observe when making voltage measurements.
- Perform voltage measurements using a digital multimeter.

7021-214-220 Current Measurements . . . . . 701

- Describe how to set up a multimeter to measure current.
- Describe how to read a multimeter's display when measuring current.
- Identify the precautions to observe when making current measurements.
- Perform current measurements using a digital multimeter.

7021-214-250 Resistance Measurements . . . . . 708

- Describe how to set up a multimeter to measure resistance.
- Describe how to read a multimeter's display when measuring resistance.

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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Automotive Test Equipment (cont.)**

7021-214-250 Resistance Measurements (cont.)

- Describe the precautions to observe when making resistance measurements.
- Define power rating.
- Define tolerance.
- Identify number/letter codes.
- Perform resistance measurements.

7021-214-280 Introduction to the Oscilloscope ..... 707, 708

- Describe the purpose of an oscilloscope.
- Identify the quantities measured by an oscilloscope.
- Describe single trace and dual trace oscilloscopes.
- Identify the four major functional sections.
- Describe the purpose of each control and switch.
- Set up an oscilloscope for normal operation.
- Use an oscilloscope to analyze a waveform.
- Measure voltage using an oscilloscope.

#### **Basic Electrical DC and AC**

7021-216-130 Ohm's Law and Power ..... 701

- Learn what Ohm's Law is and how voltage, current, and resistance are related.
- Learn what power is and how voltage, current, and Ohm's Law are related to power.
- Prove the Ohm's Law relationship of voltage, current, and resistance.

7021-216-160 Series Circuits and the Automobile ..... 702

- Identify a simple series circuit.
- Understand basic principles of a series circuit.
- Verify that Ohm's Law applies to series circuits.
- Observe a working series circuit.
- Verify basic principles of a series circuit.

7021-216-190 Parallel Circuits ..... 703

- Identify a parallel circuit.
- Recognize that the applied voltage is the same across each branch.
- Calculate current in each branch of a parallel circuit.
- Calculate total current from the sum of the individual branches of a parallel circuit.
- Calculate total resistance in a parallel circuit.
- Measure the applied voltage across each branch in a parallel circuit.
- Measure resistance in a parallel circuit.
- Measure current in a parallel circuit.

7021-216-220 Series-Parallel Circuits ..... 704

- Identify a series-parallel circuit.
- Calculate total resistance in a series-parallel circuit.
- Calculate current in a series-parallel circuit.
- Calculate voltage drops in a series-parallel circuit.
- Measure resistance values in a series-parallel circuit.
- Measure current values in a series-parallel circuit.
- Measure voltage drops in a series-parallel circuit.

7021-216-250 Voltage Divider Circuits ..... 705

- Identify a voltage divider circuit.
- Identify a voltage divider as loaded or unloaded.

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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Basic Electrical DC and AC (cont.)**

- 7021-216-250 Voltage Divider Circuits (cont.)
- Calculate loaded and unloaded voltage divider current, voltage, and resistance values.
  - Calculate % regulation for a voltage divider circuit.
  - Identify and measure various characteristics of a voltage divider circuit.
- 7021-216-280 Relay Operation ..... 706
- Describe the purpose and type of relays.
  - Describe basic relay construction and operation.
  - Describe the latched and time delay relay.
  - Observe basic relay operation.
  - Observe characteristics of a basic relay circuit.
- 7021-216-310 Alternating Current ..... ---
- Define alternating current.
  - Identify an AC sine wave.
  - Define frequency and cycle.
  - Describe hertz.
  - Determine the wavelength of a sine wave.
  - Determine the period of a sine wave.
- 7021-216-340 Magnetism, Relays, and Meters ..... ---
- Define magnetism.
  - Identify characteristics of magnets.
  - Define laws of magnetic attraction and repulsion.
  - Describe properties of magnetic lines of force.
  - Define electromagnetism.
  - Identify the characteristics of electromagnets.
  - Describe the operation of a relay.
  - Describe the operation of a magnetic circuit breaker.
  - Describe the operation of a meter.

