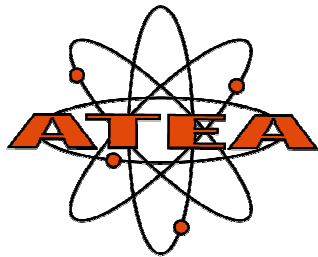


**NIDA CORPORATION  
COMPUTER ASSISTED INSTRUCTION  
and LAB/TEXT  
LESSON and OBJECTIVE LISTING**

July 2009



**NIDA CORPORATION COMPUTER ASSISTED INSTRUCTION  
and LAB/TEXT**

**LESSON/OBJECTIVE INDEX**

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LEGEND
CORE (Unmarked)
● VOCATIONAL
●● UNIVERSITY
●●● ENGINEERING LESSONS
●●●● ALTERNATE TEST EQUIPMENT

° indicates separate trainer



<b>BASIC ELECTRONICS</b>
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**MODEL 1401 DC CIRCUITS**

- 1100 - INTRODUCTION TO CAI** .....--
- \* Learn how the mouse is used in a CAI lesson.
  - \* Learn how the keyboard is used in a CAI lesson.
  - \* Identify lesson page types.
  - \* Become familiar with lesson structure.
- 1101 - 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.
- 1102 - TRAINING EQUIPMENT FAMILIARIZATION** ..... **2**
- \* Identify the power requirements for the training hardware.
  - \* Identify the test console controls, switches, and indicators.
  - \* Identify an experiment card and practice installing/removing it.
  - \* Practice making power supply voltage and current selections.
- 1103 - METRIC NOTATION** .....--
- \* Convert between decimal and powers of ten.
  - \* Convert between decimal and metric prefixes.
  - \* Adding, subtracting, multiplying and dividing powers of ten and metric prefixes.
- 1104 - VOLTAGE AND CURRENT** .....--
- \* Describe atomic structure and define electric charge as it relates to electrons and protons.
  - \* Describe the law of electrostatic force.
  - \* Define voltage and the volt as the unit of measure.
  - \* Define the relationship between voltage and potential difference.
  - \* Identify the six methods of producing voltage.
  - \* Define current and the ampere as the unit of measure.
  - \* Describe a conductor and an insulator and the behavior of electrons in an insulator.
  - \* Identify the three basic elements of an electrical circuit.
  - \* Describe an electrical circuit load and resulting current flow.
- 1105 - RESISTORS** ..... **1A (Optional)**
- \* Identify the purpose of a resistor.
  - \* Identify the unit of resistance as the ohm.
  - \* Identify the resistor reference designator code.
  - \* Identify the resistor schematic symbol.
  - \* Identify fixed and variable resistor types.
  - \* Define a resistor's power rating.
  - \* Define the tolerance of a resistor.
  - \* Identify a resistor's number and letter code.
- 1106 - SWITCHES, FUSES AND CIRCUIT BREAKERS** .....--
- \* Identify the purpose of a switch and its schematic diagram.
  - \* Describe a single and double pole switch.
  - \* Describe a single and double throw switch.
  - \* Describe four types of switches and their schematic diagrams.
  - \* Identify the purpose of a circuit protection device.
  - \* Identify a fuse and circuit breaker and their schematic symbols.

## MODEL 1401 DC CIRCUITS continued

**1107 – 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.

**• 1108 – SCHEMATIC DIAGRAMS.....--**

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

**1201 – MAGNETISM, RELAYS AND METERS.....--**

- \* Define magnetism and the characteristics of a magnet.
- \* Define the laws of magnetic attraction and repulsion.
- \* Describe the properties of magnetic lines of force.
- \* Identify magnetic and non-magnetic materials.
- \* Define electromagnetism and their characteristics.
- \* Operation of a relay, magnetic circuit breaker, and a meter.

**1202 - INTRODUCTION TO MULTIMETERS .....--**

- \* Identify the quantities measured by multimeters.
- \* Identify the two multimeter displays.
- \* Describe the functional sections of a multimeter.
- \* Describe the purpose of each functional section.

**1203 - MULTIMETER USE ..... CF**

- \* Understand how to operate a digital multimeter.
- \* Understand how to operate an analog multimeter.
- \* Operate a digital multimeter.
- \* Operate an analog multimeter.

**1204 - 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 how to set up an analog multimeter to measure voltage.
- \* Understand how to read an analog 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 multimeter.

**1205 - 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 how to set up an analog multimeter to measure current.
- \* Describe how to read an analog 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 multimeter.

**1206 - RESISTANCE MEASUREMENTS ..... 1A or 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 how to set up an analog multimeter to measure resistance.
- \* Understand how to read an analog 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 multimeter.

**1301 - OHM'S LAW AND POWER..... 5**

- \* Learn Ohm's Law and how voltage, current, and resistance are related.
- \* Learn the definition of power and how voltage, current and Ohm's Law are related to power.
- \* Prove, by experimentation, the Ohm's Law relationship of voltage, current, and resistance.

**1302 - SERIES CIRCUITS.....6A**

- \* Identify a series circuit.
- \* Calculate total resistance and current in a series circuit.
- \* Calculate voltage drops across resistors.
- \* Measure current and voltage drops in a series circuit.

## MODEL 1401 DC CIRCUITS continued

- 1303 - SERIES CIRCUIT TROUBLESHOOTING THEORY** .....--
- \* Learn a logical troubleshooting procedure.
  - \* Determine if an operating series circuit is faulty.
  - \* Identify an open, short, and changed value resistor in an operating series circuit.
- 1304 - SERIES CIRCUIT TROUBLESHOOTING EXPERIMENT** .....6A
- \* Determine if a series circuit is open and which component is faulty.
  - \* Determine if a series circuit has a short and which component is faulty.
  - \* Determine if a series circuit has a changed valued component and which component has changed.
- **1305 - SERIES CIRCUIT TROUBLESHOOTING PRACTICE** .....6A
- \* Troubleshoot a series circuit and identify if it is faulty.
  - \* Identify a faulted circuit as being open, shorted or changed value.
  - \* Identify the component most likely to be faulty.
- 1306 - PARALLEL CIRCUITS**.....8A
- \* Identify a parallel circuit.
  - \* Learn that the applied voltage is the same across each branch.
  - \* Calculate the current in each branch of a parallel circuit.
  - \* Calculate total current from the sum of the individual branch currents.
  - \* Calculate total resistance.
  - \* Measure the applied voltage across each parallel circuit branch.
  - \* Measure current through each branch of a parallel circuit.
  - \* Measure total resistance in a parallel circuit.
- 1307 - PARALLEL CIRCUIT TROUBLESHOOTING THEORY** .....--
- \* Determine if an operating parallel circuit is faulty.
  - \* Identify an open, short, and changed value resistor in an operating parallel circuit.
- **1308 - PARALLEL CIRCUIT TROUBLESHOOTING EXPERIMENT** .....8A
- \* Determine if a parallel circuit is open and which component is faulty.
  - \* Determine if a parallel circuit has a short and which component is faulty.
  - \* Determine if a parallel circuit has a changed valued component and which component has changed.
- **1309 - PARALLEL CIRCUIT TROUBLESHOOTING PRACTICE** .....8A
- \* Troubleshoot a parallel circuit and identify if it is faulty.
  - \* Identify a faulted circuit as being open, shorted or changed value.
  - \* Identify the component most likely to be faulty.
- 1310 - SERIES-PARALLEL CIRCUITS** .....9A
- \* Identify a series-parallel circuit.
  - \* Calculate total resistance.
  - \* Calculate current in a series-parallel circuit.
  - \* Calculate voltage drops in a series-parallel circuit.
  - \* Measure resistance values in series-parallel circuit.
  - \* Measure current values in a series-parallel circuit.
  - \* Measure voltage drops in a series-parallel circuit.
- 1311 - SERIES-PARALLEL CIRCUIT TROUBLESHOOTING THEORY**.....--
- \* Determine if an operating series-parallel circuit is faulty.
  - \* Identify an open, short, and changed value resistor in an operating series-parallel circuit.
- **1312 - SERIES-PARALLEL CIRCUIT TROUBLESHOOTING EXPERIMENT** .....9A
- \* Determine if a series-parallel circuit is open, short or has a changed value component.
- **1313 - SERIES-PARALLEL CIRCUIT TROUBLESHOOTING PRACTICE**.....9A
- \* Troubleshoot a series-parallel circuit and identify if it is faulty.
  - \* Identify a faulted circuit as being open, shorted or changed value.
  - \* Identify the component most likely to be faulty.

MODEL 1401 DC CIRCUITS continued

- **1401 - VOLTAGE DIVIDER CIRCUITS** .....9C
  - \* Identify a voltage divider circuit.
  - \* Identify a voltage divider as being loaded or unloaded.
  - \* Calculate voltage, current, and resistance in a loaded and unloaded voltage divider circuits.
  - \* Calculate percent regulation for voltage divider circuits.
  - \* Measure voltages in loaded and unloaded voltage divider circuits.
- **1402 - BRIDGE CIRCUITS** ..... 10A
  - \* State the purpose of a bridge circuit.
  - \* Identify a bridge circuit.
  - \* Solve for voltage outputs and unknown resistances.
  - \* Make voltage measurements in an operating bridge circuit and calculate resistances.
- **1407 - INTRODUCTION TO KIRCHHOFF'S VOLTAGE AND CURRENT LAWS**.....9C
  - \* Identify a complex circuit.
  - \* State Kirchhoff's Current and Voltage Laws.
  - \* Compare calculated and measured voltage in a circuit using Kirchhoff's Laws.
- **1403 - KIRCHHOFF'S VOLTAGE AND CURRENT LAWS** .....9C
  - \* Identify a complex circuit.
  - \* State Kirchhoff's Current and Voltage Laws.
  - \* Calculate current and voltage using Kirchhoff's Laws.
- **1404 - NORTON'S THEOREM**.....--
  - \* State the purpose of Norton's Theorem.
  - \* State the procedure for solving circuit values using Norton's Theorem.
  - \* Nortonize a series-parallel circuit.
- **1405 - THEVENIN'S THEOREM** .....--
  - \* State the purpose of Thevenin's Theorem.
  - \* Describe the six-step process for analyzing circuits using Thevenin's Theorem.
  - \* Theveninize a series-parallel and complex circuit.
- **1406 - MULTIMETER LOADING** .....9C
  - \* Describe the circuit loading effect of meters.
  - \* Describe how meter loading is reduced.
  - \* Describe the ohms-per-volt rating of analog meters.
  - \* Measure circuit voltages using an analog and digital multimeter.
  - \* Observe the loading effect of an analog meter.

MODEL 1402 AC CIRCUITS

- 2101 - ALTERNATING CURRENT** .....--
  - \* Define alternating current.
  - \* Identify an AC sine wave.
  - \* Define frequency and cycle and describe Hertz.
  - \* Determine wavelength of a sine wave.
  - \* Determine the period of a sine wave.
- 2102 - GENERATING 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.
- 2103 - NON-SINUSOIDAL WAVES** .....--
  - \* Identify harmonic frequencies.
  - \* Identify harmonic frequencies used to produce non-sinusoidal waves.
  - \* Define square waves.
  - \* Identify square wave cycles.
  - \* Define sawtooth waves.
  - \* Identify sawtooth wave cycles.

MODEL 1402 AC CIRCUITS continued

**2104 - 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 calculate resistance in an AC parallel circuit.
- \* Discuss the relationship between voltage, current, and resistance in an AC parallel circuit.
- \* Use Ohm's Law to calculate resistance in an AC series parallel circuit.
- \* Identify the relationship between voltage, current, and resistance in and AC series parallel circuit.

**2201 - INTRODUCTION TO OSCILLOSCOPES**.....--

- \* Describe the purpose of an oscilloscope.
- \* Identify the quantities measured by an oscilloscope.
- \* Describe single trace and dual trace oscilloscopes.
- \* Identify the four main functional sections of an oscilloscope.
- \* Describe the purpose of each control and switch of an oscilloscope.

**•• 2202 - OSCILLOSCOPE USE** ..... 10,804

- \* Set up an oscilloscope for normal operation.
- \* Measure voltage using an oscilloscope.
- \* Measure frequency using an oscilloscope.

**2203 - 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 two major sections of a function generator.
- \* Describe the purpose of each control and switch of a function generator.

**2204 - FUNCTION GENERATOR USE**..... 10

- \* Set up a function generator for normal operation.
- \* Adjust a function generator for various output signals.
- \* Modulate an output signal.

**• 2205 - INTRODUCTION TO THE FREQUENCY COUNTER**.....--

- \* Describe the purpose of a frequency counter.
- \* Describe the 4 major functions a frequency counter performs.
- \* Determine the quantity measured from the display.
- \* Identify the controls of a frequency counter and discuss their purpose.

**• 2206 - FREQUENCY COUNTER USE**..... 10

- \* Set up a frequency counter for normal operation.
- \* Perform calibration period, frequency, and totalize measurements.
- \* Compare frequency and period measurements using a frequency counter and an oscilloscope.

**2207 - OSCILLOSCOPE USE**..... 10

- \* Set up an oscilloscope for normal operation.
- \* Measure voltage using an oscilloscope.
- \* Measure frequency using an oscilloscope.

**•••• 2208 - INTRO TO FUNCTION GENERATOR (444)** .....--

- \* Describe the purpose of a function generator.
- \* Identify the types of output signals generated by a function generator.
- \* Identify the two major sections of a function generator.
- \* Describe the purpose of each control and switch on a function generator.

**•••• 2209 - FUNCTION GENERATOR USE (444)** ..... 10

- \* Set up a function generator for normal operation.
- \* Adjust a function generator for various output signals.
- \* Modulate an output signal.

**•••• 2210 - INTRO TO FUNCTION GENERATOR (4040)** .....--

- \* Describe the purpose of a function generator.
- \* Identify the types of output signals generated by a function generator.
- \* Identify the two major sections of a function generator.
- \* Describe the purpose of each control and switch on a function generator.

## MODEL 1402 AC CIRCUITS continued

●●●	<b>2211 - FUNCTION GENERATOR USE (4040)</b> .....	10
	* Set up a function generator for normal operation.	
	* Adjust a function generator for various output signals.	
	* Modulate an output signal.	
	<b>2301 - INTRODUCTION TO INDUCTORS</b> .....	--
	* Identify types of inductors.	
	* Discuss the current opposing characteristic of an inductor.	
	* Identify the schematic symbol for an inductor.	
	* Identify the unit of measurement for inductance.	
	* Discuss the characteristics of inductance.	
	<b>2302 - INDUCTOR IDENTIFICATION</b> .....	11
	* Identify inductors.	
	* Use inductor color codes to determine inductance.	
	<b>2303 - RL SERIES CIRCUITS</b> .....	--
	* Calculate total inductance in series circuits.	
	* Calculate total inductive reactance in series circuits.	
	* Calculate total impedance in series circuits.	
	<b>2304 - RL SERIES CIRCUIT OPERATION</b> .....	13
	* Measure the inductive phase relationship between voltage and current.	
	* Verify normal operation of a RL series circuit.	
	* Measure the phase relationship between the voltages developed across resistors and inductors.	
●	<b>2305 - RL SERIES CIRCUIT TROUBLESHOOTING EXPERIMENT</b> .....	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.	
	* Determine an open component in an RL series circuit.	
	* Determine a shorted component in an RL series circuit.	
●	<b>2306 - RL SERIES CIRCUIT TROUBLESHOOTING PRACTICE</b> .....	16B
	* Locate an open component in an RL series circuit.	
	* Locate a shorted component in an RL series circuit.	
	* Locate a changed value component in an RL series circuit.	
	<b>2307 - RL PARALLEL CIRCUITS</b> .....	--
	* Calculate total inductance in an RL parallel circuit.	
	* Calculate total inductive reactance in an RL parallel circuit.	
	* Calculate total impedance in an RL parallel circuit.	
	<b>2308 - RL PARALLEL CIRCUIT OPERATION</b> .....	13
	* Measure the current phase difference between 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.	
●	<b>2309 - RL PARALLEL CIRCUIT TROUBLESHOOTING EXPERIMENT</b> .....	16B
	* Identify an open component in an RL parallel circuit.	
	* Identify a shorted component in an RL parallel circuit.	
	* Identify a changed value component in an RL parallel circuit.	
	* Observe an open component in an RL parallel circuit.	
	* Observe a shorted component in an RL parallel circuit.	
●	<b>2310 - RL PARALLEL CIRCUIT TROUBLESHOOTING PRACTICE</b> .....	16B
	* Locate an open component in an RL parallel circuit.	
	* Locate a shorted component in an RL parallel circuit.	
	* Locate a changed value component in an RL parallel circuit.	
●●	<b>2311 - RL FILTERS</b> .....	16B
	* Identify RL filter circuits.	
	* Describe RL filter circuit characteristics.	
	* Calculate RL filter circuit values.	
	* Measure RL filter circuit values.	
	* Compare measured RL filter circuit values with calculated circuit values.	

## MODEL 1402 AC CIRCUITS continued

<b>2401 - INTRODUCTION TO CAPACITORS .....</b>	<b>--</b>
* Identify types of capacitors and schematic symbol.	
* Describe charge and discharge characteristics of a capacitor.	
<b>2402 - CAPACITOR IDENTIFICATION.....</b>	<b>11</b>
* Identify ceramic, film, mica, and electrolytic capacitors.	
* Read the capacitance and voltage values.	
<b>2403 - RC SERIES CIRCUITS .....</b>	<b>--</b>
* Calculate total capacitance in series circuits.	
* Calculate total capacitive reaction and impedance series circuits.	
<b>2404 - RC SERIES CIRCUIT OPERATION .....</b>	<b>12</b>
* Measure the capacitive phase relationship between voltage and current.	
* Verify normal operation of an RC series circuit.	
<b>● 2405 - RC SERIES CIRCUIT TROUBLESHOOTING EXPERIMENT .....</b>	<b>14A</b>
* 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.	
<b>● 2406 - RC SERIES CIRCUIT TROUBLESHOOTING PRACTICE I.....</b>	<b>14A</b>
* Locate an open component in an RC series circuit.	
* Locate a shorted component in an RC series circuit.	
* Locate a changed value component in an RC series circuit.	
<b>●● 2407 - RC SERIES CIRCUIT TROUBLESHOOTING PRACTICE II.....</b>	<b>14B</b>
* Locate an open component in an RC series circuit.	
* Locate a shorted component in an RC series circuit.	
* Locate a changed value component in an RC series circuit.	
<b>2408 - RC PARALLEL CIRCUITS .....</b>	<b>--</b>
* Calculate total capacitance in an RC parallel circuit.	
* Calculate total capacitive reactance in an RC parallel circuit.	
* Calculate total impedance in an RC parallel circuit.	
<b>2409 - RC PARALLEL CIRCUIT OPERATION .....</b>	<b>12</b>
* Measure the current phase difference between capacitive and resistive branches of a parallel RC circuit.	
* Verify normal operation of an RC parallel circuit.	
* Measure the total current phase difference in an RC parallel circuit.	
<b>● 2410 - RC PARALLEL CIRCUIT TROUBLESHOOTING EXPERIMENT .....</b>	<b>14A</b>
* 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.	
<b>● 2411 - RC PARALLEL CIRCUIT TROUBLESHOOTING PRACTICE I.....</b>	<b>14A</b>
* Locate an open component in an RC parallel circuit.	
* Locate a shorted component in an RC parallel circuit.	
* Locate a changed value component in an RC parallel circuit.	
<b>●● 2412 - RC PARALLEL CIRCUIT TROUBLESHOOTING PRACTICE II.....</b>	<b>14B</b>
* Locate an open component in an RC parallel circuit.	
* Locate a shorted component in an RC parallel circuit.	
* Locate a changed value component in an RC parallel circuit.	
<b>●● 2413 - RC FILTERS .....</b>	<b>14B</b>
* 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.	

## MODEL 1402 AC CIRCUITS continued

<b>2501 - RC AND RL TIME CONSTANTS .....</b>	<b>---</b>
* 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.	
<b>2502 - RC TIME CONSTANTS OPERATION .....</b>	<b>15</b>
* Measure the charging and discharging of a capacitor using a multimeter.	
* Measure the charging and discharging of a capacitor using an oscilloscope.	
* Verify RC time constants through measurements.	
<b>• 2503 - RC CIRCUIT TRANSIENT ANALYSIS.....</b>	<b>---</b>
* Describe the effects of a capacitor on non-sinusoidal wave shapes.	
* Describe how long and short time constants affect wave shapes.	
* Describe how RC time constant relates to capacitive reactance.	
<b>• 2504 - RC CIRCUIT TRANSIENT EXPERIMENT.....</b>	<b>14A</b>
* Predict effects on voltage and current as frequency changes.	
* Measure voltage waveform across a capacitor with a square wave applied.	
* Measure current waveform through a capacitor using a sampling resistor.	
<b>• 2505 - RC CIRCUIT TRANSIENT TROUBLESHOOTING EXPERIMENT.....</b>	<b>14A</b>
* 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.	
<b>•• 2506 - RC CIRCUIT TRANSIENT TROUBLESHOOTING PRACTICE I.....</b>	<b>14A</b>
* Identify faulty RC transient circuit operation.	
* Identify the faulty component in an RC transient circuit.	
<b>•• 2507 - RC CIRCUIT TRANSIENT TROUBLESHOOTING PRACTICE II.....</b>	<b>14B</b>
* Identify faulty RC transient circuit operation.	
* Determine the faulty component in an RC transient circuit.	
<b>2601 - CAPACITIVE/INDUCTIVE REACTANCE AND RCL CIRCUITS.....</b>	<b>---</b>
* Describe the effects of inductors and capacitors when used in the same circuit.	
* Calculate circuit values in a series RCL circuit.	
* Calculate circuit values in a parallel RCL circuit.	
<b>2602 - LCR SERIES AND PARALLEL CIRCUIT EXPERIMENT .....</b>	<b>17,19</b>
* Calculate and measure the voltage drops in an LCR series circuit.	
* Verify normal operation of an LCR series circuit.	
* Measure the phase relationship between $E_A$ , $E_R$ , $E_C$ , and $E_L$ in an LCR series circuit.	
* Calculate and measure the branch currents in an LCR parallel circuit.	
* Verify normal operation of an LCR parallel circuit.	
* Measure the phase relationship between $I_T$ , $I_R$ , $I_C$ , and $I_L$ in an LCR parallel circuit.	
<b>• 2603 - LCR CIRCUIT TROUBLESHOOTING.....</b>	<b>18A</b>
* Identify an open component in an LCR series and parallel circuit.	
* Identify a shorted component in an LCR series and parallel circuit.	
* Identify a changed value component in an LCR series and parallel circuit.	
* Observe the effects of an open component in an LCR series circuit.	
* Observe the effects of a shorted component in an LCR series circuit.	
<b>• 2604 - SERIES RESONANCE .....</b>	<b>---</b>
* Describe series resonance.	
* Calculate the resonant frequency of an LCR series circuit.	
* Describe LCR series circuit values at resonance.	
<b>• 2605 - SERIES RESONANT CIRCUITS .....</b>	<b>18A</b>
* Calculate and measure the resonant frequency in an LCR circuit.	
* Observe the effects of voltage magnification.	
* Observe the values of $E_R$ , $I_T$ and $Z_T$ below, at, and above resonance in a series LCR circuit.	

