



**NIDA CORPORATION
COMPUTER ASSISTED INSTRUCTION**

LESSON AND OBJECTIVE LISTING

College of the Canyons

2011-04-21

OBJECTIVE LISTING - College of the Canyons

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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 (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.

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DC CIRCUITS (MODEL 1401) (cont.)

Introduction to Electricity (cont.)

- 5021-112-190 Resistors (cont.)
 - 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.
- 5021-112-280 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.

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DC CIRCUITS (MODEL 1401) (cont.)

Multimeter Measurements (cont.)

- 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.
- 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.
- 5021-116-280 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.

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DC CIRCUITS (MODEL 1401) (cont.)

Basic DC Circuits (cont.)

- 5021-116-340 Parallel Circuit Troubleshooting Experiment 8A
- Determine if a parallel circuit is open and identify which component is open.
 - 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.
- 5021-116-400 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.
- 5021-116-920 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.
 - 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.

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DC CIRCUITS (MODEL 1401) (cont.)

Complex DC Circuits (cont.)

- 5021-118-220 Kirchhoff's Voltage and Current Laws (cont.)
- 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 (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.

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AC CIRCUITS (MODEL 1402) (cont.)

Introduction to AC Circuits (cont.)

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.
- 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.

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AC CIRCUITS (MODEL 1402) (cont.)

AC Test Equipment (cont.)

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)	---

Induction 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.	
▪ 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.	

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Induction and RL Circuits (cont.)

5021-316-370 RL Parallel Circuit Troubleshooting Experiment	16B
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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	---
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ Identify ceramic, film, mica, and electrolytic capacitors. ▪ Read the capacitance and voltage values. 	
5021-318-190 RC Series Circuits	---
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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	---
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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. 	

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AC CIRCUITS (MODEL 1402) (cont.)

Capacitance and RC Circuits (cont.)

5021-318-400 RC Parallel Circuit Troubleshooting Experiment (cont.)

- 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.

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.

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AC CIRCUITS (MODEL 1402) (cont.)

Resonance (cont.)

- 5021-322-160 Series and Parallel LCR Circuit Experiment (cont.)
- Verify normal operation of a parallel LCR circuit.
 - Measure the phase relationship between I_T , I_R , I_C , and I_L 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 E_r , I_t , and Z_t 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.
- 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.

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AC CIRCUITS (MODEL 1402) (cont.)

Transformers (cont.)

5021-324-190 Troubleshooting Transformers (cont.)

- 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.
- 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 (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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Diode and Diode Circuits (cont.)

- 5021-514-160 Junction Diodes (cont.)
- 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.
 - 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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Transistor Circuits (cont.)

- 5021-516-130 Introduction to Transistors (cont.)
- 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.
- 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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Power Supplies (cont.)

- 5021-518-130 Introduction to Power Supplies and Diode Rectifiers (cont.)
- 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.
 - 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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Power Supplies (cont.)

- 5021-518-340 Voltage Regulator Troubleshooting Experiment (cont.)
▪ Observe the effects of a faulted component in a variable voltage regulator circuit. 74
- 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.
- 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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Transistor Amplifiers (cont.)

- 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.
- 5021-522-220 RC Phase Shift Oscillator Operation 37
- Identify RC phase shift oscillator circuits.
 - Describe operating characteristics of RC phase shift oscillators.
 - Identify the purpose of individual components in RC phase shift oscillators.
 - Measure the input and output waveforms of an RC phase shift oscillator.
 - Recognize normal operation of an RC phase shift oscillator.
- 5021-522-250 Crystal Controlled Oscillator Operation 50
- Describe characteristics of a quartz crystal.
 - Identify and describe crystal oscillator circuits.
 - Identify the purpose of individual components in a crystal oscillator.
 - Measure the input and output waveforms of a crystal oscillator.
 - Recognize normal operation of a crystal oscillator.
- 5021-522-280 Sine Wave Oscillator Troubleshooting Experiment I 35, 36
- Describe typical faults in Hartley and Colpitts oscillators.
 - Describe Hartley and Colpitts oscillator troubleshooting procedures.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Transistor Oscillators (cont.)