#### **Basic Electronics for Automotive**

- 7021-218-130 Inductor Operation ..... 707
- Identify types of inductors.
  - Describe the current-opposing characteristic of an inductor.
  - Identify the unit of measure for inductance.
  - Identify characteristics of inductance.
  - Identify mutual inductance.
  - Examine characteristics of an inductor.
  - Examine common operations of an inductor.
- 7021-218-160 Capacitor Operation ..... 707
- Identify types of capacitors.
  - Describe charge and discharge.
  - Identify the schematic symbol for a capacitor.
  - Identify characteristics of capacitance.
  - Identify the unit of measure for capacitance.
  - Examine the circuit characteristics of a capacitor.
- 7021-218-190 Diode Operation ..... 708
- Identify the purpose of a diode.
  - Recognize diode schematic symbols and use reference designators.

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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Basic Electronics for Automotive (cont.)**

- 7021-218-190 Diode Operation (cont.)
- Describe the uses of diodes.
  - Analyze diode characteristics in a circuit.
- 7021-218-220 Transistor Operation ..... 709
- Describe the purpose of a transistor.
  - Describe types of transistors.
  - Identify transistor schematic symbols.
  - Identify leads on transistors.
  - Analyze transistor characteristics in a circuit.
- 7021-218-250 AND Gates ..... 710
- Identify AND operation.
  - Identify AND logic symbols.
  - Identify AND logic schematic symbols.
  - Construct an AND gate truth table.
  - Identify inputs and outputs.
  - Measure input and output waveforms.
- 7021-218-280 OR Gates ..... 711
- Identify OR operation.
  - Identify OR logic symbols.
  - Identify OR logic schematic symbols.
  - Construct an OR gate truth table.
  - Identify inputs and outputs.
  - Analyze OR gate circuit operation.
- 7021-218-310 NOT Gates ..... 712
- Identify NOT operation.
  - Identify NOT logic symbols.
  - Identify NOT logic schematic representation.
  - Construct a NOT gate truth table.
  - Identify input and output waveforms.
  - Analyze NOT gate circuit operation.
- 7021-218-340 Introduction to Combinational Circuits ..... 713B
- Define combinational logic.
  - Describe the uses of combinational logic.
  - Trace inputs through a combinational logic circuit.
  - Describe the universal property of the NAND gate.
  - Describe the universal property of the NOR gate.
  - Analyze the operation of a combinational circuit.

#### **Basic Automotive Systems**

- 7021-312-130 Turn Signal Systems ..... 714
- Describe the use of the turn signal.
  - Examine the characteristics of turn signals.
  - Examine the operation of a turn signal system.
- 7021-312-160 Starting Systems ..... 715
- Describe the use of the starting system.
  - Examine the characteristics of different starting system components.
  - Examine the operation of a starting system.



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### **AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)**

#### **Basic Automotive Systems (cont.)**

- 7021-312-190 Ignition Systems ..... 707, 709
- Identify the components of an ignition system.
  - Identify the types of ignition systems.
  - Describe the operation of mechanical and electronic switching circuits.
- 7021-312-220 Charging Systems ..... 708
- Identify the components of a charging system.
  - Describe the characteristics of charging systems.
  - Examine the operation of diodes in a charging system.
- 7021-312-250 Fuel Injection ..... 716
- Describe the use of fuel injection.
  - Examine the characteristics of different types of fuel injection.
  - Examine the operation and timing of fuel injection in an automobile.
- 7021-312-280 Engine Cooling and Climate Control ..... 713A
- Identify the purpose of the engine's cooling system.
  - Describe the operation and construction of an engine's cooling system.
  - Describe the operation and construction of the cooling system's components.
  - Describe the operation of electrical circuits used to control the cooling system.
  - Identify the purpose of the environmental climate control system.
  - Describe the operation and construction of an environmental climate control system.
  - Describe the operation and construction of the environmental climate control system components.
  - Describe the operation of electrical circuits used to control the climate control system.
  - Observe the operation of the circulating fan circuit in the air conditioning and engine cooling system.
  - Identify the faulty operation of the circulating fan circuit in the air conditioning and engine cooling system.