## MODEL 1402 AC CIRCUITS continued

- **2606 - PARALLEL RESONANCE** .....--
  - \* Describe parallel resonance
  - \* Calculate the resonant frequency of an LCR parallel circuit and describe circuit values at resonance.
- **2607 - PARALLEL RESONANT CIRCUITS** ..... 20A
  - \* Calculate and measure the resonant frequency of an LCR parallel circuit.
  - \* Observe the values of  $I_T$  and  $Z_T$  below, at, and above resonance in a parallel LCR circuit.
- **2608 - 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 series and parallel resonant circuit.
  - \* Observe the effects of an open component in a series and parallel resonant circuit.
  - \* Observe the effects of a shorted component in a series and parallel resonant circuit.
- **2609 - RESONANT CIRCUIT TROUBLESHOOTING I** ..... 18A,20A
  - \* Identify faulty series resonant circuit operation.
  - \* Determine the faulted component in a series resonant circuit.
  - \* Identify faulty parallel resonant circuit operation.
  - \* Determine the faulted component in a parallel resonant circuit.
- **2610 - RESONANT CIRCUIT TROUBLESHOOTING II** ..... 18B,20B
  - \* Identify faulty series resonant circuit operation.
  - \* Determine the faulted component in a series resonant circuit.
  - \* Identify faulty parallel resonant circuit operation.
  - \* Determine the faulted component in a parallel resonant circuit.
- 2701 - INTRODUCTION TO TRANSFORMERS** .....--
  - \* Describe the purpose of transformers.
  - \* Identify transformer schematic symbols and the reference designation.
  - \* Describe transformer operating characteristics.
  - \* Calculate turns ratio, secondary voltage, current, and power.
  - \* Calculate primary current and power.
- 2702 - TRANSFORMER OPERATION** ..... 21
  - \* Measure primary voltage of a transformer.
  - \* Measure secondary voltage of a transformer.
  - \* Determine step up or step down transformer action.
- **2703 - TROUBLESHOOTING TRANSFORMERS** ..... 21
  - \* Describe typical faults in transformer circuits.
  - \* Describe transformer troubleshooting procedures.
  - \* Determine when a transformer is faulted.
  - \* Observe the effects of an open and shorted secondary in a transformer circuit.
- **2801 - 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.
- **2802 - RELAYS OPERATION EXPERIMENT** ..... 84B
  - \* Trace signal flow through a relay circuit.
  - \* Measure voltages in a relay circuit.
- **2803 - TROUBLESHOOTING RELAYS AND SWITCHES** ..... 84B
  - \* Describe typical faults in relays and describe relay-troubleshooting procedures.
  - \* Recognize that a relay circuit is faulted and identify the fault in a faulted relay circuit.
- **2804 - ELECTRICAL CIRCUITS** .....--
  - \* Identify component symbols from a schematic drawing.
  - \* Describe the operation of an electrical circuit using a schematic drawing.

## MODEL 1402 AC CIRCUITS continued

- **2805 - ELECTRICAL CIRCUITS EXPERIMENT** ..... 82,83
  - \* Trace signal flow through an electrical circuit.
  - \* Measure AC and DC voltages in an electrical circuit.
- **2806 - ELECTRICAL CIRCUITS TROUBLESHOOTING** ..... 82,83
  - \* Describe typical faults in electrical circuits.
  - \* Describe electrical circuit troubleshooting procedures.
  - \* Recognize that an electrical circuit is faulted.
  - \* Identify the fault in a faulted electrical circuit.

## MODEL 1403 ANALOG CIRCUITS

- 3101 - INTRODUCTION TO DIODES** .....--
  - \* Discuss the purpose of semiconductor diodes.
  - \* 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.
- 3102 - JUNCTION DIODES**.....--
  - \* Describe the purpose of a junction diode.
  - \* Identify the schematic symbol for a junction diode.
  - \* Describe forward and reverse bias.
  - \* Calculate circuit current based on the knee voltage of the diode.
- 3103 - JUNCTION DIODE OPERATION**..... 22A
  - \* Recognize normal operation of a junction diode.
  - \* Measure current through a junction diode.
- **3104 - JUNCTION DIODE TROUBLESHOOTING EXPERIMENT** ..... 22A
  - \* Identify an open junction diode in a circuit.
  - \* Identify a shorted junction diode in a circuit.
  - \* Identify a charged value junction diode in a circuit.
  - \* Observe an open junction diode in a circuit.
  - \* Observe a shorted junction diode in a circuit.
- **3105 - JUNCTION DIODE TROUBLESHOOTING PRACTICE** ..... 22A
  - \* Identify an open junction diode in an operating circuit.
  - \* Identify a shorted junction diode in an operating circuit.
  - \* Observe diode limiter operation
  - \* 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.
- 3106 - 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.
- **3107 - 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.

MODEL 1403 ANALOG CIRCUITS continued

- **3108 - LIMITER AND CLAMPER TROUBLESHOOTING EXPERIMENT ..... 77A,77B**
  - \* Describe typical faults in diode limiter and clamper circuits and describe troubleshooting procedures.
  - \* Recognize when a parallel diode limiter circuit is faulted.
  - \* Observe the effects of a defective diode in a parallel limiter circuit.
  - \* Recognize when a diode clamper circuit is faulted.
  - \* Observe the effects of a defective diode in a clamper circuit.
- **3109 - LIMITER AND CLAMPER TROUBLESHOOTING PRACTICE ..... 77A,77B**
  - \* Identify faulty limiter circuit operation.
  - \* Determine the faulty component in a faulted clamper circuit.
  - \* Determine the faulty component in a faulted limiter circuit.
  - \* Identify faulty clamper circuit operation and determine the faulty component.
- 3110 - 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.
- 3201 - INTRODUCTION TO TRANSISTORS .....--**
  - \* Describe the purpose of a transistor.
  - \* Describe types of transistors.
  - \* Identify transistor schematic symbols.
  - \* Identify the base, emitter, and collector leads of a transistor.
  - \* Describe the purpose of DC bias in transistors.
  - \* Describe NPN transistor bias.
  - \* Describe PNP transistor bias.
- 3202 - TRANSISTOR OPERATION ..... 28,29**
  - \* Describe transistor cutoff and saturation.
  - \* Describe transistor Alpha and Beta.
  - \* Identify fixed, self, and combination biasing.
  - \* Measure Alpha and Beta.
  - \* Observe cutoff and saturation.
  - \* Measure collector current with varying load resistors.
- 3203 - 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.
- 3204 - COMMON EMITTER AMPLIFIER.....--**
  - \* Describe the operating characteristics of a common emitter amp.
  - \* Describe the purpose of individual components in a common emitter amplifier.
  - \* Describe methods to determine class of operation.
  - \* Describe methods to determine voltage gain.
- 3205 - COMMON EMITTER AMPLIFIER EXPERIMENT ..... 30A**
  - \* Measure input and output waveforms of a common emitter amp circuit to determine normal operation.
  - \* Observe waveforms in a common emitter amplifier circuit.
- 3206 - COMMON COLLECTOR AMPLIFIER .....--**
  - \* Describe the operating characteristics of a common collector amp.
  - \* Describe the purpose of individual components in a common collector amplifier.
- 3207 - COMMON COLLECTOR AMPLIFIER EXPERIMENT..... 31**
  - \* Measure input and output waveforms of a common collector amplifier circuit to determine normal operation.
  - \* Observe waveforms in a common collector amplifier circuit.

## MODEL 1403 ANALOG CIRCUITS continued

<b>3208 - COMMON BASE AMPLIFIER.....</b>	<b>--</b>
* Describe the operating characteristics of a common base amplifier.	
* Describe the purpose of individual components in a common base amp.	
* Describe methods to determine class of operation.	
* Describe methods to determine voltage gain.	
<b>3209 - COMMON BASE AMPLIFIER EXPERIMENT .....</b>	<b>32</b>
* Measure the input and output waveforms of a common amplifier circuit to determine normal operation.	
* Observe waveforms in a common base amplifier circuit.	
<b>3301 - INTRODUCTION TO POWER SUPPLIES AND DIODE RECTIFIERS.....</b>	<b>--</b>
* Describe the purpose of power supplies.	
* Describe the sections of a typical power supply.	
* Identify half-/full-wave and bridge rectifiers.	
<b>3302 - FULL- AND HALF-WAVE RECTIFIER OPERATION .....</b>	<b>23</b>
* Identify half and full wave rectifier circuits.	
* Identify the purpose of individual components in half and full wave rectifiers.	
* Describe the operating characteristics of half and full wave rectifiers.	
* Measure the input and output waveforms of half and full wave rectifiers.	
* Recognize normal operation of half and full wave rectifiers.	
<b>3303 - BRIDGE RECTIFIER OPERATION .....</b>	<b>24</b>
* 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.	
<b>3306 - INTRODUCTION TO VOLTAGE REGULATORS .....</b>	<b>--</b>
* 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.	
<b>3307 - ZENER DIODE OPERATION.....</b>	<b>22B</b>
* Identify a zener diode 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.	
● <b>3308 - ZENER DIODE REGULATOR OPERATION .....</b>	<b>23,25</b>
* Identify zener diode regulator circuits.	
* Identify purpose of individual zener diode regulator components.	
* Describe zener diode regular operating characteristics.	
* Measure the input and output waveforms of a zener diode regulator.	
* Recognize normal operation of a zener diode regulator.	
● <b>3309- VOLTAGE REGULATOR OPERATION.....</b>	<b>23,26</b>
* Identify voltage regulator circuits.	
* Identify the purpose of individual voltage regular components.	
* Identify voltage regulator operating characteristics.	
* Measure the input and output waveforms of a voltage regulator.	
* Recognize normal operation of a voltage regulator.	
● <b>3310 - VOLTAGE REGULATOR TROUBLESHOOTING EXPERIMENT .....</b>	<b>23,25,26</b>
* Describe typical faults in voltage regulator circuits.	
* Describe voltage regulator troubleshooting procedures.	
* Recognize when a zener diode voltage regulator circuit is faulted.	
* Observe the effects of a faulted component in a zener diode voltage regulator circuit.	
* Recognize that a variable voltage regulator circuit is faulted.	
* Observe the effects of a faulted component in a variable voltage regulator circuit.	

## MODEL 1403 ANALOG CIRCUITS continued

- **3311 - VOLTAGE REGULATOR TROUBLESHOOTING PRACTICE** ..... 23,25,26
  - \* Identify faulty zener diode voltage regulator operation.
  - \* Determine the faulty component in a faulted zener diode voltage regulator.
  - \* Identify faulty variable voltage regulator operation.
  - \* Determine the faulty component in a faulted variable voltage regulator.
- **3312 - IC REGULATOR OPERATION** ..... 74
  - \* Describe the purpose and operation of an IC regulator.
  - \* Verify normal operation of an IC regulator.
  - \* Define the advantages of an IC regulator.
- **3313 - VOLTAGE DOUBLER OPERATION** ..... 27
  - \* Identify the purpose of a Voltage Doubler.
  - \* Describe the operation and advantages of Half- and Full-wave Voltage Doublers.
  - \* Identify normal operation of Half- and Full-wave Voltage Doublers.
  - \* Observe the effect of loading on a Voltage Doubler's output.
  - \* Observe the effect of adding additional filter capacitance to a Voltage Doubler.
- 3401 - MULTISTAGE TRANSISTOR AMPLIFIERS** ..... --
  - \* Describe and state the purpose of cascade amplifiers.
  - \* Calculate the total gain of a cascade amplifier.
  - \* Describe the different methods used to couple amplifier stages.
- 3402 - RC COUPLED TRANSISTOR AMPLIFIER OPERATION** ..... 33
  - \* Describe operating characteristics of an RC Coupled transistor amp.
  - \* Describe the effect of an input signal's amplitude and frequency in an RC coupled transistor amplifier.
  - \* Measure input and output waveforms of an RC coupled transistor amp.
  - \* 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.
- **3403 - 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
- **3404 - MULTISTAGE AMPLIFIER TROUBLESHOOTING EXPERIMENT** ..... 33,34
  - \* Describe the troubleshooting method of signal tracing.
  - \* Identify common faults in a multistage amplifier circuit.
  - \* Recognize when a multistage amplifier circuit is faulted.
  - \* Troubleshoot a faulted multistage amplifier circuit.
- **3405 - MULTISTAGE AMPLIFIER TROUBLESHOOTING PRACTICE** ..... 33,34
  - \* Identify faulty multistage amplifier operation.
  - \* Determine the faulty component in a faulted multistage amplifier.
- 3406 - FIELD EFFECT TRANSISTOR (FET) 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 configurations.
  - \* 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 amp.
  - \* Recognize normal operation of a common source FET amplifier.
- **3407 - FET AMPLIFIER TROUBLESHOOTING EXPERIMENT** ..... 49
  - \* Describe typical faults in FET amplifier circuits.
  - \* Describe FET amplifier troubleshooting procedures.
  - \* Recognize when a FET amplifier circuit is faulted.
  - \* Identify the faulted component in a FET amplifier circuit.
- **3408 - FET AMPLIFIER TROUBLESHOOTING PRACTICE** ..... 49
  - \* Identify faulty FET amplifier operation.
  - \* Determine the faulty component in a faulted FET amplifier.

## MODEL 1403 ANALOG CIRCUITS continued

- **3409 - MOSFETS** .....--
  - \* Recognize 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.
- 3501 - 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.
- 3502 - HARTLEY OSCILLATOR OPERATION** ..... 35
  - \* Identify Hartley Oscillator circuits.
  - \* Describe the operating characteristics of Hartley Oscillators.
  - \* Identify the purpose of individual components in Hartley Oscillator.
  - \* Measure the input and output waveforms of a Hartley Oscillator.
  - \* Recognize normal operation of a Hartley oscillator.
- **3503 - COLPITTS OSCILLATOR OPERATION** ..... 36
  - \* Identify Colpitts Oscillator circuits.
  - \* Describe the operating characteristics of Colpitts Oscillators.
  - \* Identify the purpose of Individual components in Colpitts Oscillator.
  - \* Measure the input and output waveforms of a Colpitts Oscillator.
  - \* Recognize normal operation of a Colpitts.
- **3504 - RC PHASE SHIFT OSCILLATOR OPERATION** ..... 37
  - \* Identify RC Phase Shift Oscillator circuits.
  - \* Describe the operating characteristics of RC Phase Shift Oscillator.
  - \* 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.
- **3505 - CRYSTAL CONTROLLED OSCILLATOR OPERATION** ..... 50
  - \* Describe the characteristics of a quartz crystal.
  - \* Identify and describe Crystal Oscillator circuits.
  - \* Identify the purpose of individual components in Crystal Oscillator.
  - \* Measure the input and output waveforms of a Crystal Oscillator.
  - \* Recognize normal operation of a Crystal Oscillator.
- **3506 - SINE WAVE OSCILLATOR TS EXPERIMENT I** ..... 35,36
  - \* Describe typical faults in Hartley and Colpitts Oscillators.
  - \* Describe Hartley and Colpitts Oscillator troubleshooting procedures.
  - \* Recognize when a Hartley Oscillator is faulted.
  - \* Identify the faulted component in a Hartley Oscillator.
  - \* Recognize when a Colpitts Oscillator is faulted.
  - \* Identify the faulted component in a Colpitts Oscillator.
- **3507 - 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 when a Crystal Oscillator is faulted.
  - \* Identify the faulted component in a Crystal Oscillator.
- **3508 - SAWTOOTH GENERATOR OPERATION** ..... 43A
  - \* Describe purpose of a Sawtooth Generator.
  - \* Identify and describe output waveforms of a Sawtooth Generator.
  - \* Measure the input and output waveforms of a Sawtooth Generator.
  - \* Recognize normal operation of a Sawtooth Generator.

## MODEL 1403 ANALOG CIRCUITS continued

- **3509 - BLOCKING OSCILLATOR OPERATION** ..... 42
  - \* Identify the purpose of blocking oscillators.
  - \* Describe the operation of free-running and triggered blocking oscillator.
  - \* Observe normal operation of free-running and triggered blocking oscillators.
  - \* Observe normal operation of free-running blocking oscillators.
  - \* Observe normal operation of triggered blocking oscillators.
- **3510 - NON SINE WAVE OSCILLATOR TS EXPERIMENT**..... 42,43A
  - \* Describe typical faults in Blocking Oscillators and Sawtooth Generators.
  - \* Describe Blocking Oscillator and Sawtooth Generator troubleshooting procedures.
  - \* Recognize when a Blocking Oscillator is faulted.
  - \* Identify the faulted component in a Blocking Oscillator.
  - \* Recognize when a Sawtooth Generator is faulted.
  - \* Identify the faulted component in a Sawtooth Generator.
- **3511 - NON SINE WAVE OSCILLATOR TS PRACTICE**..... 42,43A
  - \* Recognize when 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.
- 3601 - INTRODUCTION TO MULTIVIBRATOR CIRCUITS** .....--
  - \* Describe the purpose of multivibrators.
  - \* Describe a basic multivibrator.
  - \* Identify Astable, Monostable, and Bistable Multivibrators.
- 3602 - ASTABLE MULTIVIBRATOR OPERATION** ..... 44
  - \* Identify Astable Multivibrator circuits.
  - \* Identify the purpose of individual components in astable multivibrators.
  - \* Describe the operation of astable multimeters.
  - \* Measure the input and output waveforms of an astable multivibrator.
  - \* Recognize normal operation of an astable multivibrator.
- 3603 - MONOSTABLE MULTIVIBRATOR OPERATION** ..... 46
  - \* Identify Monostable Multivibrator circuits.
  - \* Identify the purpose of individual components in monostable multivibrators.
  - \* Describe the operating characteristics of monostable multivibrators.
  - \* Measure the input and output waveforms of a monostable multivibrator.
  - \* Recognize normal operation of a monostable multivibrator.
- 3604 - BISTABLE MULTIVIBRATOR OPERATION** ..... 45
  - \* Identify Bistable Multivibrator circuits.
  - \* Identify the purpose of individual components in bistable 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.
- **3605 - MULTIVIBRATOR TROUBLESHOOTING EXPERIMENT** ..... 44,45,46
  - \* Describe typical faults in Astable, Monostable, and Bistable Multivibrators.
  - \* Describe multivibrator troubleshooting procedures.
  - \* Recognize when an Astable Multivibrator is faulted.
  - \* Identify the faulted component in an Astable Multivibrator.
  - \* Recognize when 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.
- **3606 - MULTIVIBRATOR TROUBLESHOOTING PRACTICE** ..... 44,45,46
  - \* Identify faulty multivibrator operation.
  - \* Determine the faulty component in a faulted multivibrator.
- **3607 - 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.

## MODEL 1403 ANALOG CIRCUITS continued

- **3608 - SCHMITT TRIGGER TROUBLESHOOTING EXPERIMENT**..... 47N
  - \* Describe typical faults in Schmitt Trigger circuits.
  - \* Describe Schmitt Trigger troubleshooting procedures.
  - \* Recognize when a Schmitt Trigger is faulted.
  - \* Identify the faulted component in a Schmitt Trigger.
- **3609 - SCHMITT TRIGGER TROUBLESHOOTING PRACTICE**..... 47N
  - \* Identify faulty Schmitt Trigger operation.
  - \* Determine the faulty component in a faulted Schmitt Trigger.
- 3701 - 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 control rectifier schematic symbols.
  - \* Describe silicon control rectifier operating characteristics.
- 3702 - UNIUNCTION TRANSISTOR OSCILLATOR OPERATION**..... 51
  - \* Describe the purpose of UJT oscillators.
  - \* Recognize UJT oscillator and describe their operation.
  - \* Recognize normal operation of a UJT oscillator circuit and measure their waveforms.
- 3703 - SCR TRIGGER CIRCUIT OPERATION**..... 52A
  - \* Describe the purpose of SCR trigger circuits.
  - \* Recognize SCR trigger circuits.
  - \* Describe the operation of a SCR trigger circuits.
  - \* Measure the gate and anode current in an operating SCR trigger circuit.
  - \* Recognize normal operation of an SCR trigger circuit.
- **3704 - SCR POWER CONTROL OPERATION**..... 52B
  - \* Describe the purpose of SCR power control circuits.
  - \* Recognize SCR power control circuits.
  - \* Describe the operation of a SCR power control circuit.
  - \* Recognize normal operation of a SCR power control circuit.
  - \* Measure the waveforms in an operating SCR power control circuit.
- **3705 - SCR 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 a SCR trigger circuit is faulted.
  - \* Identify the faulted component in a SCR trigger circuit.
  - \* Recognize when a SCR power control circuit is faulted.
  - \* Identify the faulted component is a SCR power control circuit.
- **3706 - SCR CIRCUIT TROUBLESHOOTING PRACTICE**..... 52A,52B
  - \* Identify the faulted component in a SCR trigger circuit.
  - \* Identify the faulted component is a SCR power control circuit.
- **3707 - 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.
- 3708 - PROGRAMMABLE UNIUNCTION TRANSISTORS**.....--
  - \* Recognize the PUT schematic symbol.
  - \* Describe the construction of PUT devices.
  - \* Describe the operation of PUT devices.
  - \* Identify PUT device applications.