- 5021-522-280 Sine Wave Oscillator Troubleshooting Experiment I (cont.)
- Recognize that a Hartley oscillator is faulted.
 - Identify the faulted component in a Hartley oscillator.
 - Recognize that a Colpitts oscillator is faulted.
 - Identify the faulted component in a Colpitts oscillator.
- 5021-522-310 Sine Wave Oscillator Troubleshooting Experiment II 37, 50
- Describe typical faults in RC phase shift and crystal oscillators.
 - Describe RC phase shift and crystal oscillator troubleshooting procedures.
 - Recognize that an RC phase shift oscillator is faulted.
 - Identify the faulted component in an RC phase shift oscillator.
 - Recognize that a crystal oscillator is faulted.
 - Identify the faulted component in a crystal oscillator.
- 5021-522-340 Sawtooth Generator Operation 43A
- Describe the purpose of a sawtooth generator.
 - Identify and describe input and output waveforms of a sawtooth generator.
 - Measure the input and output waveforms of a sawtooth generator.
 - Recognize normal operation of a sawtooth generator.
- 5021-522-370 Blocking Oscillator Operation 42
- Identify the purpose of blocking oscillators.
 - Describe the operation of free-running and triggered blocking oscillators.
 - Observe normal operation of free-running blocking oscillators.
 - Observe normal operation of triggered blocking oscillators.
- 5021-522-400 Non-Sine Wave Oscillator Troubleshooting Experiment 42, 43A
- Describe typical faults in blocking oscillators and sawtooth generators.
 - Describe blocking oscillator and sawtooth generator troubleshooting procedures.
 - Recognize that a blocking oscillator is faulted.
 - Identify the faulted component in a blocking oscillator.
 - Recognize that a sawtooth generator is faulted.
 - Identify the faulted component in a sawtooth generator.
- 5021-522-920 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 (MODEL 1403) (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.
- 5021-524-250 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) ---

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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Trigger Device Circuits (cont.)

- 5021-526-190 SCR Trigger Circuit Operation (cont.)
- Measure the gate and anode current in an operating SCR trigger circuit.
 - Recognize normal operation of an SCR trigger circuit.
- 5021-526-220 SCR Power Control Operation 52B
- Describe the purpose of SCR power control circuits.
 - Describe the operation of an SCR power control circuit.
 - Recognize normal operation of an SCR power control circuit.
 - Measure the waveforms in an operating SCR power control circuit.
- 5021-526-250 SCR Trigger Circuit Troubleshooting Experiment 52A, 52B
- Describe typical faults in SCR trigger and power control circuits.
 - Describe SCR trigger and power control circuit troubleshooting procedures.
 - Recognize when an SCR trigger circuit is faulted.
 - Identify the faulted component in an SCR trigger circuit.
 - Recognize when an SCR power control circuit is faulted.
 - Identify the faulted component in an SCR power control circuit.
- 5021-526-310 Triacs, Diacs, and Four-Layer Diodes 88
- Describe the relationship between triacs and SCRs.
 - Recognize triac circuit operation based on input conditions.
 - Describe the relationship between diacs and four-layer diodes.
 - Explain the beneficial use of a diac with a triac.
 - Observe the effect of AC voltages with basic triac operation.
 - Observe the effect of DC voltages with basic triac operation.
 - Understand the effects of triggering a triac with AC waveforms.
- 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.
- 5021-526-920 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.
- 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.

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ANALOG CIRCUITS (MODEL 1403) (cont.)

Operational Amplifiers (cont.)

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.
- 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.

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Introduction to Digital Circuits (cont.)

- 5021-712-220 Digital Test Equipment (cont.)
- 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.
- 5021-712-920 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.
 - Measure input and output waveforms.

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Digital Logic Functions (cont.)