### **AUTOMOTIVE TECHNOLOGY - TRAILER WIRING (MODEL 1470)**

- 7021-314-130 Trailer Wiring ..... 720, 721
- Understand the kinds of problems associated with trailer wiring.
  - Understand the process of troubleshooting trailer wiring.
  - Describe the types of test instruments used to troubleshoot trailer wiring.
  - Define a short circuit.
  - Define an open circuit.
  - Perform a basic wiring exercise including continuity and acceptance testing.
  - Recognize common malfunctions in trailer lighting systems.

### **AUTOMOTIVE TECHNOLOGY - CAR AUDIO (MODEL 1471)**

- 7021-316-130 Car Audio Systems ..... ---
- Identify the components that make up a car audio system and describe their function.
  - Identify various car audio system components that adjust certain properties of the sound.
  - Identify the components that increase the sound level and convert the electrical signals to audible sound.
  - Understand the proper way to wire the audio system.

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### **AUTOMOTIVE TECHNOLOGY - CAR AUDIO (MODEL 1471) (cont.)**

- 7021-316-160 Car Audio Design and Installation . . . . . CAS1, CAS2, CAS3, CAS4(3)
- Describe the steps in designing a car audio system.
  - Determine the basic tools needed in order to upgrade a car audio system.
  - Understand the installation procedures.
  - Design an audio system by laying out all audio devices in a functional way.
  - Install the audio system by measuring the proper lengths of wire and connecting the devices correctly.

### **SYNCHRO SERVO SYSTEMS**

- 5142-512-130 Introduction to Synchros . . . . . ---
- State the definition of a synchro.
  - Identify synchro schematic symbols.
  - Identify the basic design of a synchro.
  - Demonstrate knowledge of the function of the torque transmitter and the torque receiver.
- 5142-512-160 Differential Transmitters . . . . . ---
- State the definition of the torque differential transmitter used in a synchro system.
  - Identify the synchro torque differential transmitter schematic symbol.
  - Understand the functions of a torque differential transmitter.
- 5142-512-190 Control Synchro Systems . . . . . ---
- Describe the differences between torque synchro systems and control synchro systems.
  - Identify control synchro schematic symbols.
  - Demonstrate knowledge of the functions of the control transformer and control transolver.
- 5142-512-220 Troubleshooting Synchro Systems . . . . . ---
- Recognize symptoms of rotor winding failures in synchro systems.
  - Recognize symptoms of stator winding failures in synchro systems.
  - Demonstrate knowledge of the troubleshooting methods and techniques in repairing synchro systems.
- 5142-512-250 Stabilized Platforms . . . . . ---
- Define the terms, abbreviations, and symbols associated with gyros.
  - Describe the principles of operation of a gyroscope.
  - Describe the construction of a gyroscope.
  - Define the terms, abbreviations, and symbols associated with stabilized platforms and accelerometers.
  - Describe the principles of operation of a stabilized platform.

### **MATHEMATICS**

#### **Basic Math**

- 2011-112-130 Adding and Subtracting . . . . . ---
- Describe the decimal number system.
  - Describe the whole number line.
  - Describe addition.
  - Add whole numbers.
  - Describe subtraction.
  - Subtract whole numbers.
- 2011-112-160 Multiplying and Dividing . . . . . ---
- Describe multiplication.