## MODEL 1403 ANALOG CIRCUITS continued

<b>3801 - INTRODUCTION TO OPERATIONAL AMPLIFIERS .....</b>	<b>--</b>
* Describe operational amplifiers.	
* Describe the types of circuits used in an operational amplifier.	
* Describe the basic construction of IC operational amplifiers.	
* Recognize difference operational amplifier circuits.	
* Describe basic operating characteristics of difference amplifiers.	
<b>● 3802 - OPERATIONAL AMPLIFIER OPERATION .....</b>	<b>54</b>
* 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.	
<b>● 3803 - OPERATIONAL AMPLIFIER TROUBLESHOOTING EXPERIMENT .....</b>	<b>54</b>
* Describe typical faults in Operational Amplifier Circuits and describe troubleshooting procedures.	
* Recognize when an Operational Amplifier circuit is faulted.	
* Verify correct operation for a repaired op-amp circuit.	
<b>●● 3804 - OPERATIONAL AMPLIFIER TROUBLESHOOTING PRACTICE .....</b>	<b>54</b>
* Identify operational amplifier circuits.	
* Identify faulty operational amplifier circuit operation and determine the faulty component.	
<b>●● 3901 - INTRODUCTION TO AM RECEIVERS .....</b>	<b>--</b>
* List the primary functions of an AM receiver.	
* Describe the characteristics of an AM receiver.	
* Identify the basic functional blocks of an AM receiver.	
<b>●● 3902 - AM RECEIVER OPERATION .....</b>	<b>38,39,40</b>
* 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.	
<b>●● 3903 - AM RECEIVER TROUBLESHOOTING .....</b>	<b>38,39,40</b>
* 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.	

## MODEL 1404 DIGITAL CIRCUITS

<b>4101 - INTRODUCTION TO DIGITAL ELECTRONICS .....</b>	<b>101</b>
* 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.	
<b>4102 - DIGITAL ELECTRONICS HARDWARE .....</b>	<b>--</b>
* Define an integrated circuit.	
* Identify three forms of packaging an integrated circuit.	
* Identify markings associated with integrated circuits.	
* Identify integrated circuit functions.	
* Describe the purpose of a data book.	

## MODEL 1404 DIGITAL CIRCUITS continued

<b>4103 - BUFFERS AND INVERTERS .....</b>	<b>106</b>
* Describe the purpose of a buffer.	
* Describe the purpose of an inverter.	
* Describe input threshold voltages.	
* Describe output threshold voltages.	
* Measure threshold voltages.	
<b>4104 - DIGITAL TEST EQUIPMENT .....</b>	<b>112</b>
* 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 the basic operation of a logic probe.	
* Operate a simple clock generator circuit.	
* Operate a logic probe.	
<b>•• 4105 - 555 TIMER .....</b>	<b>153</b>
* Describe the purpose of the 555 Timer.	
* Describe the internal operation of the 555 Timer.	
* Describe the operation of a 555 Timer used for an Astable Multivibrator.	
* Describe the operation of a 555 Timer used for a Monostable Multivibrator.	
* Observe the operation of a 555 Timer circuit.	
* Operate a 555 Timer in Astable and Monostable Multivibrator configurations.	
<b>•• 4106 - INTRODUCTION TO INTEGRATED CIRCUITS .....</b>	<b>--</b>
* 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.	
<b>•• 4107 - ELECTROSTATIC SENSITIVE DEVICES .....</b>	<b>--</b>
* 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.	
<b>4201 - AND GATES .....</b>	<b>102,112</b>
* Identify AND operation, logic symbols, and logic schematic representation.	
* Construct an AND gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4202 - OR GATES .....</b>	<b>104,112</b>
* Identify OR operation, logic symbols, and logic schematic representation.	
* Construct an OR gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4203 - NOT GATES .....</b>	<b>106,112</b>
* Identify NOT operation, logic symbols, and logic schematic representation.	
* Construct a NOT gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	

## MODEL 1404 DIGITAL CIRCUITS continued

<b>4204 - NAND GATES .....</b>	<b>103,112</b>
* Identify NAND operation, logic symbols, and logic schematic representation.	
* Construct a NAND gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4205 - NOR GATES.....</b>	<b>105,112</b>
* Identify NOR operation, logic symbols, and logic schematic representation.	
* Construct a NOR gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4206 - XOR AND XNOR GATES .....</b>	<b>107,112</b>
* Identify XOR and XNOR operation, logic symbols, and 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.	
<b>4207 - INTRODUCTION TO LOGIC FUNCTIONS.....</b>	<b>--</b>
* Identify AND operation and logic symbols.	
* Construct an AND gate truth table.	
* Identify input and output waveforms.	
* Identify OR operation and logic symbols.	
* Construct an OR gate truth table.	
* Identify input and output waveforms.	
<b>4301 - INTRODUCTION TO COMBINATIONAL CIRCUITS .....</b>	<b>103,112</b>
* 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.	
<b>4302 - LOGIC FAMILIES.....</b>	<b>--</b>
* Describe TTL logic.	
* Identify supply voltages.	
* Define fan-in and fan-out.	
* Define propagation delay.	
* Describe CMOS logic.	
* Describe ECL logic.	
* Describe IIL logic.	
<b>4303 - NUMBER SYSTEMS.....</b>	<b>124,111</b>
* 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.	

## MODEL 1404 DIGITAL CIRCUITS continued

<b>4304 - BASE 10 TO BINARY CONVERSION.....</b>	<b>108</b>
* 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.	
<b>4305 - BINARY TO SEVEN SEGMENT CONVERSION.....</b>	<b>109</b>
* 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.	
<b>4306 - 4-BIT COMPARATOR.....</b>	<b>110</b>
* 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.	
<b>4401 - INTRODUCTION TO LATCHES AND FLIP-FLOPS .....</b>	<b>--</b>
* 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 $\overline{RS}$ latches.	
* Identify the RS and $\overline{RS}$ latch truth tables.	
* Describe the race condition in RS and $\overline{RS}$ latches.	
<b>4402 - RS FLIP-FLOP .....</b>	<b>113</b>
* Identify the purpose of an RS flip-flop.	
* Describe an RS flip-flop circuit.	
* Predict outputs of an RS flip-flop.	
* Probe the inputs and outputs of an RS flip-flop.	
* Recognize normal operation of an RS flip-flop.	
<b>● 4403 - CLOCKED RS FLIP-FLOP .....</b>	<b>128,111</b>
* Identify the purpose of a clocked RS flip-flop.	
* Describe a clocked RS flip-flop.	
* Predict outputs of a clocked RS flip-flop.	
* Probe the inputs and outputs of a clocked RS flip-flop.	
* Recognize normal operations of a clocked RS flip-flop.	
<b>●● 4404 - D-TYPE FLIP-FLOP .....</b>	<b>114,111</b>
* Identify the purpose of a D-type flip-flop.	
* Describe a D-type flip-flop circuit.	
* Predict the inputs and outputs of a D-type flip-flop.	
* Probe normal operation of a D-type flip-flop.	
* Recognize outputs of a D-type flip-flop.	
<b>4405 - J-K FLIP-FLOP.....</b>	<b>115,111</b>
* 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.	

## MODEL 1404 DIGITAL CIRCUITS continued

- **4406 - MASTER SLAVE FLIP-FLOP**..... 137,111
  - \* 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.
- 4501 - 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.
- **4502 - 4 BIT STORAGE REGISTER** ..... 118,111
  - \* Identify the purpose of a 4-bit storage register.
  - \* Recognize 4-bit storage register circuits.
  - \* Predict outputs of a 4-bit storage register.
  - \* Probe the inputs and outputs of a 4-bit storage register.
  - \* Recognize normal operation of a 4-bit storage register.
- **4503 - 4 BIT SHIFT REGISTER**..... 119,111
  - \* 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.
- **4504 - 8 BIT SHIFT REGISTER**..... 127,111
  - \* Identify the purpose of an 8 bit shift register.
  - \* Describe synchronous and asynchronous data transfer.
  - \* Recognize 8 bit shift register circuits.
  - \* Predict the 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.
- **4505 - 64 BIT MEMORY CIRCUIT** ..... 126,111
  - \* 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.
- 4601 - 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.

## MODEL 1404 DIGITAL CIRCUITS continued

<b>4602 - RIPPLE COUNTER</b> .....	<b>116,111</b>
* Identify the purpose of a ripple counter.	
* Describe a basic ripple counter circuit.	
* Recognize ripple counter circuits with different moduli.	
* Predict outputs of a ripple counter.	
* Probe the outputs of a ripple counter.	
* Recognize normal operation of a ripple counter.	
<b>4603 - UP COUNTER</b> .....	<b>131,111</b>
* 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.	
● <b>4604 - DOWN COUNTER</b> .....	<b>132,111</b>
* 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.	
<b>4605 - 4 BIT ADDER</b> .....	<b>121,111</b>
* 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.	
● <b>4606 - 4 BIT SUBTRACTOR</b> .....	<b>122,111</b>
* 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.	
●● <b>4701 - INTRODUCTION TO CONVERSION AND DATA CIRCUITS</b> .....	<b>--</b>
* 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.	
●● <b>4702 - D/A CONVERSION</b> .....	<b>136,111</b>
* 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 and measure the outputs of a R/2R ladder D/A converter.	
●● <b>4703 - DATA SELECTOR CIRCUITS</b> .....	<b>133,112</b>
* 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.	
●● <b>4704 - DATA DISTRIBUTOR CIRCUITS</b> .....	<b>134,112</b>
* 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.	

## MODEL 2105 DIGITAL-I CIRCUITS

<b>4A01 - INTRODUCTION TO DIGITAL ELECTRONICS .....</b>	<b>2404</b>
* 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.	
<b>4A02 - DIGITAL ELECTRONICS HARDWARE.....</b>	<b>--</b>
* Define an integrated circuit.	
* Identify three forms of packaging an integrated circuit.	
* Identify markings associated with integrated circuits.	
* Identify integrated circuit functions.	
* Describe the purpose of a data book.	
<b>4A03 - DIGITAL TEST EQUIPMENT .....</b>	<b>2402</b>
* 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.	
<b>•• 4A04 - INTRODUCTION TO INTEGRATED CIRCUITS.....</b>	<b>--</b>
* 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.	
<b>•• 4A05 - ELECTROSTATIC SENSITIVE DEVICES.....</b>	<b>--</b>
* 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.	
<b>4B01 - BUFFERS AND INVERTERS/NOT GATES.....</b>	<b>2402</b>
* Describe the purpose of a buffer.	
* Describe the purpose of an inverter.	
* Describe input threshold voltages.	
* Describe output threshold voltages.	
* Examine the purpose of an inverter/NOT gate.	
* Identify input and output waveforms for an inverter/NOT gate.	
* Construct an inverter/NOT gate truth table.	
<b>4B02 - AND GATES .....</b>	<b>2404</b>
* Identify AND operation, logic symbols, and logic schematic representation.	
* Construct an AND gate truth table.	
* Identify input to output waveform relationship.	
* Measure input to output waveform relationship.	

## MODEL 2105 DIGITAL-I CIRCUITS continued

<b>4B03 - OR GATES</b> .....	<b>2402</b>
* Identify OR operation and logic symbols.	
* Construct an OR gate truth table.	
* Identify input and output waveform relationship.	
* Measure input and output waveform relationship.	
<b>4B04 - NAND GATES</b> .....	<b>2404</b>
* Identify NAND operation and logic symbols.	
* Construct a NAND gate truth table.	
* Identify input to output waveform relationship.	
* Measure input to output waveform relationship.	
<b>4B05 - NOR GATES</b> .....	<b>2404</b>
* Identify NOR operation and logic symbols.	
* Construct a NOR gate truth table.	
* Identify NOR input to output waveform relationship.	
* Measure NOR input to output waveform relationship.	
<b>4B06 - XOR AND XNOR GATES</b> .....	<b>2406</b>
* Identify XOR and XNOR operation.	
* Identify XOR and XNOR logic symbols.	
* Construct truth tables for XOR and XNOR gates.	
* Identify XOR and XNOR input to output waveform relationship.	
* Measure XOR input to output waveform relationship.	
* Measure XNOR input to output waveform relationship.	
<b>• 4B07 - DIGITAL AND ANALOG SWITCH</b> .....	<b>2424</b>
* Compare the digital and analog switch to other switching methods.	
* Discuss the theory for digital and analog switch operation.	
* Identify the operation parameters of the digital and analog switch.	
* Analyze the digital and analog switch in SPST, SPDT, DPST, and DPDT configurations.	
* Review practical applications for the digital and analog switch.	
* Reinforce the operation of digital and analog switches through experimentation.	
* Probe and confirm all test points in the digital and analog switch circuit.	
* Troubleshoot the digital and analog switch circuit.	
<b>4C01 - INTRODUCTION TO COMBINATIONAL CIRCUITS</b> .....	<b>--</b>
* 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.	
<b>4C02 - LOGIC FAMILIES</b> .....	<b>--</b>
* Describe TTL logic.	
* Identify supply voltage.	
* Define fan-in and fan-out.	
* Define propagation delay.	
* Describe CMOS logic.	
* Describe ECL logic.	
* Describe IIL logic.	

## MODEL 2105 DIGITAL-I CIRCUITS continued

<b>4C03 - NUMBER SYSTEMS .....</b>	<b>----</b>
* 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.	
<b>4C04 - BASE 10 TO BINARY CONVERSION .....</b>	<b>2416</b>
* 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.	
<b>4C05 - BINARY TO DECIMAL CONVERSION .....</b>	<b>2418,2420</b>
* Identify the purpose of a binary decoder.	
* Describe a seven-segment display.	
* Describe a binary to LED decimal decoder circuit.	
* Describe a binary to decimal seven-segment decoder circuit.	
* Predict the inputs and outputs of a BCD to discrete decimal decoder.	
* Examine the inputs and outputs of a BCD to discrete decimal decoder.	
* Recognize normal operation of a BCD to discrete decimal decoder.	
* Predict the inputs and outputs of a BCD to seven-segment decoder.	
* Examine the inputs and outputs of a BCD to seven-segment decoder.	
* Recognize normal operation of a BCD to seven-segment decoder.	
<b>4D01 - INTRODUCTION TO LATCHES AND FLIP-FLOPS .....</b>	<b>----</b>
* Identify the difference between a sequential and a combinational circuit.	
* Recognize a SET and RESET condition.	
* Understand basic flip-flop operation.	
* Describe the operation of RS and $\overline{RS}$ latches.	
* Identify the RS and $\overline{RS}$ latch truth table.	
* Describe the race condition in the RS and $\overline{RS}$ latch.	
<b>4D02 - RS FLIP-FLOP .....</b>	<b>2408</b>
* Identify the purpose of an RS flip-flop.	
* Describe an RS flip-flop circuit.	
* Predict the outputs of the RS and $\overline{RS}$ flip-flops.	
* Verify the inputs and outputs of the RS and $\overline{RS}$ flip-flops.	
* Understand the basic principles of the RS and $\overline{RS}$ flip-flops.	
<b>•• 4D03 - D-TYPE FLIP-FLOP .....</b>	<b>2410</b>
* 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.	

## MODEL 2105 DIGITAL-I CIRCUITS continued

<b>4D04 - JK FLIP-FLOP .....</b>	<b>2410</b>
* 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 the inputs and outputs of the JK flip-flop.	
* Recognize the outputs of the JK flip-flop.	
<b>4E01 - INTRODUCTION TO REGISTERS AND MEMORY .....</b>	<b>--</b>
* 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.	
<b>4E02 - SERIAL SHIFT REGISTERS .....</b>	<b>2422</b>
* 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.	
<b>4E03 - PARALLEL SHIFT REGISTERS .....</b>	<b>2422</b>
* 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.	
<b>•• 4E04 - 64-BIT MEMORY CIRCUIT .....</b>	<b>2428</b>
* Identify the purpose of a 64-bit memory circuit.	
* Describe word, address, read, write, RAM, ROM, volatile, and nonvolatile.	
* Recognize 64-bit memory circuits.	
* Reinforce the operation of memory through experimentation.	
* Probe all test points in the memory circuit.	
* Troubleshoot the memory circuit.	
<b>4F01 - INTRODUCTION TO ARITHMETIC COUNTING CIRCUITS .....</b>	<b>--</b>
* 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.	
<b>4F02 - RIPPLE COUNTER .....</b>	<b>2414</b>
* Identify the purpose of a ripple counter.	
* Describe a basic ripple counter circuit.	
* Recognize various modulus ripple counter circuits.	
* Predict the inputs and outputs of the ripple and decade counters.	
* Probe the inputs and outputs of the ripple and decade counters.	
* Recognize normal operation of the ripple and decade counters.	
<b>4F03 - BINARY UP COUNTER .....</b>	<b>2412</b>
* 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.	

## MODEL 2105 DIGITAL-I CIRCUITS continued

- **4F04 - BINARY 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.
- **4F05 - 4-BIT ADDER ..... 2426**
  - \* Identify the purpose of a 4-bit adder.
  - \* Describe adder circuits.
  - \* Recognize serial and parallel full adder circuits.
  - \* Recognize the normal operation of the 4-bit adder circuit.
  - \* Predict the output of the 4-bit adder.
  - \* Confirm the output of the 4-bit adder circuit.
- **4F06 - 4-BIT SUBTRACTOR..... 2426**
  - \* Identify the purpose of a 4-bit subtractor.
  - \* Describe two's complement.
  - \* Recognize serial and parallel full subtractor circuits.
  - \* Predict 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.
- **4G01 - 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.
- **4G02 - D/A CONVERSION .....2430/2432 (130E), 2430 (TD2000)**
  - \* Identify the D/A conversion process.
  - \* Analyze 8-bit D/A circuitry.
  - \* Troubleshoot the D/A circuit.
  - \* Analyze tri-state devices.
  - \* Troubleshoot tri-state circuitry.
- **4G03 - A/D CONVERSION ..... 2432**
  - \* Identify the A/D conversion process.
  - \* Analyze 8-bit A/D circuitry.
  - \* Troubleshoot the A/D circuit.

## MODEL 2404 DIGITAL CIRCUITS

- 4101 - 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.
- 4102 - DIGITAL ELECTRONICS HARDWARE .....--**
  - \* Define an 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.

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4103 - BUFFERS AND INVERTERS .....</b>	<b>106</b>
* Describe the purpose of a buffer.	
* Describe the purpose of an inverter.	
* Describe input threshold voltages.	
* Describe output threshold voltages.	
* Measure threshold voltages.	
<b>4104 - DIGITAL TEST EQUIPMENT .....</b>	<b>112</b>
* 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.	
<b>4105 - 555 TIMER.....</b>	<b>153</b>
* 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.	
<b>4106 - INTRODUCTION TO INTEGRATED CIRCUITS.....</b>	<b>--</b>
* 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.	
<b>4107 - ELECTROSTATIC SENSITIVE DEVICES.....</b>	<b>--</b>
* 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.	
<b>4201 - AND GATES.....</b>	<b>102,112</b>
* Identify AND operation, logic symbols, and logic schematic representation.	
* Construct an AND gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4202 - OR GATES .....</b>	<b>104,112</b>
* Identify OR operation, logic symbols, and logic schematic representation.	
* Construct an OR gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4203 - NOT GATES.....</b>	<b>106,112</b>
* Identify NOT operation, logic symbols, and logic schematic representation.	
* Construct a NOT gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4204 - NAND GATES .....</b>	<b>103,112</b>
* Identify NAND operation, logic symbols, and logic schematic representation.	
* Construct a NAND gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4205 - NOR GATES.....</b>	<b>105,112</b>
* Identify NOR operation, logic symbols, and logic schematic representation.	
* Construct a NOR gate truth table.	
* Identify input and output waveforms.	
* Measure input and output waveforms.	
<b>4206 - XOR AND XNOR GATES .....</b>	<b>107,112</b>
* Identify XOR and XNOR operation, logic symbols, and 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.	
<b>4B07 - DIGITAL AND ANALOG SWITCHES .....</b>	<b>2424</b>
* Compare the digital and analog switch to other switching methods.	
* Discuss the theory for digital and analog switch operation.	
* Identify the operation parameters of the digital and analog switch.	
* Analyze the digital and analog switch in SPST, SPDT, DPST, and DPDT configurations.	
* Review practical applications for the digital and analog switch.	
* Reinforce the operation of digital and analog switches through experimentation.	
* Probe and confirm all test points in the digital and analog switch circuit.	
* Troubleshoot the digital and analog switch circuit.	
<b>4207 - INTRODUCTION TO LOGIC FUNCTIONS.....</b>	<b>---</b>
* Identify AND operation and logic symbols.	
* Construct an AND gate truth table.	
* Identify input and output waveforms.	
* Identify OR operation and logic symbols.	
* Construct an OR gate truth table.	
* Identify input and output waveforms.	
<b>4301 - INTRODUCTION TO COMBINATIONAL CIRCUITS .....</b>	<b>103,112</b>
* 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.	
<b>4302 - LOGIC FAMILIES.....</b>	<b>---</b>
* Describe TTL logic.	
* Identify supply voltage.	
* Define fan-in and fan-out.	
* Define propagation delay.	
* Describe CMOS logic.	
* Describe ECL logic.	
* Describe IIL logic.	

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4303 - NUMBER SYSTEMS</b> .....	<b>124,111</b>
* 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.	
<b>4304 - BASE 10 TO BINARY CONVERSION</b> .....	<b>108</b>
* 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.	
<b>4305 - BINARY TO SEVEN SEGMENT CONVERSION</b> .....	<b>109</b>
* 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.	
<b>4306 - 4-BIT COMPARATOR</b> .....	<b>110</b>
* 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.	
<b>4401 - INTRODUCTION TO LATCHES AND FLIP-FLOPS</b> .....	<b>--</b>
* 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 $\overline{RS}$ latches.	
* Identify the RS and $\overline{RS}$ latch truth tables.	
* Describe the race condition in RS and $\overline{RS}$ latches.	
<b>4402 - RS FLIP-FLOP</b> .....	<b>113</b>
* 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.	

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4403 - CLOCKED RS FLIP-FLOP .....</b>	<b>128,111</b>
* 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.	
<b>4404 - D-TYPE FLIP-FLOP .....</b>	<b>114,111</b>
* 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.	
<b>4405 - JK FLIP-FLOP .....</b>	<b>115,111</b>
* 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.	
<b>4406 - MASTER-SLAVE FLIP-FLOP .....</b>	<b>137,111</b>
* 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.	
<b>4501 - INTRODUCTION TO REGISTERS AND MEMORY .....</b>	<b>--</b>
* 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.	
<b>4502 - 4-BIT STORAGE REGISTER.....</b>	<b>118,111</b>
* Identify the purpose of a 4-bit storage register.	
* Recognize 4-bit storage register circuits.	
* Predict the outputs of a 4-bit storage register.	
* Probe the inputs and outputs of a 4-bit storage register.	
* Recognize normal operation of a 4-bit storage register.	
<b>4E02 - SERIAL SHIFT REGISTERS .....</b>	<b>2422</b>
* 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.	
<b>4E03 - PARALLEL SHIFT REGISTERS .....</b>	<b>2422</b>
* 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.	