5021-714-220 NAND Gates	103, 112
<ul style="list-style-type: none">▪ 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
<ul style="list-style-type: none">▪ 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
<ul style="list-style-type: none">▪ 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	---
<ul style="list-style-type: none">▪ 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.	
5021-714-920 Digital Logic Circuits Post-Test (Theory)	---

Combinational Logic Circuits

5021-716-130 Introduction to Combinational Circuits	103, 112
<ul style="list-style-type: none">▪ 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	---
<ul style="list-style-type: none">▪ Describe TTL logic.▪ Identify supply voltage.▪ Define fan-in and fan-out.▪ Define propagation delay.▪ Describe CMOS logic.▪ Describe ECL logic.	

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Combinational Logic Circuits (cont.)

5021-716-160 Logic Families (cont.)

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

5021-716-920 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.

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Flip-Flop Circuits (cont.)

5021-718-160 RS Flip-Flops	113
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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. 	
5021-718-920 Flip-Flop Circuits Post-Test (Theory)	---

Register Memory Circuits

5021-720-130 Introduction to Registers and Memory	---
<ul style="list-style-type: none"> ▪ 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
<ul style="list-style-type: none"> ▪ 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. 	

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Register Memory Circuits (cont.)

- 5021-720-160 4-Bit Storage Register (cont.)
- 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.
 - Recognize normal operation of a 64-bit memory circuit.
- 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.

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Arithmetic Counting Circuits (cont.)

- 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.
- 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.

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DIGITAL CIRCUITS (MODEL 1404) (cont.)

Conversion and Data Circuits (cont.)

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 (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.
- 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.

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DIGITAL CIRCUITS (MODEL 2105) (cont.)

Introduction to Digital Circuits (cont.)

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.

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.
- 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.

5022-714-310 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.

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DIGITAL CIRCUITS (MODEL 2105) (cont.)

Digital Logic Functions (cont.)

5022-714-310 Digital and Analog Switches (cont.)

- 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.

5022-714-920 Digital Logic Circuits Post-Test (Theory) ---

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.

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.

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DIGITAL CIRCUITS (MODEL 2105) (cont.)

Combinational Logic Circuits (cont.)

5022-716-250 Binary to Decimal Conversion (cont.)

- 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.

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.

5022-718-220 D-Type Flip-Flops 2410

- 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 inputs and outputs of a D-type flip-flop.
- Recognize outputs of a D-type flip-flop.

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.

5022-718-920 Flip-Flop Circuits Post-Test (Theory) ---

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.
- 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.

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DIGITAL CIRCUITS (MODEL 2105) (cont.)

Register Memory Circuits (cont.)

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.

5022-720-920 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.

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DIGITAL CIRCUITS (MODEL 2105) (cont.)

Arithmetic Counting Circuits (cont.)

5022-722-250 4-Bit Adder (cont.)

- 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.

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) ---

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.

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WIRING (MODEL 1449) (cont.)

- 5021-214-160 Basic Soldering Techniques (cont.)
▪ Understand how to correct poor solder connections.
- 5021-214-190 Basic Connector Termination Techniques ---
▪ Identify standard wire gauges.
▪ 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) ---

PERFORMANCE TESTS (MODEL 1456)

DC Circuits

- 5021-114-960 Multimeter Use Post-Test (Performance) 2W, 4AW
▪ Set up the circuit properly.
▪ Use test equipment correctly.
▪ Follow safety precautions.
- 5021-116-960 Basic DC Circuits Post-Test (Performance) 9AW
▪ Set up the circuit properly.
▪ Use test equipment correctly.
▪ Follow safety precautions.
- 5021-118-960 Complex DC Circuits Post-Test (Performance) 9CW
▪ Set up the circuit properly.
▪ Use test equipment correctly.
▪ Follow safety precautions.

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PERFORMANCE TESTS (MODEL 1456) (cont.)