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### **MATHEMATICS (cont.)**

#### **Basic Math (cont.)**

- 2011-112-160 Multiplying and Dividing (cont.)
- Multiply whole numbers.
  - Describe division.
  - Divide whole numbers.
- 2011-112-190 Fractions ..... ---
- Describe fractions.
  - Describe proper and improper fractions.
  - Change improper fractions to whole numbers or mixed numbers.
  - Change mixed numbers to improper fractions.
  - Reduce fractions to the lowest terms.
- 2011-112-220 Fraction Operations ..... ---
- Add fractions.
  - Subtract fractions.
  - Multiply fractions.
  - Divide fractions.
- 2011-112-250 Decimal Fractions ..... ---
- Describe decimal fractions.
  - Recognize positional values in decimal fractions.
  - Convert decimal fractions to standard fractions.
  - Convert standard fractions to decimal.
  - Add decimal fractions.
  - Subtract decimal fractions.
  - Multiply decimal fractions.
  - Divide decimal fractions.
- 2011-112-280 Signed Numbers ..... ---
- Describe signed numbers.
  - Describe the signed number line.
  - Determine the relationship between two signed numbers.
  - Add signed numbers.
  - Subtract signed numbers.
  - Multiply signed numbers.
  - Divide signed numbers.
- 2011-112-310 Percents ..... ---
- Describe percents.
  - Change percents to decimal numbers.
  - Change decimal numbers to percents.
  - Calculate the percentage part.
  - Calculate the percentage rate.
  - Calculate the percentage base.
- 2011-112-340 Exponents and Square Roots ..... ---
- Describe exponents.
  - Calculate the result of numbers that use exponents.
  - Describe square roots.
  - Calculate square roots.
- 2011-112-370 Metric Notation ..... ---
- Convert decimal numbers to powers of ten and vice versa.

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### **MATHEMATICS (cont.)**

#### **Basic Math (cont.)**

2011-112-370 Metric Notation (cont.)

- Convert decimal numbers to metric prefixes and vice versa.
- Add, subtract, multiply, and divide powers of ten.
- Add, subtract, multiply, and divide metric prefixes.

#### **Algebra**

2011-212-130 Fundamentals of Algebra ..... ---

- Describe real numbers.
- Describe the four fundamental operations of real numbers.
- Describe real number variables.
- Describe the order of operations.
- Combine variables.
- Describe real number properties - closure, commutative, associative, identity, inverse, distributive.

2011-212-160 Linear Equations ..... ---

- Describe addition and subtraction laws.
- Solve  $X + A = B$  type of equations.
- Solve  $X - A = B$  type of equations.
- Describe multiplication and division laws.
- Solve  $X \times A = B$  type of equations.
- Solve  $X \div A = B$  type of equations.
- Describe a formula.
- Place a word problem in an equation.
- Solve for the unknown quantity.

2011-212-190 Solving Linear Equations ..... ---

- Use the basic laws of equations to solve linear equations.
- Solve problems in the format of  $ax + b = c$  and  $ax - b = c$ .
- Solve problems in the format of  $x/a + b = c$ .
- Use the four-step process to solve word problems.
- Solve word problems in the format of linear equations.

2011-212-220 Exponents and Monomials ..... ---

- Define exponents.
- Multiply and divide powers with the same base.
- Raise a power to a power.
- Raise a product or quotient to a power.
- Describe monomials.
- Add and subtract monomials.
- Multiply and divide monomials.
- Use the 4 steps to solve word problems.
- Solve word problems that use monomials.

2011-212-250 Polynomials ..... ---

- Define polynomials.
- Add polynomials.
- Subtract polynomials.
- Multiply a monomial and a polynomial.
- Multiply polynomials.
- Describe special binomial products.

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### **MATHEMATICS (cont.)**

#### **Algebra (cont.)**

- 2011-212-250 Polynomials (cont.)
- Divide polynomials by monomials.
- 2011-212-280 Factoring Polynomials . . . . . ---
- Factor by finding the greatest common factor.
  - Factor by grouping.
  - Factor trinomials.
  - Factor by recognizing special binomial factors.
  - Solve equations by factoring.
  - Define quadratic equations and quadratic formula.
  - Solve equations using the quadratic formula.
  - Solve word problems.
- 2011-212-310 Roots and Radicals . . . . . ---
- Factor radicand terms.
  - Simplify using the Product Property of Roots.
  - Simplify using the Product Quotient Property of Roots.
  - Rationalize denominators.
  - Multiply radicals.
  - Divide radicals.
  - Add radicals.
  - Subtract radicals.
  - Rationalize denominators.
  - Use the Squaring Property of Equations to solve for the unknown.
  - Solve equations containing one radical expression.
  - Solve equations containing two radical expressions.
- 2011-212-340 Graphs . . . . . ---
- Describe the rectangular coordinate system.
  - Locate points on a rectangular coordinate system.
  - Find the coordinates of a point in a rectangular coordinate system.
  - Graph linear equations.
  - Find the slope of a line.
  - Find the equation of a line.
- 2011-212-370 Systems of Linear Equations . . . . . ---
- Define a system of equations.
  - Solve systems of equations by graphing.
  - Identify consistent, inconsistent, and dependent systems by their graphs.
  - Solve systems of equations by substitution.
  - Identify consistent, inconsistent, and dependent systems by the results of substitution.
  - Solve systems of equations by addition.
  - Identify consistent, inconsistent, and dependent systems by the results of addition.
- 2011-212-400 Introduction to Statistics . . . . . ---
- Understand the role of statistics in industry.
  - Understand the concepts of mean, median, mode, standard deviation, percentiles, and quartiles.
  - Understand the analysis of statistical data.
  - Understand the various statistical diagrams.
  - Understand the statistical histogram.