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4E04 - 64-BIT MEMORY CIRCUIT.....</b>	<b>2428</b>
* Identify the purpose of a 64-bit memory circuit.	
* Describe word, address, read, write, RAM, ROM, volatile and nonvolatile.	
* Recognize 64-bit memory circuits.	
* Reinforce the operation of memory through experimentation.	
* Probe all test points in the memory circuit.	
* Troubleshoot the memory circuit.	
<b>4601 - INTRODUCTION TO ARITHMETIC COUNTING CIRCUITS.....</b>	<b>--</b>
* 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.	
<b>4602 - RIPPLE COUNTER .....</b>	<b>116,111</b>
* 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.	
<b>4603 - UP COUNTER .....</b>	<b>131,111</b>
* 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.	
<b>4604 - DOWN COUNTER.....</b>	<b>132,111</b>
* 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.	
<b>4605 - 4-BIT ADDER .....</b>	<b>121,111</b>
* 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.	
<b>4606 - 4-BIT SUBTRACTOR.....</b>	<b>122,111</b>
* 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.	
<b>4G01 - INTRODUCTION TO CONVERSION AND DATA CIRCUITS .....</b>	<b>--</b>
* 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.	

## MODEL 2404 DIGITAL CIRCUITS continued

<b>4G02 - D/A CONVERSION</b> .....	2430/2432 (130E), 2430 (TD2000)
* Identify the D/A conversion process.	
* Analyze 8-bit D/A circuitry.	
* Troubleshoot the D/A circuit.	
* Analyze tri-state devices.	
* Troubleshoot tri-state circuitry.	
<b>4G03 - A/D CONVERSION</b> .....	2432
* Identify the A/D conversion process.	
* Analyze 8-bit A/D circuitry.	
* Troubleshoot the A/D circuit.	
<b>4703 - DATA SELECTOR CIRCUITS</b> .....	133,112
* 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.	
<b>4704 - DATA DISTRIBUTOR CIRCUITS</b> .....	134,112
* 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.	

## MODEL 1413 CIRCUIT CONSTRUCTION

<b>T501 - CIRCUIT BREADBOARDING</b> .....	130X
* Describe soldering and breadboarding method of circuit construction.	
* Describe the Nida Series 130 Experiment Card PC130X	
* Describe how to construct a simple series circuit using PC130X.	
* Insert and remove a component from the PC130X breadboard card.	
<b>T502 - DC CIRCUIT CONSTRUCTION</b> .....	130X
* Construct a series circuit.	
* Verify series circuit operation.	
* Construct a parallel circuit.	
* Verify parallel circuit operation.	
* Construct a series-parallel circuit.	
* Verify series-parallel circuit operation.	
* Construct a circuit using various components.	
* Verify circuit operation.	
<b>T503 - AC CIRCUIT CONSTRUCTION</b> .....	130X
* Construct an AC circuit.	
* Verify AC circuit operation.	
<b>T504 - ANALOG CIRCUIT CONSTRUCTION</b> .....	130X
* Construct an analog circuit.	
* Verify analog circuit operation.	
<b>T505 - DIGITAL CIRCUIT CONSTRUCTION</b> .....	130X
* Construct a digital circuit.	
* Verify digital circuit operation.	

## MODEL 1449 WIRING

- **1601 - 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 printed circuit boards.
- \* Identify common faults which may occur when installing components on printed circuit boards.
- \* Identify the general techniques for extracting components from printed circuit boards.
- \* Identify general techniques for repairing printed circuit board traces and pads.
- **1602 - BASIC SOLDERING TECHNIQUES .....**
- \* Identify different types of solder.
- \* Identify different types of flux.
- \* Be able to select the correct soldering iron for a particular task.
- \* State the proper method of wire preparation for soldering.
- \* State how to make a "Western Union" wire splice.
- \* Identify different types of wire terminals and their connection methods.
- \* Reemphasize the methods for making reliable solder connections.
- \* Describe how to correct poor solder connections.
- **1603 - BASIC CONNECTOR TERMINATION TECHNIQUES .....**
- \* Introduce the student to standard wire gauges.
- \* Show the common types of wire and cable.
- \* Introduce the typical uses of common wire and cable types.
- \* Introduce the student to basic connector termination techniques.
- \* Show the correct method of terminating banana plugs, crimp connectors, and BNC connectors.
- \* Develop the skills required to effect routine repairs to electronic equipment.
- **1604 - BASIC WIRE WRAPPING TECHNIQUES .....**
- \* Introduce wire wrapping terminology.
- \* Describe common types of wire wraps.
- \* Introduce common wire wrap tools.
- \* Describe the characteristics of good wire wrap connections.
- \* Describe the procedure for making good wire wrap connections.
- \* Recognize common wire wrapping faults.
- **1605 - 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.
- **1606 - 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.

## MODEL 2010 ELECTRONICS TECHNOLOGY

- S201 - INTRODUCTION TO ELECTRONICS TECHNOLOGY .....**
- \* Define the terms electricity and electronics.
- \* Identify how electronics affects your daily life.
- \* State the four groups that comprise the subject of electronics.
- S202 - DIRECT CURRENT ELECTRICITY ..... 791**
- \* Define the term Direct Current (DC).
- \* Identify how direct current affects a circuit.
- \* Identify applications that might use DC current.

## MODEL 2010 ELECTRONICS TECHNOLOGY continued

<b>S203 - ALTERNATING CURRENT ELECTRICITY .....</b>	<b>792</b>
* Define the term Alternating Current (AC).	
* Identify how alternating current affects a circuit.	
* Identify appliances that use AC current.	
<b>S204 - ANALOG ELECTRONICS .....</b>	<b>793</b>
* Define the term Analog.	
* Identify how analog affects a circuit.	
* Identify applications that use analog components.	
<b>S205 - DIGITAL ELECTRONICS .....</b>	<b>794</b>
* Define the term Digital Electronics.	
* Identify how digital components affect a circuit.	
* Identify appliances that might use digital components.	
<b>S206 - ELECTRONICS TECHNOLOGY PROJECT .....</b>	<b>795</b>
* Construct the DC section of an alarm circuit.	
* Construct the AC section of an alarm circuit.	
* Construct the analog section of an alarm circuit.	
* Construct the digital section of an alarm circuit.	
* Test the alarm circuit operation.	
<b>S301 - MAGNETISM, RELAYS AND METERS .....</b>	<b>--</b>
* 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 electromagnets.	
* Describe the operation of a relay.	
* Describe the operation of a magnetic breaker.	
* Describe the operation of a meter.	
<b>S302 - INTRODUCTION TO MULTIMETERS .....</b>	<b>5</b>
* Identify the quantities measured by multimeters.	
* Identify the two multimeter displays.	
* Describe the five functional sections of a multimeter.	
* Describe the purpose of each functional section.	
* Read a digital meter display.	
* Compare meter readings to voltages selected.	
<b>S303 - MULTIMETER USE.....</b>	<b>793</b>
* Operate a Digital Multimeter	
<b>S304 - VOLTAGE MEASUREMENTS .....</b>	<b>6A</b>
* Describe how to set up a multimeter to measure voltage.	
* Describe how to read a multimeter's display when measuring voltage.	
* Describe the correct way to connect a multimeter to a circuit for measuring voltage.	
* Perform voltage measurements using a digital multimeter.	
<b>S305 - CURRENT MEASUREMENTS .....</b>	<b>6A</b>
* Describe how to set-up a multimeter to current.	
* Describe how to read a 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.	
<b>S306 - RESISTANCE MEASUREMENTS.....</b>	<b>6A</b>
* Describe how to set up a multimeter to measure resistance.	
* Describe how to read a multimeter's display when measuring resistance.	
* Describe the correct way to connect a multimeter to a circuit for measuring resistance.	
* Describe the precautions to observe when making resistance measurements.	
* Perform resistance measurements.	

## MODEL 2010 ELECTRONICS TECHNOLOGY continued

<b>S307 - INTRODUCTION TO THE OSCILLOSCOPE</b> .....	<b>707</b>
* 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.	
<b>S401 - OHM'S LAW AND POWER</b> .....	<b>5</b>
* 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.	
<b>S402 - SERIES CIRCUITS</b> .....	<b>6A</b>
* 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.	
<b>S403 - PARALLEL CIRCUITS</b> .....	<b>8A</b>
* 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.	
<b>S404 - SERIES-PARALLEL CIRCUITS</b> .....	<b>9A</b>
* Identify a series-parallel circuit.	
* Calculate total resistance in a series circuit.	
* Calculate current in a series-parallel circuit.	
* Calculate voltage drops in a series circuit.	
* Measure resistance values in a series circuit.	
* Measure current values in series-parallel circuit.	
* Measure voltage drops in a series-parallel circuit.	
<b>S405 - INDUCTOR OPERATION</b> .....	<b>707</b>
* 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.	
<b>S406 - CAPACITOR OPERATION</b> .....	<b>707</b>
* Identify types of capacitors.	
* Describe charge and discharge.	
* Identify the schematic symbol for a capacitor.	
* Identify characteristics of capacitance.	
* Identify the unit of measurement for capacitance.	
* Examine the circuit characteristics of a capacitor.	

## MODEL 2010 ELECTRONICS TECHNOLOGY continued

<b>S407 - DIGITAL LOGIC</b> .....	<b>101</b>
* Identify Digital Logic.	
* Define Logic.	
* Describe various logic types.	
* Identify the seven basic logic gates.	
* Examine the truth tables for the seven basic logic gates.	
* Observe the operation of logic gates.	
* Verify AND gate operations.	
* Verify OR gate operations.	
* Verify NAND gate operations.	
* Verify NOR gate operations.	
<b>S501 - INTRODUCTION TO TEAMWORK</b> .....	<b>--</b>
* Describe the benefits of teamwork.	
<b>S502 - CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Describe breadboarding methods of circuit construction.	
* Describe the Nida Series PC130X.	
* Describe how to construct a simple series circuit using PC130X.	
* Insert and remove a component from the PC130X breadboard card.	
<b>S503 - SERIES CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct a series circuit.	
* Verify series circuit operation.	
<b>S504 - PARALLEL CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct a parallel circuit.	
* Verify parallel circuit operation.	
<b>S505 - SERIES-PARALLEL CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct a series-parallel circuit.	
* Verify series-parallel circuit operation.	
<b>S506 - CAPACITIVE CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct a capacitive circuit.	
* Verify capacitive circuit operation.	
<b>S507 - INDUCTIVE CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct an inductive circuit.	
* Verify inductive circuit operation.	
<b>S508 - DIGITAL CIRCUIT CONSTRUCTION</b> .....	<b>130X</b>
* Construct a digital circuit.	
* Verify digital circuit operation.	
<b>S509 - ALARM SYSTEM OPERATIONAL CHECK</b> .....	<b>796,797,798</b>
* Perform Operational Check	
* Assemble a Three Trainer Configuration	
* Daisy chain three Tec Dec Trainers in Series	
* Test Individual Alarm Circuits	
<b>S510 - OSCILLATOR INTEGRATED CIRCUIT OPERATION</b> .....	<b>130X</b>
* Construction of the Oscillator Integrated System.	
* Perform Operational Test of Oscillator.	
<b>S511 - ALARM DETECTOR INTEGRATED CIRCUIT OPERATION</b> .....	<b>796,130X</b>
* Construction of Alarm Detector Integrated System.	
* Perform Operational Test of Alarm Detector.	
<b>S512 - SOUND GENERATOR INTEGRATED CIRCUIT OPERATION</b> .....	<b>796,797,130X</b>
* Construction of Sound Generator Integrated System.	
* Perform Operational Test of Sound Generator.	
<b>S101 - INTRODUCTION TO MICROPROCESSORS</b> .....	<b>--</b>
* Describe a brief development of microprocessors.	
* Identify the major parts of a microprocessor system.	
* Define common terms associated with microprocessors.	
* Identify parts of a microprocessor and describe microprocessor operation.	
* Define and describe internal registers and counters.	

## MODEL 2010 ELECTRONICS TECHNOLOGY continued

**S102 - INTRODUCTION TO COMMUNICATION AND SIGNAL PROCESSING.....--**

- \* Describe the basic elements that compose a communications system.
- \* State the two fundamental limiting factors in a communication system.
- \* Describe the basic differences between analog and digital signals.
- \* Describe signal processing.
- \* Identify various signal processing techniques.

**S103 - INTRODUCTION TO TRANSDUCERS .....--**

- \* Identify types of transducers.
- \* Understand transducer operating principles.

**S104 - INTRODUCTION TO FIBER OPTICS.....--**

- \* 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.

**S105 - INTRODUCTION TO LASERS .....--**

- \* Describe the basic particle theory of light.
- \* Describe the basic wave theory of light.
- \* Describe the principle behind Quantum Electrodynamics theory of light.
- \* Define the term Laser.
- \* Describe the Quantum Theory of Radiation.
- \* Describe the characteristics of laser light.
- \* Describe the fundamental elements of a laser.
- \* Describe the various uses of lasers.

**S106 - INTRODUCTION TO COMPUTERS AND MAINTENANCE .....--**

- \* Identify Main Chassis.
- \* Identify Monitor.
- \* Identify Keyboard.
- \* Identify CPU.
- \* Identify Memory.
- \* Identify I/O.
- \* Identify Bus Systems.

**S107 - INTRODUCTION TO 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.

**S108 - INTRODUCTION TO MICROWAVES.....--**

- \* Describe a brief history of microwave inception and explain how microwave communications were initiated.
- \* Identify basic microwave principles and recognize the Radio Frequency spectrum.
- \* Identify microwave frequencies and factors affecting communications.
- \* Identify metric prefixes.
- \* Perform conversions between different metric prefixes.

**S109 - INTRODUCTION TO THE INTERNET.....--**

- \* Define the Internet.
- \* History of the Internet.
- \* Realize uses of the Internet.

## MODEL 1459 CABLES AND CONNECTORS

- C101 - 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.
- C102 - 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 .156 KK Series connector.
  - \* Build and test single wire assemblies without guidance.
- C103 - FLAT SATIN CABLE ASSEMBLIES .....W6**
- \* Describe Flat Satin Cable.
  - \* Understand Flat Satin Cable applications.
  - \* Describe the RJ-11 connector.
  - \* Describe the RJ-45 connector.
  - \* Understand RJ-11 and RJ-45 applications.
  - \* Assemble an RJ-14 cable.
  - \* Assemble an RJ-45 cable.
  - \* Build and test flat satin cable assemblies without guidance.
- C104 - CABLING STANDARDS AND CATEGORIES OF PERFORMANCE.....**
- \* Understand the origin of cabling standards.
  - \* Know the agencies responsible for establishing standards.
  - \* Define Universal Service Ordering Codes.
  - \* Understand the types of serial data connections.
  - \* Describe characteristics of a Multi-conductor cable.
  - \* Describe characteristics of a Flat satin cable.
  - \* Describe characteristics of a Twisted pair cable.
  - \* Describe characteristics of a Coaxial Cable.
  - \* Identify UTP, SCTP, and STP cable.
  - \* Understand Cat 1 through Cat 7 cable properties.
- C105 - TWISTED PAIR CABLE .....W6**
- \* Identify and describe how a modular RJ-45 plug is used.
  - \* Identify and describe how a keystone jack is used.
  - \* Identify the difference between an ATT 110 punch down type jack and a CAT 5 TIA/EIA 568A/B keystone type jack.
  - \* Identify and describe how CAT 5 UTP cable is used.
  - \* Understand T568A, T568B, and 10 Base-T wiring standards.
  - \* Understand Straight-Through and Cross-Over wiring methods.
  - \* Understand how to prepare CAT 5 UTP cable for assembly with an RJ-45 modular plug and CAT 5 TIA/EIA 568A/B keystone type jack.
  - \* Identify the tools used to attach a modular RJ-45 plug and CAT 5 TIA/EIA 568A/B keystone type jack to CAT 5 UTP.
  - \* Understand how to attach a CAT 5 TIA/EIA 568A/B keystone type jack to a UTP cable following T568A standards.
  - \* Prepare, build, and test a CAT 5 UTP cable with RJ-45 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 568A/B keystone type jack following T568A standards and the Straight-Through wiring method.

## MODEL 1459 CABLES AND CONNECTORS continued

**C106 - 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 a DCE and DTE device.
- \* 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.

**C107 - 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 assemble 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.

## MODEL 1410 SOLDERING

**C509 - SOLDERING SAFETY AND ELECTROSTATIC SENSITIVE DEVICES.....--**

- \* Understand the safety requirements of soldering chemicals and supplies.
- \* Describe the procedure for use of an eye wash 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.

**C501 - 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.

**C502 - 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.

## MODEL 1410 SOLDERING, continued

**C503 - 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.

**C504 - PC BOARD TYPES AND MANUFACTURING METHODS .....Solder Project**

- \* Identify the general characteristics of PC boards.
- \* Identify several connection methods used on PC boards.
- \* Identify the options and procedures available for repairing broken circuit board copper lands.
- \* Prepare a circuit board for repair using a surface mount jumper.
- \* Repair a circuit board using a surface mount jumper.

**C505 - THROUGH-HOLE NON-POLARIZED COMPONENT SOLDERING & DESOLDERING .....Solder Project**

- \* 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.

**C506 - THROUGH-HOLE POLARIZED COMPONENT SOLDERING .....Solder Project**

- \* Identify common polarized components.
- \* Identify orientation of components.
- \* Explain heat fragility of some components.
- \* Forming leads of polarized components.
- \* Mounting polarized components on a PCB.
- \* Solder heat-sensitive components on a PCB.
- \* Solder polarized components on a PCB.

**C507 - SOLDERING SURFACE MOUNT DEVICES .....Solder Project**

- \* 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.

**C508 - COAX CABLE CONNECTORS .....**

- \* Review BNC connector history, advantages, and limitations.
- \* Review RG-58 cable history, advantages, and limitations.
- \* Understand the assembly of a 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.

<b>BASIC CIRCUIT APPLICATIONS</b>
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**MODEL 1411 PHASE LOCK LOOP****TB01 - PHASE LOCK LOOP CIRCUITS ..... 86,224,225**

- \* Describe phase lock loop circuits to the block diagram level.
- \* Describe phase lock loop FM demodulators.
- \* Define phase lock loop circuitry.
- \* Describe the operation of a phase lock loop detector circuit.
- \* Observe the operation of a phase lock loop system configured as a band pass filter, FM Demodulator, and a Frequency Synthesizer.

**MODEL 1414 OPTOELECTRONICS**  
**(Available in Lab/Text Only)**

**Lesson 1 – Introduction to Infrared Transmission and Reception ..... 214,215**

- \* Obtain a basic understanding of electromagnetic waves and the electromagnetic spectrum.
- \* Describe the characteristics and qualities of infrared light and its relationship in the electromagnetic spectrum.
- \* Observe the operation of a representative infrared transmission and reception system.

**Lesson 2 - Infrared Audio Transmission ..... 214,215**

- \* Describe the discovery of infrared light.
- \* Observe the operation of and construct an infrared LED.
- \* Observe the operation of basic infrared transmitter circuit.

**Lesson 3 - Infrared Audio Reception ..... 214,215**

- \* Describe the different devices used to detect and measure infrared radiation.
- \* Observe the operation and construction of photo transistors.

**Lesson 4 - Infrared Fiberoptic Communications ..... 251**

- \* Describe the operation of fiberoptic communications transmission and reception system.
- \* Observe the operation of the fiberoptic transmission and reception system.

**MODEL 1415 RADAR SYSTEMS****TD01 - INTRODUCTION TO RADAR CHARACTERISTICS.....--**

- \* Define terms, abbreviations, and symbols used in conjunction with RADAR principles.
- \* Convert Decibel and Power Ratio into standardized reference power (dBm).
- \* Describe the composition of a basic RADAR system.
- \* Identify the blocks of a basic RADAR system.
- \* Define abbreviations, terms, symbols and characteristics used in conjunction with RADAR systems.
- \* State the purpose and use of the Surface Search, Air Search and Targeting RADAR systems.
- \* Explain the basic operation of a Pulse, Continuous Wave (CW) and Doppler RADAR systems.
- \* Describe a block diagram of a Pulse RADAR.
- \* Understand Pulse RADAR circuit functions.
- \* Describe Basic RADAR antennas.

**TD02 - BASIC RADAR OPERATION ..... 231**

- \* Examine a typical RADAR timing circuit.
- \* Examine both a sweep and video amplifier.
- \* Examine typical RADAR characteristics.

**TD03 - 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.

**MODEL 1415 RADAR SYSTEMS continued**

- TD04 - TRANSMISSION LINES** .....
- \* Identify transmission line operating characteristics.
  - \* Identify the different types of transmission lines.
- TD05 - 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.
- TD06 - ANTENNAS** .....
- \* Understand antenna characteristics.
  - \* Explain the propagation of energy in antennas.
- TD07 - CAVITY RESONATORS & 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.
- TD08 - 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.
- TD09 - 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).
- TD10 - RADAR AUXILIARY SYSTEMS** .....
- \* Define terms, abbreviations and symbols used with RADAR Dry Air systems.
  - \* Describe the function, operational characteristics of RADAR Dry Air systems.
  - \* Define terms, abbreviations and symbols used with RADAR Cooling systems.
  - \* Describe the function, operational characteristics of RADAR Cooling systems.

**MODEL 1416 REGULATED POWER SUPPLIES  
(Available in Lab/Text Only)**

- Lesson 1 – Voltage Regulators**.....PC130-96, 97, 290
- \* Describe a power supply to the block diagram level.
  - \* Define the purpose of a voltage and current regulator.
  - \* Describe the operation of voltage regulator circuits.
  - \* Observe the normal operation and troubleshoot a voltage regulator circuit.
- Lesson 2 – Current Regulators**.....PC130-96, 97, 290
- \* Define the purpose of a current regulator.
  - \* Describe the operation of current regulator circuits.
  - \* Observe the normal operation and troubleshoot a current regulator circuit.

**MODEL 1418 INTRODUCTION TO FILTERS**

- T101 - INTRODUCTION TO FILTERS** .....
- \* Define an active and passive filter.
  - \* Define inductive and capacitive reactance.
  - \* Define a low pass filter.
  - \* Define a high pass filter.
  - \* Define a band reject filter.