Wiring

- 5021-214-960 Wiring Post-Test (Performance) W1W, W2W, W3W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

AC Circuits

- 5020-314-960 AC Test Equipment Post-Test (Performance) 10W, 804W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-316-960 Inductance and RL Circuits Post-Test (Performance) 16BW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-318-960 Capacitance and RC Circuits Post-Test (Performance) 14AW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-320-960 RC Time Constants and Transients Post-Test (Performance) 14BW, 804W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-322-960 Resonance Post-Test (Performance) 18AW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-324-960 Transformers Post-Test (Performance) 21W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-326-960 Relays and Switches Post-Test (Performance) 84BW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

Analog Circuits

- 5021-514-960 Diodes and Diode Circuits Post-Test (Performance) 22AW, 77AW, 77BW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-516-960 Transistor Circuits Post-Test (Performance) 30AW, 31W, 32W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-518-960 Power Supplies Post-Test (Performance) 23W, 25W, 26W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

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PERFORMANCE TESTS (MODEL 1456) (cont.)

Analog Circuits (cont.)

- 5021-520-960 Transistor Amplifiers Post-Test (Performance) 30AW, 31W, 32W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-522-960 Transistor Oscillators Post-Test (Performance) 42W, 43AW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-524-960 Transistor Pulse Circuits Post-Test (Performance) 44W, 45W, 46W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-526-960 Trigger Device Circuits Post-Test (Performance) 52AW, 52BW
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-528-960 Operational Amplifiers Post-Test (Performance) 54W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-530-960 RF Electronics Post-Test (Performance) 38W, 39W, 40W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

Digital Circuits

- 5021-712-960 Introduction to Digital Circuits Post-Test (Performance) 101W, 105W, 112W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-714-960 Digital Logic Circuits Post-Test (Performance) 102W, 105W, 112W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-716-960 Combinational Logic Circuits Post-Test (Performance) 108W, 109W, 110W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-718-960 Flip-Flop Circuits Post-Test (Performance) 111W, 113W, 115W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-720-960 Register Memory Circuits Post-Test (Performance) 111W, 118W, 126W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

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PERFORMANCE TESTS (MODEL 1456) (cont.)

Digital Circuits (cont.)

- 5021-722-960 Arithmetic Counting Circuits Post-Test (Performance) 111W, 116W, 121W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.
- 5021-724-960 Conversion and Data Circuits Post-Test (Performance) 112W, 133W, 134W
- Set up the circuit properly.
 - Use test equipment correctly.
 - Follow safety precautions.

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.

SOLDERING (MODEL 1410)

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SOLDERING (MODEL 1410) (cont.)

- 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.
- 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.
- 5021-914-220 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.
- 5021-914-250 Printed Circuit Board Types and Manufacturing Methods 1410K1
- Identify the general characteristics of PC boards.
 - Identify several connection methods used on PC boards.

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SOLDERING (MODEL 1410) (cont.)

- 5021-914-250 Printed Circuit Board Types and Manufacturing Methods (cont.)
- 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.
- 5021-914-280 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.
- 5021-914-310 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.
- 5021-914-340 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.
- 5021-914-370 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.

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.

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RADAR (MODEL 1415) (cont.)

- 5061-212-130 Introduction to Radar (cont.)
 - 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.
 - 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).

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RADAR (MODEL 1415) (cont.)

- 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.

8051 MICROPROCESSOR (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.
 - Describe and perform number system conversions.
 - Describe and perform binary addition and subtraction.
 - Describe and perform multiplication and division.

8051 Microprocessor 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.

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8051 MICROPROCESSOR (MODEL 1439) (cont.)

8051 Microprocessor Circuits (cont.)

5082-222-220 Troubleshooting the 8051 Microcontroller (cont.)

- 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.
- 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.

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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.
 - 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.

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CARDS/KITS

8086 MICROPROCESSOR (MODEL 1441) (cont.)

8086 Microprocessor Circuits (cont.)

- 5082-226-250 8086 Data Transfer Instructions (cont.)
- 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.

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.

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68000 MICROPROCESSOR (MODEL 1468) (cont.)

68000 Microprocessor Circuits (cont.)

- 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.
 - 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.