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### **MATHEMATICS (cont.)**

#### **Trigonometry**

- 2011-214-130 Fundamentals of Trigonometry . . . . . ---
- Define the term angle.
  - Identify positive angles and negative angles.
  - Identify acute, obtuse, complementary, and supplementary angles.
  - Identify angle measurements using degrees, minutes, and seconds.
  - Add and subtract angle measurements.
  - Understand the relationship between degrees and radians.
  - Convert degrees into radians.
  - Convert radians into degrees.
- 2011-214-160 Trigonometric Functions . . . . . ---
- Find the measurement of an unknown angle in a right triangle.
  - Find the unknown side of a right triangle using the Pythagorean Theorem.
  - Identify the properties of the 45-45-90 and 30-60-90 right triangles.
  - Identify the six trigonometric functions.
  - Find the sine, cosine, tangent, cosecant, secant, and cotangent of a given angle.
  - Identify the relationships between the unit circle and the trigonometric functions.
- 2011-214-190 Graphing Trigonometric Functions . . . . . ---
- Identify the basic graphs for the six trigonometric functions.
  - Define period and amplitude.
  - Define the period and amplitude for the six trigonometric functions.
  - Determine the amplitude of the sine and cosine functions.
  - Find the change in the period of a trigonometric function.
  - Determine the phase shift of a trigonometric function.
- 2011-214-220 Trigonometric Identities . . . . . ---
- Understand the origins of the reciprocal and ratio identities.
  - Find the trigonometric function of an angle using either a reciprocal or ratio identity.
  - Find the trigonometric function of an angle using combinations of reciprocal and ratio identities.
  - Understand the origins of the Pythagorean and related identities.
  - Find the trigonometric function of an angle using the Pythagorean and related identities.
- 2011-214-250 Angle Formulas . . . . . ---
- Know the sum and difference formulas for sine, cosine, and tangent.
  - Find the exact trigonometric function value of a given angle using the sum and difference formulas.
  - Know the double angle formulas for sine, cosine, and tangent.
  - Know the power reducing formulas for sine, cosine, and tangent.
  - Know the half-angle formulas for sine, cosine and tangent.
  - Use the proper formula to find the exact trigonometric value of a given angle.
- 2011-214-280 Inverse Trigonometric Functions . . . . . ---
- Understand the methods for finding the inverse trigonometric functions.
  - Know the domains, ranges, and graphs of arcsine, arccosine, and arctangent.
  - Solve problems involving arcsine, arccosine, and arctangent.
  - Know the domains, ranges, and graphs of arcsecant, arccosecant, and arccotangent.
  - Solve problems involving arcsecant, arccosecant, and arccotangent.
- 2011-214-310 Applications of Trigonometry . . . . . ---
- Identify an oblique triangle.

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### MATHEMATICS (cont.)

#### Trigonometry (cont.)

2011-214-310 Applications of Trigonometry (cont.)

- Use the law of sines to find the missing parts of oblique triangles.
- Understand the four possibilities resulting from the ambiguous case.
- Use the law of cosines to solve oblique triangles when given two sides and the included angle.
- Use the law of cosines to solve oblique triangles when given three sides.