## MODEL 1418 INTRODUCTION TO FILTERS continued

<b>T102 - HIGH-PASS FILTERS</b> .....	<b>145</b>
* Describe the operation of high pass filters.	
* Describe the types of high pass filters.	
* Calculate high pass filter circuit values.	
* Observe the normal operation of a high pass filter.	
* Measure circuit values in a high pass filter circuit.	
* Verify correct operation of a high pass filter circuit.	
* Determine if a high pass filter circuit is faulted.	
* Identify a faulted component in a high pass filter circuit.	
<b>T103 - LOW-PASS FILTERS</b> .....	<b>146</b>
* Describe the theory of operation of a low-pass filter.	
* Discuss the cut off frequency of a low pass RC filter circuit.	
* Identify a low pass filter circuit.	
* Verify proper low pass filter operation.	
* Determine the cut off frequency of a low pass RC filter circuit.	
<b>T104 - BANDPASS FILTER OPERATION</b> .....	<b>147</b>
* Describe the theory of operation of a bandpass filter.	
* Discuss the upper and lower cut off frequencies of a bandpass filter.	
* Identify a bandpass filter circuits.	
* Verify proper bandpass filter operation.	
* Determine the bandwidth of a bandpass filters.	
<b>T105 - BAND REJECT FILTERS</b> .....	<b>148</b>
* Describe the theory of operation of a band reject filter.	
* Identify a typical band reject filter circuit.	
* Verify proper band reject filter operation.	
* Determine the cut off frequency of a band reject filter circuit.	
<b>T106 - COMBINATION FILTERS</b> .....	<b>145,146</b>
* Discuss the theory of operation of a combination filter.	
* Identify a typical combinational filter circuit.	
* Verify proper combination circuit operation.	
* Experimentally determine the bandwidth of a combination filter.	

## MODEL 1419 OPERATIONAL AMPLIFIERS

<b>T701 - OPERATIONAL AMPLIFIERS</b> .....	<b>--</b>
* Describe the operational amplifier and how it is used.	
* Describe the schematic symbol and packaging of operational amplifiers.	
* Describe the basic operation of operational amplifiers.	
* Describe operational amplifier characteristics.	
* Describe linear operational amplifiers.	
* Describe arithmetic operational amplifiers.	
* Describe wave shaping operational amplifiers.	
<b>T702 - OPERATIONAL AMPLIFIER EXPERIMENT</b> .....	<b>161,162,163</b>
* Observe the operation of inverting and non-inverting amplifiers.	
* Measure signals in inverting and non-inverting amplifiers.	
* Locate faults in inverting and non-inverting amplifiers.	
* Observe the operation of summing and difference amplifiers.	
* Measure signals in summing and difference amplifiers.	
* Locate faults in summing and difference amplifiers.	
* Observe the operation of integrator and differentiator amplifiers.	
* Measure signals in integrator and differentiator amplifiers.	
* Locate faults in integrator and differentiator amplifiers.	

**MODEL 1420 BACKUP POWER SUPPLY  
(Available in Lab/Text Only)**

- Lesson 1 – Backup Power Supply Circuits ..... 293**
- \* State the purpose of backup power supplies.
  - \* Describe the block diagram operation of backup power supplies.
  - \* Describe typical backup power supply circuits.
  - \* Operate and troubleshoot a typical backup power supply.

**MODEL 1435 ELECTROMAGNETICS**

**T300 - MAGNETISM AND ELECTROMAGNETIC PRINCIPLES..... 182, 183**

- \* Define magnetism.
- \* Describe different types of magnetism.
- \* Describe relays, motors, transformers, and generators.
- \* Observe magnetic poles.
- \* Demonstrate temporary magnets.
- \* Examine electromagnetic operation.
- \* Demonstrate an application of magnetism.

**T305 - MAGNETIC CALCULATIONS .....-- (Optional)**

- \* Describe properties of magnetic lines of force.
- \* Identify magnetic and non-magnetic materials.
- \* Identify the characteristics of electromagnetism.
- \* Calculate magnetomotive force.
- \* Calculate magnetic field strength.
- \* Determine force.
- \* Determine torque.
- \* Understand the operation of magnetic circuits.
- \* Understand the effects of magnetic and non-magnetic materials in magnetic circuits.
- \* Use magnetization curves for magnetic materials.
- \* Examine step-by-step solutions to numerical examples.
- \* Define solenoids.
- \* Describe the operation of typical solenoid circuits.
- \* Introduce numerical examples of simple solenoid circuits.

**MODEL 1460 SIGNAL FORMAT CONVERSIONS  
(Available in Lab/Text Only)**

**Lesson 1 - Analog-to-Digital Conversion (A/D)..... 139**

- \* Identify the principle of analog-to-digital conversion.
- \* Describe various discrete analog-to-digital frequency circuits.
- \* Describe the operation of drivers, buffers and tri-state devices.
- \* Identify the properties of binary conversion and binary coded decimal.
- \* Describe integrated analog-to-digital conversion using the FLASH method.
- \* Analyze the operation of an ADC080X 8-bit  $\mu$ P-compatible analog-to-digital converter for analog-to-digital FLASH conversion.

**Lesson 2 - Digital-to-Analog Conversion (D/A) ..... 139,140, 455(Optional)**

- \* Identify the principles of serial or parallel digital-to-analog conversion terms and circuits.
- \* Analyze the operation of an integrated D/A circuit.

MODEL 4050 INSTRUMENTATION MODULE<sup>o</sup>

- IM01 - INTRODUCTION TO TEST EQUIPMENT.....--**
- \* Identify basic test equipment.
  - \* Understand the purpose of a multimeter, oscilloscope, function generator, and frequency counter.
  - \* Identify basic components of the Model 4050.
  - \* Perform initial startup procedures.
- IM02 - MULTIMETER OPERATIONS .....4050-1,4050-2**
- \* Describe how the Model 4050 Digital Multimeter (DMM) is used to measure continuity and resistance.
  - \* Make continuity and resistance measurements using the Model 4050 Digital Multimeter (DMM).
  - \* Describe how the Model 4050 Digital Multimeter (DMM) is used to measure voltage and current.
  - \* Make voltage and current measurements using the Model 4050 Digital Multimeter (DMM).
- IM03 - OSCILLOSCOPE OPERATIONS .....4050-2**
- \* Describe the operation of the Model 4050 Digital Storage Oscilloscope (DSO).
  - \* Measure voltage, time, and phase using the Model 4050 Digital Storage Oscilloscope (DSO).
- IM04 - FREQUENCY COUNTER OPERATIONS.....4050-2**
- \* Describe operation of the Nida Model 4050 Frequency Counter.
  - \* Use the Nida Model 4050 Frequency Counter to measure frequency.
- IM05 - FUNCTION GENERATOR OPERATIONS .....4050-2**
- \* Describe the purpose and use of a function generator.
  - \* Describe the Nida Model 4050 function generator controls and indicators.
  - \* Demonstrate the Nida Model 4050 function generator.

<sup>o</sup> indicates separate trainer

<b>MICROPROCESSORS</b>
------------------------

**BASIC MICROPROCESSOR SYSTEMS****T821 - INTRODUCTION TO MICROPROCESSORS .....--**

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

**T822 - BASIC MICROPROCESSOR OPERATIONS .....--**

- \* Identify parts of a microprocessor and describe microprocessor operation.
- \* Define and describe internal registers and counters.
- \* Understand ROM and RAM.
- \* Describe the difference between ROM and RAM.
- \* Understand the logical configuration of memory: conventional, extended, upper, high, expanded, caches.

**T823 - 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.

**MODEL 1439 8051 MICROCONTROLLER****T851 - 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.

**T852 - 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.

**T853 - INTERFACING WITH THE 8051 ..... 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 keypad circuitry in the microcontroller system.

**T854 - TROUBLESHOOTING THE 8051 ..... 405,406,407**

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

**MODEL 1440 8085 MICROPROCESSOR****T831 - 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.

**T832 - 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.

**MODEL 1440 8085 MICROPROCESSOR continued**

- T833 - 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 the microprocessor system.
- T834 - 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.

**MODEL 1441 8086 MICROPROCESSOR**

- T841 - 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.
- T842 - OPERATION OF THE 8086 MICROPROCESSOR..... 401,404,410,411**
- \* Describe the external timing and control connections to the 8086 microprocessor.
  - \* Describe the memory connections to the 8086 microprocessor.
  - \* Observe the operation of timing and control signals in a 8086 microprocessor system.
  - \* Observe memory interface signals during actual microprocessor operation.
- T843 - INTERFACING WITH THE 8086..... 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.
- T844 - TROUBLESHOOTING THE 8086..... 401,404,410,411**
- \* Describe the techniques required to troubleshoot a defective microprocessor system.
  - \* Describe preventive maintenance.
  - \* Describe the basic tool used to troubleshoot a microprocessor system.
  - \* Perform successful troubleshooting with the 8086 microprocessor trainer.
  - \* Understand basic fault types in a microprocessor system.
- T845 - 8086 DATA TRANSFER ..... 401,404,410,411**
- \* Describe Immediate Data Transfers.
  - \* Describe Direct Data Transfers.
  - \* Describe Indirect Data Transfers.
  - \* Perform Immediate Data Transfers in an 8086 microprocessor.
  - \* Perform Direct Data Transfers in an 8086 microprocessor.
  - \* Perform Indirect Data Transfers in an 8086 microprocessor.
- T846 - 8086 ADDITION AND SUBTRACTION ..... 401,404,410,411**
- \* Describe computer addition.
  - \* Describe computer subtraction.
  - \* Perform computer addition.
  - \* Perform computer subtraction.
- T847 - 8086 LOGIC INSTRUCTIONS ..... 401,404,410,411**
- \* Describe Logic Instructions.
  - \* Perform Logic Instructions.
- T848 - 8086 JUMP INSTRUCTIONS..... 401,404,410,411**
- \* Describe Jump Instructions
  - \* Perform Jump Instructions

## MODEL 1468 68000 MICROPROCESSOR

<b>T801 - INTRODUCTION to MICROPROCESSORS .....</b>	<b>---</b>
* 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.	
<b>T802 - THE 68000 MICROPROCESSOR .....</b>	<b>401,403,404,468</b>
* Define the different package styles of the 68000 microprocessor.	
* Understand labeling 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.	
<b>T803- REGISTERS AND MEMORY .....</b>	<b>401,403,404,468</b>
* 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.	
<b>T804 - INPUT/OUTPUT CIRCUITS .....</b>	<b>401,403,404,468</b>
* 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.	
<b>T805 - OPERATION OF THE 68000 .....</b>	<b>401,403,404,468</b>
* 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.	
<b>T806 - INTRODUCTION TO PROGRAMMING .....</b>	<b>401,403,404,468</b>
* Explain the purpose and usage of programming a microprocessor system.	
* Understand the different types of programming and what type the Nida 68000 microprocessor trainer uses.	
* Define the different groups of instruction and which instructions are in those groups.	
* Observe and understand all of the instruction codes of a simple program.	
* Observe the effects of executing the simple program.	
<b>T807 - MOVE AND BRANCH COMMANDS .....</b>	<b>401,403,404,468</b>
* 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.	
<b>T808 - ARITHMETIC AND LOGIC COMMANDS.....</b>	<b>401,403,404,468</b>
* Understand the different types and usages of arithmetic instructions.	
* Understand the different types and usages of logic instructions.	
* Demonstrate the usage of both arithmetic and logic instructions.	
<b>T809 - TEST AND ADDITIONAL COMMANDS .....</b>	<b>401,403,404,468</b>
* 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 usage of a test instruction.	
* Demonstrate the usage of an additional instruction.	

MODEL 1468 68000 MICROPROCESSOR continued

- T810 - 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.
- T811 - TROUBLESHOOTING .....401,403,404,468**
- \* Describe 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.

**500EMT MICROPROCESSOR SYSTEMS°  
(Available in Lab/Text Only)**

- Block 1-Lesson 1 - Introduction to Microprocessors.....--**
- \* Describe a brief history of the development of digital counting and calculating devices.
  - \* Understand the basic functions of the different sections of a computer.
  - \* Explain the relationship between a microprocessor and a computer.
  - \* Define terms commonly associated with computers.
  - \* Grasp the fundamentals of how microprocessors operate to process information.
- Block 1-Lesson 2 - Computer Arithmetic .....--**
- \* Understand the format of data for a microprocessor's input and output.
  - \* Perform conversions of binary, decimal, and hexadecimal numbers.
  - \* Perform basic math operations using binary numbers.
  - \* Understand double-precision addition and subtraction in both 8-bit and 16-bit modes.
  - \* Describe signed binary numbers and perform conversions between signed decimal numbers and signed binary numbers.
  - \* Describe signed and unsigned Binary Coded Decimal (BCD) numbers and perform addition and subtraction on signed and unsigned BCD numbers.
  - \* Perform double-precision addition, double-precision subtraction, multi-length BCD addition, and BCD subtraction in both 8-bit and 16-bit modes.
- Block 1-Lesson 3 - Basic Microprocessor Operation .....--**
- \* Understand how memory locations are addressed and how data is stored in them.
  - \* Describe the 5 basic internal registers of a microprocessor and explain their functions.
  - \* Explain how a computer fetches and executes an instruction.
  - \* Describe the processes of moving, pushing, and popping.
  - \* Discuss the logic functions of AND, OR, XOR, and NOT.
- Block 1-Lesson 4 - Architecture of the 8080A and 8086 Microprocessors.....--**
- \* Describe the major components of the 8080A microprocessor.
  - \* Describe the major components of the 8086 microprocessor.
  - \* Discuss the differences between the 8080A and the 8086 microprocessors.
- Block 1-Lesson 5 - Model 500EMT Microcomputer Operation.....--**
- \* Identify various microcomputer hardware components.
  - \* Display registers.
  - \* Display and change memory.
  - \* Load and run programs in different execution modes (real time, with breakpoints, tracing).
  - \* Fill and move a block of memory.
  - \* Convert hexadecimal numbers into different number systems.
  - \* Address I/O ports.
- Block 2-Lesson 1 - Data Transfer Instructions .....--**
- \* Transfer immediate data within the microprocessor using instruction programming.
  - \* Transfer data directly within the microprocessor using instruction programming.
  - \* Transfer data indirectly within the microprocessor using instruction programming.

° indicates separate trainer

**500EMT MICROPROCESSOR SYSTEMS<sup>o</sup> continued**  
**(Available in Lab/Text Only)**

**Block 2-Lesson 2 - Addition and Subtraction Instructions** .....

- \* Implement the addition instructions to add single-byte numbers and single-byte numbers with overflow.
- \* Implement the subtraction instructions to subtract single-byte numbers and single-byte numbers with overflow.
- \* Recognize flag altering due to addition and subtraction instructions.

**Block 2-Lesson 3 - Computer Arithmetic Instructions** .....

- \* Perform double-precision addition and subtraction in the 8080 and 8086 modes.
- \* Perform multi-length BCD addition and subtraction in the 8080 and 8086 modes.

**Block 2-Lesson 4 - Logic Instructions** .....

- \* Explain AND, OR, XOR, and NOT gates.
- \* Understand the concept behind programs involving logic instructions.
- \* State the common purpose of each logic operation.
- \* Perform logic operations on the Nida Model 500EMT Microprocessor Trainer in the 8080 and 8086 modes.

**Block 2-Lesson 5 - Compare Instructions** .....

- \* Understand the concept of how the compare instructions work.
- \* Perform compare instructions in the 8080 and 8086 modes using the Nida Model 500EMT Microprocessor Trainer.

**Block 2-Lesson 6 - Increment and Decrement Instructions** .....

- \* Increment a register or the contents of a memory location using the increment instruction.
- \* Decrement a register or the contents of a memory location using the decrement instruction.

**Block 2-Lesson 7 - Jump Instructions** .....

- \* Define unconditional/conditional jumps and their purposes in the 8080 mode.
- \* Calculate 8086 mode jump displacements.
- \* Define unconditional/conditional jumps and their purposes in the 8086 mode.
- \* Perform unconditional jumps and conditional jumps using the Nida Model 500EMT Microprocessor Trainer in both 8080 and 8086 modes.

**Block 2-Lesson 8 - Multiplication and Division Instructions** .....

- \* Describe multiplication and division in the 8080 mode.
- \* Describe multiplication and division using the available instructions in the 8086 mode.
- \* Perform multiplication and division instructions using the Nida Model 500EMT Microprocessor Trainer in both the 8080 and 8086 modes.

**Block 2-Lesson 9 - Input and Output Ports Instructions** .....

- \* Implement the INPUT instructions to read data from the user ports.
- \* Implement the OUTPUT instructions to write data to the user ports.

**Block 3-Lesson 1 - Microprocessor Unit (MPU)** .....

- \* Name the three main sections of a computer.
- \* Recognize pin names on the V30 microprocessor and know the general purpose of each pin.
- \* Describe the clock generator and know its function in a computer.
- \* Describe the internal architecture of the V30 microprocessor and describe the differences between the 8080 and 8086 modes.
- \* Describe how the microprocessor switches between the 8086 mode and 8080 modes.
- \* Observe the waveforms of the crystal oscillator, CLK input to the V30, and the PCLK output, and then calculate the frequency of each clock.

**Block 3-Lesson 2 - Data Bus** .....

- \* Explain what the data bus is and its purpose in a computer system.
- \* Explain what a bus transceiver is and its purpose.
- \* Explain the control signals involved in a data transfer instruction.
- \* Read the data on the data bus during a short loop program.

**Block 3-Lesson 3 - Address Bus** .....

- \* Explain the purpose of the address bus.
- \* Describe the operation of an electronic latch.
- \* Measure and record address bus and address logic signals.

<sup>o</sup> indicates separate trainer

**500EMT MICROPROCESSOR SYSTEMS<sup>o</sup> continued  
(Available in Lab/Text Only)**

- Block 3-Lesson 4 - Memory**.....--
- \* Explain the difference between RAM and ROM and explain the purpose of each.
  - \* Examine the signals involved in writing data to and reading data from the 62256 Static RAM (SRAM).
  - \* Examine the signals involved in reading data from the 27C256 EPROM.
  - \* Examine the signals involved in writing data to and reading data from the 28C256 EEPROM.
  - \* Measure the power supplied to the memory chips and examine the memory decoder chip select function.
- Block 3-Lesson 5 - Keyboard**.....--
- \* Describe the basic Windows® keyboard.
  - \* Describe the keyboard microcontroller.
  - \* Describe Nida Model 500EMT keyboard interface circuitry
  - \* Observe normal keyboard signals using standard test equipment.
- Block 3-Lesson 6 - Display**.....--
- \* Describe the operation of a liquid crystal display (LCD).
  - \* Describe how the liquid crystal display (LCD) is controlled by the address bus and describe the purpose of each support component.
  - \* Monitor the Nida Model 500EMT display circuit signals.
- Block 3-Lesson 7 - Interrupts** .....--
- \* Describe how a microprocessor responds to an interrupt.
  - \* Describe software interrupts.
  - \* Describe hardware interrupts.
  - \* Describe the reset interrupt.
  - \* Observe the operation of a software interrupt and measure the logic levels in an interrupt controller.
- Block 3-Lesson 8 - Digital-to-Analog Converter Interface** .....--
- \* Describe the purpose and operation of digital-to-analog conversion circuits.
  - \* Describe the operation of the Nida Model 500EMT digital-to-analog converter circuitry.
  - \* Convert digital signals to analog waveforms using the 500EMT.
- Block 3-Lesson 9 - Analog-to-Digital Converter Interface** .....--
- \* Describe the purposes and operation of A/D conversion circuits.
  - \* Describe the operation of the Nida Model 500EMT analog-to-digital conversion circuitry.
  - \* Determine the parameters of the analog-to-digital converter through experimentation.
- Block 3-Lesson 10 -Serial Interface** .....--
- \* Describe Synchronous Serial Interface Operations (SSIO)
  - \* Describe Asynchronous Serial Interface Operations (ASIO).
  - \* Describe Recommended Standards (RS) for RS-232, RS-422, and RS-485.
  - \* Observe an active RS-232 interface during normal operation.
- Block 3-Lesson 11 - Parallel Interface** .....--
- \* Describe basic parallel interfacing techniques.
  - \* Describe SCSI, HiPPI, and Centronics® parallel interfaces.
  - \* Describe Nida Model 500EMT parallel interface I/O circuitry.
  - \* Monitor an active parallel data interface link.
- Block 4-Lesson 1 - Troubleshooting Techniques**.....--
- \* Describe the techniques required to troubleshoot a defective microprocessor system.
  - \* Describe the procedures and precautions used to handle a microprocessor system.
  - \* Describe preventive maintenance.
- Block 4-Lesson 2 - Troubleshooting Tools** .....--
- \* Describe the basic tools used to troubleshoot microprocessor systems.
  - \* State the characteristics of each tool and how it is used to determine faults.
- Block 4-Lesson 3 - Troubleshooting Drill and Practice** .....--
- \* Visually inspect the microprocessor system for faults.
  - \* Use troubleshooting trees to diagnose problems in microprocessor operation.
  - \* Run diagnostic routines to check for faults in the microprocessor system.

<sup>o</sup> indicates separate trainer

**500EMT MICROPROCESSOR SYSTEMS<sup>o</sup> continued**  
**(Available in Lab/Text Only)**

<b>Block 5-Lesson 1 - Sound Capture/Reproduction .....</b>	<b>431</b>
* Describe the function of a sound capture system.	
* Describe the operation of a sound capture system.	
* Record and play back using the sound capture system.	
<b>Block 5-Lesson 2 – DC Motor Control .....</b>	<b>184</b>
* Describe the purpose and operation of a microprocessor feedback controlled motor with a fiberoptic link.	
* Describe the purposes and operation of fiberoptic cable interfacing.	
* Observe the operation of a DAC/ADC conversion circuit, motor feedback control with fiberoptic link, and the Nida Model 500EMT.	
<b>Block 5-Lesson 3 - Ultrasonic Devices .....</b>	<b>250</b>
* Describe the function of an ultrasonic system.	
* Describe the operation of an ultrasonic motion detection system.	
* Describe the operation of an ultrasonic distance measurement system.	
<b>Block 5-Lesson 4 - Temperature Control.....</b>	<b>189</b>
* Identify the principles and properties of temperature measurement and heat dissipation.	
* Understand the principles of basic heat sensors and temperature transducers.	
* Analyze the operation of a solid-state (IC) temperature transducer and control system.	
* Understand the principles used in a microprocessor-controlled temperature control system.	
<b>Block 5-Lesson 5 - Stepper Motor.....</b>	<b>181</b>
* Describe the operation of stepper motors.	
* Describe the characteristics of stepper motors.	
* Describe stepper motor driver and controller circuits.	
* Observe the operation of a microprocessor controlled stepper motor.	