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CARDS/KITS

68000 MICROPROCESSOR (MODEL 1468) (cont.)

68000 Microprocessor Circuits (cont.)

- 5082-228-370 Test and Additional Commands (cont.)
- 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.
 - 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.

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FIBEROPTIC CIRCUITS (MODEL 1406) (cont.)

- 5102-114-190 Signal Transmission (cont.)
- 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.

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.

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SIGNAL PROCESSING (MODEL 1407) (cont.)

AM/FM Circuits (cont.)

- 5101-114-130 AM Circuits (cont.)
- 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.
 - 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.

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SIGNAL PROCESSING (MODEL 1407) (cont.)

Modulation Techniques (cont.)

- 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.
- 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.

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SIGNAL PROCESSING (MODEL 1407) (cont.)

Modulation Techniques (cont.)

- 5101-128-160 Phase Shift Keying Circuit Operation (cont.)
- 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.
- 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.

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BASIC TELEPHONE (MODEL 1429) (cont.)

- 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).
 - 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.

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TELECOMMUNICATIONS (cont.)

- 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.
- 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.

APPLICATIONS - 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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APPLICATIONS - 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.

MOTORS (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.
 - Compute linear and rotary motion rates based on system mechanical and electrical parameters.

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MOTORS (MODEL 170) (cont.)

Motor Control Systems (cont.)

- 5142-318-130 Motion Detection (cont.)
- 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.
- 5142-412-160 Introduction to Pneumatic Systems ---
- Describe pneumatics.
 - Understand the concept of pneumatics.

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HYDRAULIC AND PNEUMATIC SYSTEMS (cont.)

- 5142-412-160 Introduction to Pneumatic Systems (cont.)
- 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.

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.

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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.
 - 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.

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AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)

Introduction to Automotive Electricity (cont.)

- 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.
- 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.

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AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)

Automotive Test Equipment (cont.)

- 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.
 - 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.

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AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)

Basic Electrical DC and AC (cont.)

- 7021-216-250 Voltage Divider Circuits 705
- Identify a voltage divider circuit.
 - Identify a voltage divider as loaded or unloaded.
 - 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.

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AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)

Basic Electronics for Automotive (cont.)

7021-218-190 Diode Operation	708
▪ Identify the purpose of a diode.	
▪ Recognize diode schematic symbols and use reference designators.	
▪ 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.	

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AUTOMOTIVE TECHNOLOGY (MODEL 1431) (cont.)

Basic Automotive Systems (cont.)

- 7021-312-160 Starting Systems (cont.)
▪ Examine the operation of a starting system.
- 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.

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.
 - 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.

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CARDS/KITS

MATHEMATICS (cont.)

Basic Math (cont.)

2011-112-280 Signed Numbers (cont.)

- 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.
- 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.

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CARDS/KITS

MATHEMATICS (cont.)

Algebra (cont.)

- 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.
 - 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.

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MATHEMATICS (cont.)

Algebra (cont.)

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.

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.

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CARDS/KITS

MATHEMATICS (cont.)

Trigonometry (cont.)

- 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 arccosecant, arcsecant, and arccotangent.
 - Solve problems involving arccosecant, arcsecant, and arccotangent.
- 2011-214-310 Applications of Trigonometry ---
- Identify an oblique triangle.
 - 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 ΔX goes to 0.

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MATHEMATICS (cont.)

Calculus (cont.)

- 2011-216-130 Fundamentals of Calculus (cont.)
▪ 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.
▪ 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.

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MATHEMATICS (cont.)

Calculus (cont.)

2011-216-340 Integration (cont.)

- 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.

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.

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CARDS/KITS

MATHEMATICS (cont.)

Computer Math (cont.)

2011-312-220 Logic Expressions (cont.)

- 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.
- 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.

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CARDS/KITS

MATHEMATICS (cont.)

Measurements (cont.)

2011-412-160 Metric and Scientific Conversions (cont.)

- 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- level, 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.
- 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).