2011-214-340 Graphing Polar Equations . . . . . ---

- Define the polar coordinate pair.
- Graph polar coordinates.
- Understand the techniques for graphing polar equations.
- Recognize and graph basic polar equations.

2011-214-370 Conic Sections: Circles and Parabolas . . . . . ---

- Recognize the general equation for a circle.
- Find the center and radius of a circle from a given equation.
- Find the equation for a circle given the center and radius.
- Recognize the general equations for parabolas.
- Find the focus, vertex, and directrix of a parabola from a given equation.
- Find the equation for a parabola given the focus, vertex, and/or directrix.

2011-214-400 Conic Sections: Ellipses and Hyperbolas . . . . . ---

- Recognize the general equations for ellipses.
- Find the center, vertices, and foci of an ellipse from a given equation.
- Find the equation for an ellipse given the center, vertices, and foci.
- Recognize the general equations for hyperbolas.
- Find the center, vertices, foci, and asymptotes of a hyperbola from a given equation.
- Find the equation for a hyperbola given the center, vertices, and foci.

#### Calculus

2011-216-130 Fundamentals of Calculus . . . . . ---

- Apply the slope formula to particles moving along straight paths.
- Recognize functions and identify the domain and range.
- Find the composite of two given functions.
- Find the average rate of change of a function.
- Understand the transition as a secant line becomes a tangent line when  $\Delta X$  goes to 0.
- Find the slope at a given point on a curve.

2011-216-160 Limits . . . . . ---

- Understand the concept of a limit.
- Recognize right-hand limits and left-hand limits.
- Find limit values.
- Understand the sandwich property.
- Understand how the sandwich property is used to find the limits of trigonometric functions.
- Find limits involving trigonometric functions.

2011-216-190 Limits: Continuity and Infinity . . . . . ---

- Identify continuous functions.
- Determine continuity at a point.
- Determine continuity over an interval.
- Understand how infinity is used as a limit.
- Identify the limit form as the variable approaches infinity.

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### **MATHEMATICS (cont.)**

#### **Calculus (cont.)**

- 2011-216-190 Limits: Continuity and Infinity (cont.)
- Find limits involving infinity.
- 2011-216-220 Derivatives . . . . . ---
- Understand the definition of a derivative.
  - Find derivatives using the definition.
  - Find derivatives using the constant rule, power rule, and sum rule.
  - Find the derivative of the product of two functions.
  - Find the derivative of the quotient of two functions.
- 2011-216-250 The Chain Rule . . . . . ---
- Identify the chain rule.
  - Find derivatives using the chain rule.
  - Identify the derivatives of the six trigonometric functions.
  - Find derivatives of functions using trigonometric expressions.
- 2011-216-280 Additional Differentiation Methods . . . . . ---
- Identify implicit functions.
  - Find derivatives using implicit differentiation.
  - Identify higher order derivatives.
  - Find second and third derivatives of functions.
  - Find the velocity and acceleration functions given the position function.
- 2011-216-310 Applications of Derivatives . . . . . ---
- Sketch curves using the first and second derivatives.
  - Identify intervals where the function is increasing or decreasing.
  - Locate local maximum or minimum points.
  - Determine concavity.
  - Find inflection points.
  - Develop strategy for solving maxima-minima word problems.
  - Solve max-min problems.
- 2011-216-340 Integration . . . . . ---
- Understand the relationship between integration and differentiation.
  - Integrate simple algebraic indefinite integrals.
  - Integrate simple trigonometric indefinite integrals.
  - Identify integrals resulting from use of the chain rule.
  - Integrate indefinite integrals using the u substitution method.
- 2011-216-370 Definite Integrals . . . . . ---
- Understand the relationship between the limits of integration and an interval of x values.
  - Identify upper and lower limits of integration.
  - Evaluate definite integrals.
  - Use definite integrals to find the area involving only positive regions.
  - Use definite integrals to find the area of both positive and negative regions.
- 2011-216-400 Applications of Definite Integrals . . . . . ---
- Find the area of a region bounded by two curves.
  - Find the area of a region bounded by two curves and the x-axis.
  - Understand the theory of rotation about the x-axis.
  - Find the volume of an object formed by rotating  $y = f(x)$  about the x-axis.