**MODEL 1443 PROGRAMMABLE LOGIC DEVICES**  
**(Available in Lab/Text Only)**

<b>Lesson 1 - Programmable Logic Devices.....</b>	<b>--</b>
* Identify and describe the basic programmable logic device array structure.	
* Describe the architecture of programmable logic devices.	
* Understand the minimizing processes.	
<b>Lesson 2 - Programming PLDs.....</b>	<b>158</b>
* Describe the PLD programming and verification process.	
* Program a generic array logic (GAL) device.	
* Verify the operation of a GAL device.	

<b>TELECOMMUNICATIONS</b>
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**MODEL 1434 INTRODUCTION TO FIBER OPTICS****T401 - INTRODUCTION TO FIBER OPTICS.....--**

- \* Explore the history of optical communications.
- \* Discuss how fiberoptic technology evolved.
- \* Discussion of fiberoptic light propagation using a block diagram.
- \* Basic fiberoptic cable construction.
- \* Theory of light propagation.
- \* Explore some of the key advantages of using fiberoptic technology.
- \* Discuss the limitations of fiberoptic technology.

**T402 - FIBEROPTIC APPLICATIONS ..... 301,302,251**

- \* Describe the theory of fiberoptic communications.
- \* Identify the purpose of optical transmitters, receivers, and optical fibers.
- \* Understand light energy terms and measurements.
- \* Describe operation of an optical transmitter.
- \* Understand operation and characteristics of incandescent lamps and LEDs as optical transmitters.
- \* Describe operation of an optical receiver.
- \* Understand operation and characteristics of photocells, photodiodes, photovoltaics, and phototransistors as optical receivers.
- \* Verify the principles of fiberoptic communications.
- \* Demonstrate a simple fiberoptic communication link.
- \* Observe the operation of LEDs and incandescent lamps as light sources.
- \* Observe the operation of photocells, photodiodes, photovoltaic cells, and phototransistors as light detectors.

**T403 - INTRODUCTION TO LASERS .....--**

- \* Describe the basic particle theory of light.
- \* Describe the basic wave theory of light.
- \* Describe the principles behind the quantum theory of light.
- \* Define the term Laser.
- \* Describe the quantum theory of radiation.
- \* Describe the characteristics of laser light.
- \* Describe the fundamental elements of a laser.
- \* Describe the various uses of lasers.

**T404 - FIBEROPTIC CABLE CONNECTIONS ..... 301,302**

- \* Explain losses due to the different types of misalignment and waveguide geometry.
- \* Describe the basic steps to properly splicing waveguides.
- \* 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.

**T405 - 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 properly troubleshooting a fiberoptic system using a troubleshooting flowchart.
- \* Examine the characteristics of a faulty transmission circuit, transmission medium, and receiver circuit.

## MODEL 1406 FIBEROPTIC CIRCUITS

<b>A201 - INTRODUCTION TO FIBER OPTICS .....</b>	<b>251,301,302,323</b>
* 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.	
<b>A202 - FIBEROPTIC COMPONENTS.....</b>	<b>251</b>
* 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 difference between LEDs and lasers.	
* Identify some of the characteristics for optical detectors.	
* Describe the difference 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.	
<b>A203 - SIGNAL TRANSMISSION .....</b>	<b>301,302,303,305,306,322</b>
* Describe the five areas of signal processing.	
* Explain AM, FM, PCM, and intensity modulation.	
* Explain TDM, FDM, and WDM.	
* Define SNR and BER.	
* Construct and set up a fiberoptic system utilizing time division multiplexing.	
* Demonstrate the operational characteristics of time division multiplexing.	
<b>A204 - FIBEROPTIC CABLE CONNECTIONS .....</b>	<b>301,302</b>
* Explain losses due to the different types of misalignment and waveguide geometry.	
* Describe the basic steps to properly splicing waveguides.	
* 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.	
<b>A205 - FIBEROPTIC SYSTEM TROUBLESHOOTING .....</b>	<b>301,302</b>
* 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 properly troubleshooting a fiberoptic system using a troubleshooting flowchart.	
* Examine the characteristics of a faulty transmission circuit, transmission medium, and receiver circuit.	

## MODEL 1407 SIGNAL PROCESSING CIRCUITS

<b>B101 - COMMUNICATION SYSTEMS AND SIGNAL PROCESSING .....</b>	<b>--</b>
* Describe the basic elements that compose a communication system.	
* State the two fundamentals limiting factors in a communication system.	
* Describe the basic difference between analog and digital signals.	
* Identify various signal processing techniques.	
* Describe safety.	
* Describe warning/caution statements and tags.	
* Describe personal and laboratory safety habits.	

## MODEL 1407 SIGNAL PROCESSING continued

<b>B102 - AMPLITUDE MODULATION</b> .....	--
* Describe Amplitude Modulation and discuss the characteristics of Amplitude Modulated signals.	
* Generate Amplitude Modulation signals using a function generator.	
* Observe and measure the characteristics of an Amplitude Modulated signal.	
<b>B103 - FREQUENCY MODULATION</b> .....	--
* Describe Frequency Modulation.	
* Describe the characteristics of Frequency Modulation.	
* Generate Frequency Modulation signals using a Function Generator.	
* Observe and measure the characteristics of a Frequency Modulated signal.	
<b>B104 - SINGLE SIDEBAND AND TRANSMISSION LINES</b> .....	--
* Identify 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.	
<b>B201 - AM CIRCUITS</b> .....	--
* Describe a diode AM modulator circuit.	
* Describe a transistor collector AM modulator circuit.	
* Describe a transistor series AM modulator circuit.	
* Describe a diode AM demodulator circuit.	
* Describe a transistor AM demodulator circuit.	
<b>B202 - BASIC AM CIRCUIT CONSTRUCTION</b> .....	130X
* 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.	
<b>B203 - AM CIRCUIT OPERATION</b> .....	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.	
<b>B204 - AM CIRCUIT TROUBLESHOOTING</b> .....	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.	
<b>B205 - FM CIRCUITS</b> .....	--
* Describe a reactance modulator circuit.	
* Describe a varactor modulator circuit.	
* Describe an IC Voltage Controlled Oscillator.	
* Describe a slope demodulator circuit.	
* Describe a ratio demodulator circuit.	
<b>B206 - BASIC FM CIRCUIT OPERATION</b> .....	130X
* Construct a FM reactance Modulator circuit.	
* Measure signals in a FM reactance modulator circuit.	
* Construct a FM slope demodulator circuit.	
* Measure signals in a FM slope demodulator circuit.	
<b>B207 - FM CIRCUIT OPERATION</b> .....	86
* Observe the operation of a varactor (VCO) modulator transmitter.	
* Measure signals in a varactor (VCO) modulator transmitter.	
* Observe the operation of a discriminator demodulator receiver.	
* Measure signals in a discriminator demodulator receiver.	
* Observe the operation of a ratio demodulator receiver.	
* Measure signals in a ratio demodulator receiver.	
<b>B208 - IC FM CIRCUIT OPERATION</b> .....	336
* Observe the operation of a ratio demodulator receiver.	
* Measure signals in a integrated circuit transmitter and receiver.	

## MODEL 1407 SIGNAL PROCESSING continued

<b>B209 - FM CIRCUIT TROUBLESHOOTING</b> .....	--
* Determine if a FM transmitter and receiver system is operating correctly.	
* Identify the faulted circuit in a malfunctioning FM transmitter and receiver system.	
* Determine if a FM transmitter and receiver system is operating correctly.	
* Identify the faulted circuit in a malfunctioning FM transmitter and receiver system.	
<b>B210 - ANALOG PULSE MODULATION</b> .....	--
* Define analog pulse modulation.	
* Describe pulse amplitude modulation.	
* Describe pulse width modulation.	
* Describe pulse position modulation.	
<b>B301 - PULSE CODE MODULATION (PCM)</b> .....	--
* Describe Pulse Code Modulation.	
* 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.	
<b>B302 - PCM CIRCUIT OPERATION</b> .....	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.	
<b>B303 - PCM CIRCUIT TROUBLESHOOTING</b> .....	284,326,327
* Determine if an PCM transmitter and receiver system is operating correctly.	
* Identify the faulted component in a malfunctioning PCM transmitter and receiver system.	
<b>B304 - DELTA MODULATION (DM)</b> .....	--
* Describe Delta Modulation	
* Describe the characteristics of DM signals.	
* Describe a typical DM modulator circuit.	
* Describe the MC3418 DM modulator integrated circuit.	
* Describe a typical DM demodulator circuit.	
* Describe the MC3418 DM demodulator integrated circuit.	
<b>B305 - DELTA MODULATION (DM) CIRCUIT OPERATION</b> .....	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.	
<b>B306 - DM CIRCUIT TROUBLESHOOTING</b> .....	332,333
* Determine if an DM transmitter and receiver system is operating correctly.	
* Identify the faulted component in a malfunctioning DM transmitter and receiver system.	
<b>B307 - FREQUENCY SHIFT KEYING (FSK)</b> .....	--
* 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.	
<b>B308 - FREQUENCY SHIFT KEYING CIRCUIT OPERATION</b> .....	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.	
<b>B309 - FSK CIRCUIT TROUBLESHOOTING</b> .....	328,329
* Determine if a FSK transmitter and receiver system is operating correctly.	
* Identify the faulted component in a malfunctioning FSK transmitter and receiver system.	

## MODEL 1407 SIGNAL PROCESSING continued

<b>B310 - PHASE SHIFT KEYING</b> .....	--
* Describe Phase Shift Keying.	
* Describe the characteristics of PSK signals.	
* Describe a typical PSK modulator circuit.	
* Describe a typical PSK demodulator circuit.	
<b>B311 - PHASE SHIFT KEYING CIRCUIT OPERATION</b> .....	323,330,331
* Observe the operation of a typical PSK modulator.	
* Measure signals in a typical PSK modulator.	
* Observe the operation of a typical PSK demodulator.	
* Measure signals in a typical PSK demodulator.	
<b>B312 - PHASE SHIFT KEYING TROUBLESHOOTING</b> .....	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.	
<b>B401 - TIME DIVISION MULTIPLEXING</b> .....	--
* 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.	
<b>B402 - TIME DIVISION MULTIPLEXING CIRCUIT OPERATION</b> .....	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.	
<b>B403 - TDM CIRCUIT TROUBLESHOOTING</b> .....	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.	
<b>B404 - FREQUENCY DIVISION MULTIPLEXING</b> .....	--
* Describe Frequency Division Multiplexing.	
* Describe the characteristics of FDM signals.	
* Describe a typical FDM multiplexer circuit.	
* Describe the NE564 PLL circuit used as a FM modulator.	
* Describe a typical FDM demultiplexer circuit.	
* Describe the NE564 PLL circuit used as a FM demodulator.	
<b>B405 - FDM CIRCUIT OPERATION</b> .....	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.	
<b>B406 - FDM CIRCUIT TROUBLESHOOTING</b> .....	322,324,325
* Determine if a FDM transmitter and receiver system is operating correctly.	
* Identify the faulted component in a malfunctioning FDM transmitter and receiver system.	

**MODEL 1428 DATA NETWORKS**  
(Available in Lab/Text Only)

<b>Lesson 1 - Broadband Networks</b> .....	--
* Describe Integrated Services Digital Network (ISDN).	
* Describe Switched Multimegabit Data Service (SMDS).	
* Describe Asynchronous Transfer Mode (ATM).	
* Describe Synchronous Optical Network (SONET).	

**MODEL 1428 DATA NETWORKS continued  
(Available in Lab/Text Only)**

**Lesson 2 - Network Topology** .....

- \* Describe Point-to-Point Topology.
- \* Describe Bus Topology.
- \* Describe Star Topology.
- \* Describe Ring Topology.
- \* Describe Fiber Distributed Data Interface (FDDI).

**Lesson 3 - Serial Data Interfaces** .....

- \* Describe Synchronous Serial Interface Operations (SSIO).
- \* Describe Asynchronous Serial Interface Operations (ASIO).
- \* Describe Recommended Standards (RS) for RS-232, RS-422, and RS-485.

**Lesson 4 - Data Network Operations** ..... **345(x3), 345A**

- \* Observe the operation of a data network.
- \* Identify relationships between data rate and bandwidth.
- \* Examine frame formats and byte-oriented protocols.
- \* Recognize and diagnose data frame collisions.

**MODEL 1429 DIGITAL TELEPHONE CIRCUITS**

**T601 - INTRODUCTION TO COMMUNICATION SYSTEMS** .....

- \* Define the basic elements that make up communication systems.
- \* Describe circuits and components that are contained in the elements of communication systems.
- \* Describe bandwidth as a limiting factor in communication systems.
- \* Describe noise as a limiting factor in communication systems.

**T602 - TELEPHONE SYSTEMS** .....

- \* Define the basic telephone system construction.
- \* 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.

**T603 - 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.

**TELECOMMUNICATION SYSTEMS**

**T610 - INTRODUCTION TO TELECOMMUNICATIONS** .....

- \* Define Telecommunications.
- \* Identify a basic telecommunications system.
- \* Identify the mission of the Federal Communications Commission (FCC).
- \* Identify types of telecommunications systems.
- \* Recognize the difference between wired and wireless.
- \* Describe basic electromagnetic wave principles.
- \* Understand the anatomy of the frequency spectrum.

**T605 - TYPES OF TELECOMMUNICATIONS CAREERS** .....

- \* Identify types of careers that support the telecommunications industry.
- \* Identify the educational requirements of telecommunications careers.
- \* Describe certification requirements of the telecommunications industry.

## TELECOMMUNICATION SYSTEMS continued

**T606 - HISTORY OF TELECOMMUNICATIONS.....--**

- \* Identify innovators and inventors in the telecommunications industry.
- \* Describe a brief history of telecommunications.

**T607 - SPECIAL INTEREST GROUPS.....--**

- \* Describe telecommunications industry special interest groups.

**T608 - 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.

**T611 - 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.

**T612 - 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.

**T613 - 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.

**T614 - 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.

**T615 - 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.

**T616 - 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.

**T617 - 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.

**MODEL 1436 ADVANCED TELEPHONE CIRCUITS  
(Available in Lab/Text Only)**

**Lesson 1 - Telephone Operation ..... 301,302,303,305,306,322,326,327**

- \* Describe time division multiplexing and how it is used in telecommunication systems.
- \* Describe pulse code modulation and how it is used in telecommunication systems.
- \* Describe fiberoptic transmission mediums and how they are used in telecommunication systems.
- \* Observe the operation of time division multiplexing, pulse code modulation, and fiber optics in a telecommunication system.

**MODEL 4444 RF COMMUNICATIONS**

**T901 - INTRODUCTION TO COMMUNICATIONS .....--**

- \* Define a typical communications system.
- \* Understand common communications terminology.
- \* Understand the process of sound to audio frequency, audio frequency to sound conversion.

**T921 - WAVE PROPAGATION .....--**

- \* Define Wave Propagation.
- \* Define Wave Propagation terms.
- \* Describe wave characteristics and their propagation paths.

**T922 - HF FUNDAMENTALS .....--**

- \* Define the purpose of an HF system.
- \* Identify the HF frequency range.
- \* Define the different modes of operation of an HF system.
- \* Describe the HF system components.
- \* Describe a block diagram of an HF system.
- \* Understand HF Radio system circuit functions.
- \* Understand basic Fault Isolation of an HF system.

**T902 - AMPLITUDE MODULATION (AM) RECEIVERS ..... 438,439,440**

- \* Define and understand Amplitude Modulation and Heterodyning.
- \* Identify the major components of a typical AM receiver.
- \* Explain the major methods of tuning.
- \* Experiment - The AM Signal.

**T903 - AM RECEIVER ANALYSIS ..... 438,439,440**

- \* Identify AM Receiver components.
- \* Describe AM Receiver component functions.
- \* Examine the operation of AM Receiver circuits.

**T904 - AM RECEIVER TROUBLESHOOTING ..... 438,439,440**

- \* Practice troubleshooting AM receivers

**T905 - FREQUENCY MODULATION RECEIVERS.....--**

- \* The merits and deficiencies of FM vs. AM.
- \* Terminology associated with FM.
- \* FM Generation Methods.
- \* Methods of Tuning.

**T906 - FM RECEIVER ANALYSIS..... 441,442,443**

- \* Perform schematic analysis of an FM Receiver.
- \* Analyze the FM Receiver circuits used in the FM Receiver.
- \* Perform a receiver alignment on an FM Receiver.

**T907 - FM RECEIVER TROUBLESHOOTING ..... 441,442,443**

- \* Practice troubleshooting FM receivers.

**T908 - AM/CB TRANSCEIVER .....--**

- \* Understand a transmitter block diagram.
- \* Identify high level modulation.
- \* Understand amplitude modulation and its power requirements.
- \* Understand VSWR and SWR.
- \* Understand a receiver block diagram.
- \* Describe a CB radio.

## MODEL 4444 RF COMMUNICATIONS continued

<b>T909 – AM/CB TRANSCEIVER ANALYSIS .....</b>	<b>444,445,446</b>
* Examine the major sections of a CB Transceiver.	
* Experiment - Observe a signal on a CB Transceiver.	
<b>T910 - TRANSCEIVER (CB) TROUBLESHOOTING .....</b>	<b>444,445,446</b>
* Localize and isolate faults.	
<b>T911 - SINGLE SIDEBAND TRANSMITTERS/RECEIVERS .....</b>	<b>---</b>
* Define and describe SSB Communications.	
* Understand SSB Generation (Transmitters).	
* Understand SSB Receivers.	
<b>T912 - SSB ANALYSIS .....</b>	<b>450,451,452,453,454,455</b>
* Analyze the SSB transmitter and receiver.	
* Examine the SSB transmitter and receiver circuits.	
<b>T913 - SSB TROUBLESHOOTING.....</b>	<b>450,451,452,453,454,455</b>
* Understand the particulars of troubleshooting SSB equipment.	
* Identify faults in a typical SSB system.	
<b>T914 - NARROW BAND FM.....</b>	<b>456,457</b>
* Understand NBFM theory and analysis.	
* Observe signals associated with NBFM systems.	
<b>T915 - NARROWBAND FM TROUBLESHOOTING.....</b>	<b>456,457</b>
* Understand the particulars of troubleshooting Narrowband FM equipment.	
* Identify faults in a typical Narrowband FM system.	
<b>T916 - COMMUNICATIONS TROUBLESHOOTING .....</b>	<b>---</b>
* Perform an assessment of an FM receiver.	
* Localize a faulty receiver stage.	
* Isolate faulty components.	
* Reassess a receiver after repair.	

## MODEL 3301 BASIC MICROWAVE

<b>8101 - INTRODUCTION TO MICROWAVES.....</b>	<b>---</b>
* Describe the history of microwave inception and explain how microwave communications were initiated.	
* Identify basic microwave principles and recognize the Radio Frequency Spectrum.	
* Identify microwave frequencies and factors affecting communications.	
* Identify metric prefixes	
* Perform conversions between different metric prefixes.	
<b>8102 - INTRODUCTION TO MICROWAVE SYSTEMS .....</b>	<b>307,308</b>
* Identify various stages in a basic microwave communication system.	
* Describe the basic principle of multiplexing.	
* Describe the purpose of microwave repeater stations.	
* Identify basic microwave components and devices.	
* Observe the effects of blocked microwave transmission signals and misaligned microwave antennas.	
* Become familiar with the Nida Model 330 Microwave Trainer.	
<b>8103 - MICROWAVE TRANSMITTERS.....</b>	<b>307,308</b>
* Describe the operation of typical microwave transmitters.	
* Describe the operation of the receiver in the Nida Model 330 Microwave Trainer.	
* Observe and trace signals through a basic microwave transmitter.	
<b>8104 - MICROWAVE RECEIVERS .....</b>	<b>307,308</b>
* Describe the operation of typical microwave receivers.	
* Describe the operation of the receiver in the Nida Model 330 Microwave Trainer.	
* Observe and trace signals through a basic microwave receiver.	
<b>8105 - WAVEGUIDE THEORY.....</b>	<b>---</b>
* Describe a waveguide and explain the advantages and disadvantages of waveguides over other means of transferring RF energy.	
* Explain how waveguides are developed from parallel to wire transmission lines.	
* Describe waveguide plumbing.	

**MODEL 3301 BASIC MICROWAVE continued**

<b>8106 - ANTENNAS</b> .....	<b>307,308</b>
* Describe the basic construction and theory of operation of horn antennas.	
* Describe the basic construction and theory of operation of microwave reflectors.	
* Describe the basic construction and theory of operation of microwave lenses.	
* Verify that microwave signals can be reflected.	
<b>8107 - CAVITY RESONATORS AND TUBE MICROWAVE DEVICES</b> .....	<b>---</b>
* 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.	
<b>8108 - SEMICONDUCTOR MICROWAVE DEVICES</b> .....	<b>---</b>
* Describe the limitations of Bipolar and Field Effect Transistors at microwave frequencies.	
* Describe methods to minimize limitations in Bipolar & Field Effect Transistors at microwave frequencies.	
* Describe the basic theory of operation of Varactor Diodes, Tunnel Diodes, Gunn Diodes, and DROs.	