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### **MATHEMATICS (cont.)**

#### **Computer Math**

- 2011-312-130 Fundamentals of Computer Math ..... ---
- Understand concept of number systems other than base 10.
  - Add and subtract numbers of base N.
  - Convert numbers of base N to base 10.
  - Convert numbers of base 10 to base N.
  - Construct a base N multiplication table.
  - Multiply and divide base N numbers.
- 2011-312-160 The Binary System ..... ---
- Add and subtract binary numbers.
  - Convert binary numbers to decimal numbers.
  - Convert decimal numbers to binary numbers.
  - Use BCD (8421) codes.
  - Use Gray codes.
  - Use ASCII codes.
  - Use EBCDIC codes.
- 2011-312-190 Octal and Hexadecimal Systems ..... ---
- Perform computations using octal numbers.
  - Convert binary numbers to octal numbers.
  - Convert octal numbers to binary numbers.
  - Convert hexadecimal numbers to decimal numbers.
  - Convert decimal numbers to hexadecimal numbers.
  - Convert binary numbers to hexadecimal numbers.
  - Convert hexadecimal numbers to binary numbers.
- 2011-312-220 Logic Expressions ..... ---
- Identify a valid logic statement.
  - Describe a negated logic statement.
  - Identify and use the "and" connector.
  - Identify and use the "or" connector.
  - Construct truth tables.
  - Identify conditional logic statements.
  - Identify and use the "If..., then..." connector.
  - Identify and use the "...if and only if..." connector.
  - Construct truth tables.
  - Decipher complex compound logic statements.
  - Understand logic arguments.
  - Construct truth tables.
- 2011-312-250 Boolean Algebra ..... ---
- Describe basic Boolean operations.
  - Describe basic properties of Boolean algebra.
  - Describe electronic circuits that perform basic Boolean algebra.
  - Describe sum of products equations.
  - Describe product of sums equations.
  - Describe complements.
- 2011-312-280 Gate Networks ..... ---
- Develop gate networks from sum of products equations.
  - Develop gate networks from product of sums equations.

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### **MATHEMATICS (cont.)**

#### **Computer Math (cont.)**

- 2011-312-280 Gate Networks (cont.)
- Find the output of a gate network.
  - Develop a truth table for a gate network.
- 2011-312-310 Simplifying Boolean Equations . . . . . ---
- Review the basic principles of Boolean algebra.
  - Describe the rules of Boolean algebra.
  - Describe DeMorgan's theorems.
  - Use the basic principles, rules, and DeMorgan's theorems to simplify Boolean equations.
- 2011-312-340 Karnaugh Maps . . . . . ---
- Describe Karnaugh maps.
  - Develop a Karnaugh map for two, three, and four variables.
  - Simplify Boolean algebra equations using Karnaugh maps.
- 2011-312-370 Algorithms and Flowcharts . . . . . ---
- Describe the three basic computer operations.
  - Describe algorithms.
  - Describe flowcharts.
  - Recognize flowchart symbols.
- 2011-312-400 Sequences and Matrices . . . . . ---
- Define sequences.
  - Solve sequence problems.
  - Define matrices.
  - Solve matrix problems.

#### **Measurements**

- 2011-412-130 Introduction to Linear Measurements . . . . . ---
- Become familiar with the two different standards of measurement.
  - Define precision and determine which measurement applications require more or less precision.
  - Identify the following measurement tools:a. Standard rulerb. Micrometerc. Vernier caliper
  - Define linear measurement.
  - Describe how the following measurement tools are used:a. Standard rulerb. Micrometerc. Vernier caliper
- 2011-412-160 Metric and Scientific Conversions . . . . . ---
- Become familiar with units of British and metric units and be able to convert from one to the other.
  - Become familiar with the concepts of scientific notation and be able to add, subtract, multiply, and divide values in scientific notation.
- 2011-412-190 Angular and Circular Measurements . . . . . ---
- Become familiar with some basic concepts of angular and circular characteristics including: angle, diameter, and radius.
  - Describe angular measurement using: try square, carpenter's square, protractor, sliding T-bevel, and combination square.
  - Describe diameter and radius measurements using calipers, micrometers, and vernier calipers.
- 2011-412-220 Area Measurements . . . . . ---
- Define rectangles and squares.
  - Determine the difference between the two.

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### **MATHEMATICS (cont.)**

#### **Measurements (cont.)**

2011-412-220 Area Measurements (cont.)

- Use the area formula for squares and rectangles.
- Define parallelograms and triangles.
- Determine the relationship between the two.
- Use the area formula for parallelograms and triangles.
- Define a trapezoid.
- Differentiate trapezoids from parallelograms.
- Define the dimensions of a circle: radius, diameter, and circumference.
- Use the formulas for area and circumference.

2011-412-250 Volume Measurements . . . . . ---

- Define volume and describe how it relates to area.
- Differentiate between liter, centimeter, and meter.
- Solve problems of volume measurement in a solid rectangle.
- Define and be able to recognize a prism.
- Define and be able to recognize a pyramid.
- Using the formulas for each, solve problems of prism and pyramid volume.
- Define and be able to recognize a cylinder.
- Define and be able to recognize a cone.
- Define and be able to recognize a sphere.
- Using the formulas for each, solve problems of cylinder, cone, and sphere volume.

2011-412-280 Velocity and Acceleration Measurements . . . . . ---

- Define vector and scalar quantities and be able to differentiate between the two.
- Define and be able to solve problems of velocity.
- Define and be able to solve problems of acceleration.

2011-412-310 Force Measurements . . . . . ---

- Describe force as it relates to inertia and Newton's First Law of Motion.
- Describe force as it relates to acceleration and Newton's Second Law of Motion.
- Describe force as it relates to interaction and Newton's Third Law of Motion.

2011-412-340 Work and Power Measurements . . . . . ---

- Define work and be able to solve problems using the standard measure of work, the newton (N).
- Define power and be able to solve problems using the standard measure of power, the joule (J).

### **CHEMISTRY**

3011-112-130 Introduction to Chemistry . . . . . ---

- Define chemistry.
- Describe the history of chemistry.
- Recognize chemistry's impact on everyday life.

3011-112-160 Matter and Energy . . . . . ---

- Define Matter and Energy.
- Name the three states of matter.
- Distinguish classes of matter.
- Differentiate between physical changes and chemical reactions.

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### **CHEMISTRY (cont.)**

3011-112-190 The Periodic Table . . . . .	---
▪ Recognize the periodic table.	
▪ Understand the structure of the periodic table.	
▪ Identify Groups and Periods.	
▪ Relate various element names to their corresponding chemical symbol.	
▪ Describe some properties that are common to elements located in the same groups on the periodic table.	
3011-112-220 Solids, Liquids, and Gases . . . . .	---
▪ Identify the three physical states of matter.	
▪ Define the properties of the three states of matter.	
▪ Understand how matter changes from one state to another.	
3011-112-250 Atomic Structure . . . . .	---
▪ Describe the structure of the atom.	
▪ Understand how atomic structure gives rise to the chemical properties of the elements.	
3011-112-280 Bonding . . . . .	---
▪ Understand the process of atomic bonding.	
▪ Distinguish the types of chemical bonds.	
▪ Use the electron dot structure to represent chemical compounds.	
3011-112-310 Chemical Quantities . . . . .	---
▪ Identify the units of measure used in chemistry.	
▪ Recognize the correct units to use in various chemical calculations.	
▪ Use dimensional analysis for converting chemical quantities and verifying correctness of chemical calculations.	
3011-112-340 Chemical Names . . . . .	---
▪ Understand and apply standard conventions for naming inorganic chemical compounds.	
3011-112-370 Chemical Reactions . . . . .	---
▪ Identify different types and classes of chemical reactions.	
▪ Understand the basic mechanisms of chemical reactions.	
▪ Recognize the role of chemical reactions in our day-to-day lives.	
3011-112-400 Applications of Chemistry . . . . .	---
▪ Identify the impact of some different fields of chemical science on the world today.	