**MODEL 3302 MICROWAVE COMMUNICATIONS**  
(Available in Lab/Text Only)

<b>Lesson 1 - Introduction to Microwave Communications</b> .....	<b>307,308</b>
* Describe the reasons why microwaves are used in the communications field.	
* Describe the various signal processing techniques that are used in microwave transmission and reception.	
* Set up and align the microwave trainer for use in communication systems.	
<b>Lesson 2 - Pulse Modulation (PCM)</b> .....	<b>307,308,326,327</b>
* Describe the three basic methods of analog pulse modulation.	
* Describe pulse code modulation (PCM) for digital signals in detail.	
* Describe PCM modulator circuits.	
* Describe PCM demodulator circuits.	
* Observe the normal operation and troubleshoot typical PCM modulator and demodulator circuits.	
<b>Lesson 3 - Frequency Shift Keying (FSK)</b> .....	<b>307,308,328,329</b>
* Describe the characteristics of Frequency Shift Key (FSK) signals.	
* Describe FSK modulator circuits.	
* Describe FSK demodulator circuits.	
* Observe the normal operation and troubleshoot an FSK transmitter and receiver.	
<b>Lesson 4 - Phase Shift Keying (PSK)</b> .....	<b>307,308,323,330,331</b>
* Describe the characteristics of Phase Shift Keying (PSK) signals.	
* Describe PSK modulator circuits.	
* Describe PSK demodulator circuits.	
* Observe the normal operation and troubleshoot a PSK transmitter and receiver.	
<b>Lesson 5 - Time Division Multiplexing (TDM)</b> .....	<b>303,305,306,307,308,322</b>
* Describe the characteristics of Time Division Multiplexing (TDM) signals.	
* Describe TDM multiplexer circuits.	
* Describe TDM demultiplexer circuits.	
* Observe the normal operation and troubleshoot a TDM transmitter and receiver.	
<b>Lesson 6 - Frequency Division Multiplexing (FDM)</b> .....	<b>303,307,308,322,324,325</b>
* Describe the characteristics of Frequency Division Multiplexing (FDM) signals.	
* Describe FDM multiplexer circuits.	
* Describe FDM demultiplexer circuits.	
* Observe the normal operation and troubleshoot an FDM transmitter and receiver.	
<b>Lesson 6A - Frequency Division Multiplexing (FDM)</b> .....	<b>303,307,308,322,324A,325</b>
* Describe the characteristics of Frequency Division Multiplexing (FDM) signals.	
* Describe FDM multiplexer circuits.	
* Describe FDM demultiplexer circuits.	
* Observe the normal operation and troubleshoot an FDM transmitter and receiver.	

**MODEL 3303 STANDING WAVE RATIO MEASUREMENT  
(Available in Lab/Text Only)**

**Lesson 1 - Standing Waves and Frequency ..... 304,307**

- \* Describe standing waves in a microwave system.
- \* Describe the Standing Wave Ratio (SWR) and SWR measurement in a microwave system.
- \* Describe frequency measurement in a microwave system.
- \* Observe standing waves and, measure the Standing Wave Ratio and frequency in a microwave transmitter waveguide.

**MODEL 3304 MICROWAVE REFLECTION  
(Available in Lab/Text Only)**

**Lesson 1 - Reflection and Polarization ..... 307,308**

- \* Describe the basic characteristics of reflected microwaves.
- \* Describe the basic characteristics of polarized microwaves.
- \* Observe and measure reflected and polarized microwaves.

**MODEL 205ECT RF COMMUNICATIONS<sup>o</sup>  
(Available in Lab/Text Only)**

**Block 1-Lesson 1 - History of Communications .....--**

- \* Describe a brief history of the important discoveries in the field of communications.
- \* Recognize and avoid potential dangers when working in and around electronic devices.
- \* Demonstrate good personal and laboratory habits.

**Block 1-Lesson 2 - General Communications Theory ..... 205ECT-3, 205ECT-4, 205ECT-5**

- \* Describe a typical AM receiver and transmitter.
- \* Describe a typical FM receiver and transmitter.
- \* Describe the Nida Model 205ECT and its operating procedures.

**Block 1-Lesson 3 - Theory of Power Supplies .....--**

- \* Describe the purpose of a power supply.
- \* Describe a typical block diagram of a power supply.
- \* Describe typical half wave, full wave, and bridge rectifier circuits.
- \* Describe typical shunt regulator, series regulator, and current limiter circuits.

**Block 1-Lesson 4 - Power Supply Ripple ..... 205ECT-3**

- \* Define power supply ripple and recognize it on the oscilloscope.
- \* Measure ripple voltage and calculate % ripple.
- \* Identify the ripple in a typical power supply.

**Block 1-Lesson 5 - Output Impedance .....--**

- \* Understand how output impedance relates to power supplies.
- \* Measure output impedance of power supplies.
- \* Measure the output impedance of a typical power supply.

**Block 1-Lesson 6 - Audio Amplifier Theory .....--**

- \* Describe the purpose of the audio section in a communications receiver.
- \* Describe the five classes of amplifiers.
- \* Analyze the audio section of the Nida Model 205ECT.

**Block 1-Lesson 7 - Voltage Amplifier Frequency Response .....--**

- \* Perform frequency response measurements on an audio voltage amplifier.
- \* Produce a graph showing the frequency response of the audio voltage amplifier in the Nida 205ECT.

**Block 1-Lesson 8 - Voltage Amplifier Input Impedance .....--**

- \* Measure the input impedance of an audio voltage amplifier.

**Block 1-Lesson 9 - Square Wave Testing .....--**

- \* Appreciate the value of square wave testing.
- \* Interpret square wave test patterns.
- \* Perform a square wave test on the audio voltage amplifier used in the Nida Model 205ECT.

<sup>o</sup> indicates separate trainer

**MODEL 205ECT RF COMMUNICATIONS<sup>o</sup> continued**  
**(Available in Lab/Text Only)**

<b>Block 1-Lesson 10 - Harmonic Distortion.....</b>	<b>--</b>
* Recognize the presence of harmonic distortion.	
* Demonstrate a technique for measuring harmonic distortion.	
* Measure the amount of 2nd harmonic distortion present at the output of the voltage amplifier in the Nida Model 205ECT.	
<b>Block 2-Lesson 1 - AM Broadcast Receiver Theory.....</b>	<b>--</b>
* Draw a block diagram of an AM broadcast receiver.	
* Describe the AM broadcast receiver circuits used in the 205ECT.	
<b>Block 2-Lesson 2 - Heterodyning .....</b>	<b>205ECT-3</b>
* Understand the heterodyning process and observe its operation in an AM receiver.	
* Describe the "image frequency" phenomenon.	
<b>Block 2-Lesson 3 - IF Frequency Response.....</b>	<b>205ECT-3</b>
* Understand a typical IF response curve.	
* Measure the IF response of a receiver.	
<b>Block 2-Lesson 4 - IF Amplifier Gain .....</b>	<b>205ECT-3</b>
* Perform a voltage gain measurement of an IF amplifier.	
* Determine the dB gain of individual and cascaded amplifiers.	
* Perform gain measurements of the IF amplifier in an actual receiver.	
<b>Block 2-Lesson 5 - AM Detector Operation.....</b>	<b>205ECT-3</b>
* Identify the waveforms present in an AM detector.	
* Identify the voltages normally present in an AM detector.	
<b>Block 2-Lesson 6 - Automatic Gain Control (AGC) .....</b>	<b>205ECT-3</b>
* Recognize a typical AGC circuit in operation.	
* Measure the performance of the AGC circuit used in the AM receiver.	
<b>Block 2-Lesson 7 - AM Broadcast Receiver Noise .....</b>	<b>205ECT-3</b>
* Calculate the receiver noise figure (NF).	
* Practice a simple technique for measuring receiver noise.	
<b>Block 2-Lesson 8 - AM Broadcast Receiver Sensitivity.....</b>	<b>205ECT-3</b>
* Practice a technique for measuring the sensitivity of a receiver.	
* Measure the sensitivity of the Nida AM broadcast receiver.	
<b>Block 2-Lesson 9 - Image Frequency Rejection .....</b>	<b>205ECT-3</b>
* Define image rejection.	
* Describe simple and effective methods of measuring image rejection.	
* Perform an image rejection measurement on an actual AM receiver.	
<b>Block 2-Lesson 10 - AM Broadcast Receiver Alignment.....</b>	<b>205ECT-3</b>
* Understand why receivers are aligned.	
* Describe the techniques for receiver alignment.	
* Perform an alignment on an actual AM receiver.	
<b>Block 2-Lesson 11 - Adjacent Channel Rejection .....</b>	<b>205ECT-3</b>
* Recognize adjacent channel signals.	
* Describe a simple and effective method of measuring adjacent channel rejection.	
* Measure the adjacent channel rejection on an actual AM broadcast receiver.	
<b>Block 3-Lesson 1 - FM Receiver Theory.....</b>	<b>--</b>
* Describe the differences between AM and FM receivers.	
* Describe circuit operation of FM front end circuits (RF amplifier, oscillator and mixer).	
* Describe the operation of the IF section and FM decoder circuits.	
* Describe the operation of the FM stereo transmitter to a basic block diagram level.	
<b>Block 3-Lesson 2 - FM Receiver Operations .....</b>	<b>205ECT-4</b>
* Identify the 10.7 MHz intermediate frequency FM signal.	
* Manually tune the receiver and perform decoder alignment.	
* Assess stereo quality and adjust the IF section.	

<sup>o</sup> indicates separate trainer



**MODEL 205ECT RF COMMUNICATIONS<sup>o</sup> continued  
(Available in Lab/Text Only)**

**Block 4-Lesson 14 - Squelch .....205ECT-5**

- \* Describe how the squelch circuit in the Nida transceiver works.
- \* Define and measure the "squelch threshold".
- \* Measure the squelch threshold in the Nida transceiver.

**Block 5-Lesson 1 - Single Sideband Theory .....--**

- \* Describe single sideband (SSB) operation, including advantages and disadvantages.
- \* Describe basic SSB circuitry.
- \* Describe the Nida Model 205ECT SSB Transceiver to the block diagram level.

**Block 5-Lesson 2 - Balanced Modulators..... 205ECT-7 (2)**

- \* Understand the operation of balanced modulators.
- \* Understand Weaver SSB mixing techniques.

**Block 5-Lesson 3 - SSB Transceiver Alignment..... 205ECT-7 (2)**

- \* Align a Weaver type SSB transceiver.
- \* Identify various SSB waveforms.

**Block 6-Lesson 1 - Narrowband FM (NBFM) Theory .....--**

- \* Describe narrowband FM (NBFM) operation, including advantages and disadvantages.
- \* Describe basic NBFM circuitry.
- \* Describe the Nida Model 205ECT NBFM Transceiver to the block diagram level.

**Block 6-Lesson 2 - Narrowband FM (NBFM) Transceiver Alignment .....205ECT-6**

- \* Align a typical NBFM transceiver.
- \* Identify various NBFM signals and waveforms.

**Block 7-Lesson 1 - Troubleshooting.....--**

- \* Describe the four-phase process of basic troubleshooting.
- \* Recall series and parallel laws.
- \* Understand how to troubleshoot diodes, transistors, capacitors, and power supplies.
- \* Describe TTL and CMOS characteristics and troubleshooting methods.
- \* Understand signal tracing and signal flow.

**Block 7-Lesson 2 - Troubleshooting Exercises**

..... 205ECT-3, 205ECT-4, 205ECT-5, 205ECT-6, 205ECT-7

- \* Apply the four-phase process of basic troubleshooting.
- \* Localize a problem to a particular stage or section.
- \* Identify the bad component within the localized stage or section (Isolation).
- \* Systematically observe a tuned frequency along its signal path (Signal Tracing).
- \* Apply a generated signal to some point along the signal path (Signal Injection).

<sup>o</sup> indicates separate trainer

<b>INDUSTRIAL TECHNOLOGY</b>
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**MODEL 1405 TRANSDUCERS**

<b>7107 - INTRODUCTION TO TRANSDUCERS.....</b>	
* Identify Types of Transducers	
* Understand Transducer Operating Principles.	
<b>7101 - NATURE OF LIGHT .....</b>	
* Describe opto-electronics.	
* Describe the classification of opto-electronics devices.	
* Describe light.	
* Describe photometric and radiometric energy.	
<b>7102 - LIGHT TRANSDUCERS .....</b>	
* Describe the ratings of light sources.	
* Describe incandescent lamps.	
* Describe LEDs.	
* Describe the ratings of light sensors.	
* Describe photocells.	
* Describe photodiodes.	
* Describe photovoltaics.	
* Describe phototransistors	
<b>7103 - LIGHT TRANSDUCER OPERATION .....</b>	<b>251</b>
* Observe the operation of typical light transmitters.	
* Measure the voltage/current characteristics of typical light transmitters.	
* Observe the operation of typical light receivers.	
* Measure the resistance/current/voltage characteristics of typical light receivers.	
<b>7104 - NATURE OF HEAT .....</b>	
* Describe thermo-electronics.	
* Describe the classification of thermo-electronics devices.	
* Describe heat.	
* Describe heat-measuring systems.	
* Describe heat units.	
<b>7105 - HEAT TRANSDUCERS .....</b>	
* Describe 12R heat generators.	
* Describe thermal resistance.	
* Describe heat dissipation.	
* Describe mechanical heat sensors.	
* Describe thermo-couples.	
* Describe thermistors.	
* Describe resistance temperature detectors.	
* Describe solid state sensors.	
<b>7106 - HEAT TRANSDUCER OPERATION .....</b>	<b>252</b>
* Observe the operation of typical heat sensors.	
* Measure the resistance/voltage output of typical heat sensors.	
* Determine the sensitivity of typical heat sensors.	
<b>7201 - NATURE OF MOTION.....</b>	
* Define motion.	
* Describe distance and velocity as related to motion.	
* Describe acceleration as related to motion.	
* Define circular motion.	
* Describe the rotation per minute as related to circular motion.	
* Describe runout rate and runout distance as related to circular motion.	

## MODEL 1405 TRANSDUCERS continued

<b>7202 - MOTION TRANSDUCERS .....</b>	<b>---</b>
* Describe photo interrupter motion sensors.	
* Describe photo reflector motion sensors.	
* Describe magnetic pickup motion sensors.	
* Describe velocity circuits.	
* Describe acceleration circuits.	
* Describe rpm circuits.	
<b>7203 - MOTION TRANSDUCER OPERATION .....</b>	<b>255</b>
* Observe the operation of typical motion sensors.	
* Measure the rpm and velocity output of typical motion sensors.	
* Measure acceleration/deceleration using an oscilloscope.	
<b>7204 - NATURE OF POSITION .....</b>	<b>---</b>
* Define position.	
* Describe positional devices.	
* Describe the characteristics of prime movers.	
* Calculate various output quantities of prime movers.	
<b>7205 - POSITION TRANSDUCERS .....</b>	<b>---</b>
* Describe analog angular position sensors.	
* Describe analog linear position sensors.	
* Describe digital angular position sensors.	
* Describe digital linear position sensors.	
<b>7206 - POSITION TRANSDUCER OPERATION .....</b>	<b>256</b>
* Observe the operation of an encoder position sensor.	
* Measure the output signals in an encoder position sensor.	
* Observe the operational of an increment position sensor.	
<b>LAB/TEXT LESSONS</b>	
<b>1405-Lesson 1 Photoelectric Transducers .....</b>	<b>251</b>
* Analyze the DC characteristics of devices that convert electricity into light.	
* Analyze the DC characteristics of devices that convert light into electricity.	
* Observe the usage of optical fiber as a medium for light transmission.	
<b>1405-Lesson 2 Temperature Transducers .....</b>	<b>252</b>
* Analyze the static thermal sensitivity of 4 basic temperature transducers.	
* Determine the range, linearity, and sensitivity of various thermal transducers using graphical analysis.	
* Analyze dynamic temperature transducer amplifiers, including null type bridge circuits (Optional Activities).	
<b>1405-Lesson 3 Motion Detection .....</b>	<b>255</b>
* Identify the principles of motion transducers.	
* Compute linear and circular motion rates based on a system's mechanical and electrical parameters.	
* Analyze the operation of optical-motion-to-frequency and motion-to-analog-DC-voltage transducer circuits for rpm and velocity.	
* Analyze the operation of optical-motion-to-analog-DC-voltage transducer circuits for acceleration and deceleration (Optional Activities).	
<b>1405-Lesson 4 Position Detection .....</b>	<b>256; 257(opt)</b>
* Identify the principles of analog and digital position-sensing circuits.	
* Compute linear and rotary position based on electrical and mechanical circuit parameters.	
* Analyze the operation of an encoder wheel position-sensing circuit with CCW/CW sensing and digital readout.	
* Analyze the operation of an increment wheel position-sensing circuit with pulse-modulated 2-digit, 7-segment readout (Optional Activities).	
<b>1405-Lesson 5 Digital-to-Analog Conversion (D/A) .....</b>	<b>256,257,258</b>
* Identify the principles of serial or parallel digital to analog conversion terms and circuits.	
* Analyze the operation of a simple R-2R D/A circuit used for increment wheel position sensing.	
* Analyze the operation of a DAC-08 D/A integrated circuit used for increment wheel position sensing (Optional Activities).	

## MODEL 1405 TRANSDUCERS continued

<b>1405-Lesson 6 Analog-to-Digital Conversion (A/D)</b> .....	<b>260; 252(opt)</b>
* Identify the principle of analog-to-digital conversion.	
* Analyze various discrete and IC A/D frequency circuits.	
* Analyze the operation of a 555 timer for A/D frequency conversion.	
* Analyze the operation of a 565 phase locked loop for D/A conversion.	
* Analyze a complete temperature to 7-segment readout A/D count system (Optional Activities).	
<b>1405-Lesson 7 Pulse Modulation and Demodulation</b> .....	<b>261,273</b>
* Analyze the operation of IC PAM and PWM modulation circuits.	
* Analyze the operation of IC PAM and PWM demodulation circuits.	
* Analyze the operation of a PPM modulator/demodulator circuit.	
<b>1405-Lesson 8 Pulse Code Modulation</b> .....	<b>262,269</b>
* Analyze the operation of a pulse code modulator circuit with DC inputs.	
* Analyze the operation of a pulse code demodulator circuit with DC inputs.	
* Analyze a complete PCM system for sample rates and reconstruction errors with AC inputs.	
<b>1405-Lesson 9 Time Division Multiplexing</b> .....	<b>72,271,272</b>
* Understand the basic principles of multiplex-demultiplex in telemetry circuits.	
* Analyze the operation of an IC analog TDMUX circuit.	
* Analyze the operation of an IC analog TDEMUX circuit.	
* Determine the effects of frame and sample rates on DEMUX reconstructed analog waveforms (Optional Activities).	

## MODEL 1432 INTRODUCTION TO MOTORS

<b>T300 - MAGNETISM AND ELECTROMAGNETIC PRINCIPLES</b> .....	<b>182, 183</b>
* Define magnetism.	
* Describe different types of magnetism.	
* Describe relays, motors, transformers, and generators.	
* Observe magnetic poles.	
* Demonstrate temporary magnets.	
* Examine electromagnetic operation.	
* Demonstrate an application of magnetism.	
<b>T305 - MAGNETIC CALCULATIONS</b> .....	<b>-- (Optional)</b>
* Describe properties of magnetic lines of force.	
* Identify magnetic and non-magnetic materials.	
* Identify the characteristics of electromagnetism.	
* Calculate magnetomotive force.	
* Calculate magnetic field strength.	
* Determine force.	
* Determine torque.	
* Understand the operation of magnetic circuits.	
* Understand the effects of magnetic and non-magnetic materials in magnetic circuits.	
* Use magnetization curves for magnetic materials.	
* Examine step-by-step solutions to numerical examples.	
* Define solenoids.	
* Describe the operation of typical solenoid circuits.	
* Introduce numerical examples of simple solenoid circuits.	
<b>T301 - INTRODUCTION TO ROTATING MACHINERY</b> .....	<b>---</b>
* Describe the various devices that are called rotating machinery.	
* Describe speed, torque, counter electromotive force, loads, power, and efficiency in rotating machinery.	

**MODEL 1432 INTRODUCTION TO MOTORS continued**

**T302 - 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.

**T303 - 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.

**T304 - 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.

**MODEL 170 MOTOR CONTROL SYSTEMS**

**T311 - 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.

**T312 - 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.

**T314 - 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.

**T315 - PULSE WIDTH MODULATION & 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.

**T316 - 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.

**T321 - 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.
- \* Analyze motion to frequency for rpm and velocity.
- \* Analyze motion to analog DC for rpm and velocity.

## MODEL 170 MOTOR CONTROL SYSTEMS continued

<b>T322 - ERROR DETECTION AND FEEDBACK .....</b>	<b>177,178,179</b>
* 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.	
<b>T323 - TROUBLESHOOTING CLOSED LOOP SYSTEMS .....</b>	<b>177,178,179</b>
* 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.	
<b>T331 - POSITION DETECTION .....</b>	<b>177,178,179</b>
* 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.	
<b>T332 - PROPORTIONAL, INTEGRAL, &amp; DERIVATIVE (PID) CONTROL SYSTEM.....</b>	<b>---</b>
* 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.	
<b>T333 - PID CONTROL SYSTEM EXPERIMENT .....</b>	<b>177,178,179</b>
* Identify the Proportional, Integral and Derivative circuits.	
* Adjust the PID proportional gain.	
* Adjust the PID integral reset control.	
* Adjust the PID derivative rate control.	

MODEL 5050 PROGRAMMABLE LOGIC CONTROLLERS<sup>o</sup>

<b>N101 -INTRODUCTION TO PLCs .....</b>	<b>5050-1</b>
* Recognize a basic PLC block diagram.	
* Identify the basic PLC functions.	
* Identify PLC principles of operation.	
* Recognize and understand a simple ladder logic diagram.	
* Recognize the symbols used in a basic ladder logic diagram.	
* Use the PLC trainer to control LEDs.	
* Use the PLC trainer to control the motor.	
* Understand how the PLC's operation changes by changing the ladder logic program.	
<b>N105 - PLC TRAINER FAMILIARIZATION .....</b>	<b>5050-1</b>
* Identify the power requirements for the Nida Model 5050 PLC Trainer.	
* Recognize trainer controls, switches, and indicating devices.	
* Identify an experiment card.	
* Describe insertion and removal procedures.	
* Perform procedures to start an experiment.	
* Insert and remove an experiment card.	
* Perform procedures to end an experiment.	

<sup>o</sup> indicates separate trainer

MODEL 5050 PROGRAMMABLE LOGIC CONTROLLERS<sup>o</sup> continued

<b>N102 - PLC HARDWARE</b> .....	<b>5050-1</b>
* Understand the functions of I/O modules.	
* Identify the different types of I/O modules.	
* Know the basic operation of both discrete and analog I/O modules.	
* Know the function of the processor module's microprocessor (CPU).	
* Describe a memory map and the different memory modules.	
* Know the purpose of the communications circuitry.	
* Understand the scan cycle.	
* Use an analog I/O module for analog input and output devices.	
* Use an analog I/O module for an analog input device with a relay	
* Observe the processor modules operation using the scan cycle.	
<b>N103 - PLC PROGRAMMING</b> .....	<b>5050-1</b>
* Understand the arrangement of input instruction for AND and OR operations.	
* Identify different input instruction.	
* Identify different output instructions.	
* Use a four step process to develop an organized programming strategy.	
* Identify the correct ladder logic program for a specified process.	
* Understand the basic operation of counter instructions.	
* Use the sequencer instruction to display the contents of a data file.	
* Observe an application of the sequencer instruction.	
<b>N104 - PLC TROUBLESHOOTING</b> .....	<b>5050-1, 5050-2</b>
* Use a four-step process to develop an organized troubleshooting strategy.	
* Identify areas of a PLC controlled system most and least likely to fail.	
* Observe and understand the normal operation of a PLC controlled system.	
* Recognize a faulty PLC controlled system.	
* Identify the possible causes of the faulty system.	
<b>N200 – RSLOGIX FAMILIARIZATION</b> .....	--
* Understand the different file types associated with the PLC.	
* Recognize the importance of proper configuration settings.	
* Understand the process for creating ladder programs.	
* Develop an understanding of commands used for ladder program development.	
* Identify the different modes of operation of the PLC.	
* Understand the usage of each processor mode.	
* Understand the steps required to transfer a file to and from the PLC.	
<b>N201 - APS FAMILIARIZATION</b> .....	--
* Understand the different file types associated with the PLC.	
* Recognize the importance of proper configuration settings.	
* Understand the process for creating ladder programs.	
* Develop an understanding of commands used for ladder program development.	
* Understand the usage of each processor mode.	
* Understand the steps required to transfer a file to and from a PLC.	
<b>N202 - BIT INSTRUCTIONS</b> .....	<b>5050-1</b>
* Understand the concepts of bit instructions.	
* Describe the operation of bit instructions.	
* Demonstrate the usage of bit instructions.	
<b>N203 - TIMER AND COUNTER INSTRUCTIONS</b> .....	--
* Understand the concepts of timer instructions.	
* Describe the operation of timer instructions.	
* Understand the concepts of counter instructions.	
* Describe the operation of counter instructions.	
* Demonstrate the usage of timer and counter instructions.	

<sup>o</sup> indicates separate trainer

MODEL 5050 PROGRAMMABLE LOGIC CONTROLLERS<sup>o</sup> continued

**N204 - I/O AND INTERRUPT INSTRUCTIONS**.....--  
 \* Understand the concepts of I/O instructions.  
 \* Describe the operation of I/O instructions.  
 \* Understand the concepts of Interrupt instructions.  
 \* Describe the operation of Interrupt instructions.  
 \* Demonstrate the usage of I/O instructions.

**N205 - COMPARISON INSTRUCTIONS** .....--  
 \* Understand the concepts of comparison instructions.  
 \* Describe the operation of comparison instructions.  
 \* Demonstrate the usage of comparison instructions.

**N206 - MATH INSTRUCTIONS** .....--  
 \* Understand the concepts of math instructions.  
 \* Describe the operation of math instructions.  
 \* Demonstrate the usage of math instructions.

**N207 - MOVE AND LOGICAL INSTRUCTIONS**.....--  
 \* Understand the concepts of move instructions.  
 \* Describe the operation of move instructions.  
 \* Understand the concepts of logical instructions.  
 \* Describe the operation of logical instructions.  
 \* Demonstrate the usage of move and logical instructions.

**N208 - FILE INSTRUCTIONS**.....--  
 \* Understand the concepts of the File instructions.  
 \* Describe the operation of File instructions.  
 \* Demonstrate the usage of File instructions.

**N209 - BIT SHIFT, FIFO AND LIFO INSTRUCTIONS**.....--  
 \* Understand the concepts of the Bit Shift, FIFO and LIFO instructions.  
 \* Describe the operation of the Bit Shift, FIFO and LIFO instructions.  
 \* Demonstrate the usage of Bit Shift instructions.

**N210 - SEQUENCER INSTRUCTIONS** .....--  
 \* Understand the concepts of the Sequencer Instructions.  
 \* Describe the operation of the Sequencer Instructions.  
 \* Demonstrate the usage of Sequencer Instructions.

**N211 - CONTROL INSTRUCTIONS** .....--  
 \* Understand the concepts of the Control Instructions.  
 \* Describe the operation of the Control Instructions.  
 \* Demonstrate the usage of Control Instructions.

**N301 - TRAFFIC LIGHT CONTROL SCENARIO** .....5050-1, 5050-3  
 \* Develop ladder logic programs to satisfy the needs of the traffic light control scenario.  
 \* Demonstrate knowledge of programming the PLC.

**N302 - ELEVATOR CONTROL SCENARIO**.....5050-1, 5050-4  
 \* Develop ladder logic programs to satisfy the needs of the elevator control scenario.  
 \* Demonstrate knowledge of programming the PLC.

**N303 - SECURITY CONTROL SCENARIO** ..... 5050-5  
 \* Develop ladder logic programs to satisfy the needs of the security system scenario.  
 \* Demonstrate knowledge of programming the PLC.

**N304 - AMUSEMENT RIDE SCENARIO** .....5050-1, 5050-6  
 \* Develop ladder logic programs to satisfy the needs of the amusement ride scenario.  
 \* Demonstrate knowledge of programming the PLC.

**N305 - POWER MANAGEMENT SYSTEM SCENARIO** ..... 5050-7  
 \* Develop ladder logic programs to satisfy the needs of the power management system scenario.  
 \* Demonstrate knowledge of programming the PLC.

<sup>o</sup> indicates separate trainer

**MODEL 1442 TEMPERATURE CONTROL SYSTEMS  
(Available in Lab/Text Only)**

- Lesson 1 - Temperature Transducers and Control ..... 189,190**
- \* Identify the principles and properties of temperature measurement and heat dissipation.
  - \* Understand the principles of basic heat sensors and temperature transducers.
  - \* Analyze the operation of a solid-state (IC) temperature transducer and control system.
- Lesson 2 - Temperature Display and Warning..... 189,190,191**
- \* Describe the process of a basic digital temperature display system.
  - \* Describe the process of an audio/visual temperature warning system.
  - \* Analyze the operation of a temperature-activated warning system.

**HYDRAULIC/PNEUMATIC SYSTEMS**

- TC01 - 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.
- TC02 - INTRODUCTION TO PNEUMATIC SYSTEMS.....--**
- \* Describe Pneumatics.
  - \* Understand the concept of Pneumatics.
  - \* Realize Pneumatic applications.
  - \* Understand basic Pneumatic applications.
  - \* Describe a basic Pneumatic System and its components.
  - \* Describe different system components and their schematic symbols.
- TC03 - 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.
- TC04 - HYDRAULIC AND PNEUMATIC PUMPS.....--**
- \* Recognize the types of pumps used in hydraulic systems.
  - \* 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 pumps.
- TC05 - TROUBLESHOOTING HYDRAULIC AND PNEUMATIC SYSTEMS .....--**
- \* Recognize the symptoms of common hydraulic and pneumatic component failures.
  - \* Demonstrate component troubleshooting procedures.

**SYNCHRO/SERVO CIRCUITS**

- 6401 - INTRODUCTION TO SYNCHROS.....--**
- \* State the definition of a synchro.
  - \* Identify synchro schematic symbols.
  - \* Identify the basic design of a synchro.
  - \* Demonstrate knowledge of the functions of the Torque Transmitter and the Torque Receiver.
- 6402 - 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.
- 6403 - 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.

SYNCHRO/SERVO CIRCUITS continued

**6404 - 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.

**6405 - 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.

<b>TRANSPORTATION</b>
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**MODEL 1431 AUTOMOTIVE ELECTRONICS**

- L101 - INTRODUCTION TO THE AUTOMOBILE.....--**
- \* Understand the history of the automobile.
  - \* Identify nine automobile systems.
  - \* Identify careers associated with the automobile.
- L102 - ELECTRICAL SYSTEM .....--**
- \* 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.
- L103 - CHARGING and IGNITION SYSTEM.....--**
- \* Understand how the alternator works to recharge the battery.
  - \* Understand how the ignition coil works to ignite the fuel in the engine.
- L104 - FUEL SYSTEM.....--**
- \* Understand how a carburetor functions.
  - \* Understand how fuel injection functions.
- L105 - THE ENGINE.....--**
- \* Identify basic engine parts.
  - \* Understand how the engine functions.
  - \* Understand how engines are classified.
- L106 - THE COOLING SYSTEM.....--**
- \* Identify the parts of the automobiles cooling system.
  - \* Understand the function of the cooling system.
- L107 - THE HYDRAULIC SYSTEM .....--**
- \* Understand the automobiles braking system.
  - \* Understand the automobiles power steering system.
- L108 - AIR CONDITIONING AND HEATING SYSTEM.....--**
- \* 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.
- L109 - 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.
- L110 - BODY DESIGN.....--**
- \* Identify the automobile body parts.
  - \* Understand the function of the automobile body parts.
- L201 - AUTOMOTIVE SAFETY .....--**
- \* Identify safety habits associated with electrical and other equipment.
  - \* Identify hazards associated with the automobile.
- L202 - TRAINING EQUIPMENT FAMILIARIZATION ..... 702**
- \* Identify the power requirements for the training hardware.
  - \* Identify the test console controls, switches, and indicators.
  - \* Identify an experiment card and practice installing/removing it.
  - \* Practice making power supply voltage and current selections.
- L203 - METRIC NOTATION .....--**
- \* Convert between decimal and powers of ten.
  - \* Convert between decimal and metric prefixes.
  - \* Adding, subtracting, multiplying and dividing powers of ten.
  - \* Adding, subtracting, multiplying and dividing metric prefixes.
  - \* Understand metric notation applications in automobile.

## MODEL 1431 AUTOMOTIVE ELECTRONICS continued

<b>L204 - VOLTAGE, CURRENT AND RESISTANCE .....</b>	<b>--</b>
* 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 the unit of measure.	
* Define the relationship between voltage and potential difference.	
* Define current and the ampere as the unit of measure.	
* Describe a conductor and the behavior of electrons in a conductor.	
* Describe an insulator and the behavior of electrons in an insulator.	
* Identify the purpose of a resistor.	
* Identify the unit of resistance as the ohm.	
<b>L205 - SWITCHES and PROTECTIVE DEVICES .....</b>	<b>--</b>
* Identify the purpose of a switch.	
* Identify switch schematic symbols.	
* Identify schematic symbols for fuses and circuit breakers.	
* Identify a fusible link.	
<b>L301 - INTRODUCTION TO MULTIMETERS .....</b>	<b>--</b>
* Describe the purpose of a multimeter.	
* Identify the electrical quantities measured by multimeters.	
* Identify analog and digital multimeter displays.	
* Describe the five functional sections of multimeters.	
* Describe the purpose of each functional section.	
* Read a analog meter scale.	
* Compare meter readings to selected voltages.	
<b>L302 - MULTIMETER USE .....</b>	<b>701</b>
* Understand the operation of an analog multimeter.	
* Understand the steps to make a proper measurement using an analog multimeter.	
* Understand the operation of a digital multimeter.	
* Understand the steps to make a proper measurement using a digital multimeter.	
<b>L303 - VOLTAGE MEASUREMENTS .....</b>	<b>701</b>
* Describe how to set-up a multimeter to measure voltage.	
* Describe how to read a multimeter's display when measuring voltage.	
* State the precautions to observe when making voltage measurements.	
* Make voltage measurements with an analog and digital multimeter.	
<b>L304 - CURRENT MEASUREMENTS .....</b>	<b>701</b>
* Describe how to set-up a multimeter to measure current.	
* Describe how to read a multimeter's display when measuring current.	
* State the precautions to observe when making current measurements.	
* Make current measurements with a multimeter.	
<b>L305 - RESISTANCE MEASUREMENTS .....</b>	<b>708</b>
* Describe how to set-up a multimeter to measure resistance.	
* Describe how to read a multimeter's display when measuring resistance.	
* State the precautions to observe when making resistance measurements.	
* Make resistance measurements with a multimeter.	
<b>L306 - INTRODUCTION TO THE OSCILLOSCOPE .....</b>	<b>708,708</b>
* Describe the purpose of an oscilloscope.	
* Identify the quantities measured by an oscilloscope.	
* Describe single trace and dual trace oscilloscopes.	
* Identify the four main functional sections of an oscilloscope.	
* Describe the purpose of each control and switch on an oscilloscope.	
* Set up an oscilloscope for normal operation.	
* Use an oscilloscope to analyze a waveform.	
* Measure voltage using an oscilloscope.	

## MODEL 1431 AUTOMOTIVE ELECTRONICS continued

<b>L401 - OHM'S LAW AND POWER .....</b>	<b>701</b>
* 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.	
<b>L402 - SERIES CIRCUITS AND THE AUTOMOBILE .....</b>	<b>702</b>
* 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.	
<b>L403 - PARALLEL CIRCUITS.....</b>	<b>703</b>
* Identify a parallel circuit.	
* Recognize that the applied voltage is the same across each branch.	
* Calculate the current in each branch of a parallel circuit.	
* Calculate the 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.	
<b>L404 - SERIES - PARALLEL CIRCUITS .....</b>	<b>704</b>
* 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 in a series-parallel circuit.	
* Measure voltage in a series-parallel circuit.	
<b>L405 - VOLTAGE DIVIDER CIRCUITS.....</b>	<b>705</b>
* 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.	
* Identify and measure various characteristics of a voltage divider circuit.	
<b>L406 - RELAY OPERATION .....</b>	<b>706</b>
* 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.	
<b>L407 - ALTERNATING CURRENT .....</b>	<b>--</b>
* Define alternating current	
* Identify an AC sine wave.	
* Define frequency and cycle.	
* Describe Hertz.	
* Determine wavelength of a sine wave.	
* Determine the period of a sine wave.	
<b>L408 - MAGNETISM, RELAYS AND METERS .....</b>	<b>--</b>
* Define magnetism.	
* Identify the characteristics of magnets.	
* Define the laws of magnetic attraction and repulsion.	
* Describe properties of magnetic lines of force.	
* Describe magnetic and non-magnetic materials.	
* Define electromagnetism.	
* Identify the characteristics of electromagnetism.	
* Describe the operation of a relay.	
* Describe the operation of a magnetic circuit.	
* Describe the operation of a meter.	

## MODEL 1431 AUTOMOTIVE ELECTRONICS continued

<b>L501 - INDUCTOR OPERATION .....</b>	<b>707</b>
* Identify types of inductors.	
* Describe the current opposing characteristics of an inductor.	
* Identify the unit of measure of an inductor.	
* Identify the characteristics of inductance.	
* Identify mutual inductance.	
* Examine the characteristics of an inductor.	
* Examine the common operations of an inductor.	
<b>L502 - CAPACITOR OPERATION .....</b>	<b>707</b>
* Identify types of capacitors.	
* Describe charge and discharge.	
* Identify the schematic symbol of a capacitor.	
* Identify the characteristics of capacitance.	
* Identify the unit of measure for capacitance.	
* Examine the circuit characteristics of a capacitor.	
<b>L503 - DIODE OPERATION .....</b>	<b>708</b>
* Describe the purpose of a diode.	
* Recognize diode schematic symbols and use reference designators.	
* Describe the uses of diodes.	
* Analyze diode characteristics in a circuit.	
<b>L504 - TRANSISTOR OPERATION .....</b>	<b>709</b>
* Describe the purpose of a transistor.	
* Describe types of transistors.	
* Identify transistor schematic symbols.	
* Identify leads on transistors.	
* Analyze transistor characteristics in a circuit.	
<b>L505 - AND GATES .....</b>	<b>710</b>
* Identify AND operation.	
* Identify AND logic symbols.	
* Identify AND logic schematic symbols.	
* Construct an AND gate truth table.	
* Identify inputs and outputs.	
* Analyze an AND gate circuit operation.	
<b>L506 - OR GATES .....</b>	<b>711</b>
* Identify OR operation.	
* Identify OR logic symbols.	
* Identify OR logic schematic symbols.	
* Construct an OR gate truth table.	
* Identify inputs and outputs.	
* Analyze an OR gate circuit operation.	
<b>L507 - NOT GATES .....</b>	<b>712</b>
* Identify NOT operation.	
* Identify NOT logic symbols.	
* Identify NOT logic schematic symbols.	
* Construct a NOT gate truth table.	
* Identify inputs and outputs.	
* Analyze a NOT gate circuit operation.	
<b>L508 - INTRODUCTION TO COMBINATIONAL CIRCUITS .....</b>	<b>713B</b>
* 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.	

**MODEL 1431 AUTOMOTIVE ELECTRONICS continued**

**L601 - 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.

**L602 - STARTING SYSTEMS** ..... 715

- \* Describe the use of the starting system.
- \* Examine the characteristics of different starting system components.
- \* Examine the operation of a starting system.

**L603 - 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.

**L604 - CHARGING SYSTEMS** ..... 708

- \* Identify the components and characteristics of charging systems.
- \* Examine the operation of the diodes in a charging system.

**L605 - FUEL INJECTION** ..... 716

- \* Describe the use of fuel injectors.
- \* Examine the characteristics of different types of fuel injectors.
- \* Examine the operation and timing of fuel injection in an automobile.

**L606 - 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 cooling 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.

**MODEL 1470 TRAILER WIRING**

**L801 - 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.

**MODEL 1471 CAR AUDIO SYSTEMS**

**L701 - 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.

**L702 - 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 amounts of wire and connecting the devices together correctly.

MODEL 1438 AVIONICS

- Z101 - INTRODUCTION TO OPERATIONAL SYSTEMS .....**
- \* Understand the history of aircraft.
- \* Identify aircraft operational systems.
- \* Identify careers associated with aircraft.
- Z102 - FLIGHT CONTROL SYSTEMS.....**
- \* Define and describe the primary flight controls of an aircraft.
- \* Define and describe the secondary flight controls of an aircraft.
- \* Define and describe the auxiliary flight controls of an aircraft.
- \* Identify the basic autopilot components.
- \* Describe the principles of operation of the autopilot.
- Z103 - IGNITION SYSTEMS.....**
- \* Identify the types of ignition systems.
- \* Describe spark discharge and coil ignition systems.
- \* Describe the types of magneto ignition systems.
- \* Describe gas turbine ignition systems.
- \* Describe the principles of operation of ignition systems.
- \* State the advantages and disadvantages of high and low tension magneto systems.
- Z104 - FUEL SYSTEMS .....**
- \* Describe the characteristics and properties of aviation fuels.
- \* Identify the effects of fuel system contamination.
- \* Describe the Gravity Type Fuel System.
- \* Describe the Pump Type Fuel System.
- \* Describe the operational characteristics of the fuel system components.
- \* Describe the operation of a carburetor.
- \* Describe the operation of fuel injection.
- Z105 - NAVIGATIONAL SYSTEMS .....**
- \* Describe the operation of the VHF Omnidirectional System (VOR).
- \* Describe the operation of the Automatic Direction Finder System (ADF).
- \* Describe the operation of Distance Measuring Equipment (DME).
- \* Identify TACAN and its use with DME.
- \* Describe the operation of the Instrument Landing System (ILS).
- \* Describe the operation of marker beacons.
- \* Identify the compass and its purpose.
- \* Describe the operation of the VLF/OMEGA Navigational System.
- \* Describe the operation of the Global Positioning System (GPS).
- \* Describe the operation of the Inertial Navigational System (INS).
- Z106 - AIRCRAFT SUPPORT SYSTEMS.....**
- \* Identify and describe the basic types of aircraft landing systems.
- \* Identify and describe the operating principles of the aircraft braking system.
- \* Describe the basic operating principles of the de-icing system.
- \* Identify and describe the basic types of aircraft lighting systems.
- Z107 - PROPULSION SYSTEMS.....**
- \* Describe the principles and operation of an Internal Combustion.
- \* Describe the principles and operation of a Jet Propulsion.
- \* Understand Propeller Fundamentals.
- Z108 - AIRCRAFT INSTRUMENTS .....**
- \* Identify the classifications of aircraft instruments.
- \* Define and describe basic aircraft instruments.
- \* Describe the various operating principles of aircraft instruments.
- Z201 - BASIC POWER DISTRIBUTION .....** 734,735
- \* Describe the operation of a Basic Power Distribution System.
- \* Identify the basic requirements for a Power Distribution System.
- \* Identify the various components of Basic Power Distribution Systems.
- \* Observe the operation of a Basic Power Distribution System.
- \* Observe faults in a Basic Power Distribution System.

## MODEL 1438 AVIONICS continued

<b>Z202 - SPLIT BUS POWER DISTRIBUTION</b> .....	<b>735,736</b>
* Understand the structure of a Split-Bus Distribution System.	
* Understand the benefits of the Split-Bus Distribution System.	
* Identify the different Busses of the Split Bus Distribution System.	
* Observe the operation of a basic Split-Bus Distribution System.	
* Observe faults in a basic Split-Bus Distribution System.	
<b>Z203 - THREE PHASE POWER GENERATION</b> .....	<b>229,230,290</b>
* Describe the operation of a typical power supply.	
* Describe 3 Phase 400 Hz power and its advantages.	
* Describe a 3 Phase, 400 Hz Power Supply.	
* Measure signals in a 3 Phase, 400 Hz Power Supply.	
* Troubleshoot a faulted 3 Phase, 400 Hz Power Supply.	
<b>Z204 - PWM SWITCHING POWER SUPPLY</b> .....	<b>85A,290</b>
* Describe basic switching power supplies.	
* Describe pulse width modulated switching power supplies.	
* Describe a pulse width modulated switching power supply circuit.	
* Measure signals in a pulse width modulated switching power supply circuit.	
* Troubleshoot a faulted pulse width modulated switching power supply circuit.	
<b>Z301 - MASTER WARNING and ANNUNCIATOR SYSTEMS</b> .....	<b>735,737</b>
* Describe the operation of the master warning annunciator system.	
* Identify annunciator system applications.	
* Observe normal system operation.	
* Identify faulty system operation.	
<b>Z302 - ENGINE MONITORING and CREW ALERTING SYSTEMS</b> .....	<b>--</b>
* Describe the systems and components of the aircraft monitoring and alerting systems.	
* Describe the different types of aircraft built-in fault and maintenance test equipment.	
<b>Z303 - FIRE WARNING and EXTINGUISHING SYSTEMS</b> .....	<b>738</b>
* Identify different types of fire warning systems.	
* Explain the basic operation of each type of system.	
* Explain the distinct fire protection requirement for each area of the aircraft.	
* Describe the different types of fire extinguishing agents.	
* Explain the basic operation of the fire extinguishing system.	
* Identify a normal operating fire warning system.	
* Identify a faulty operating fire warning system.	
<b>Z304 - ENVIRONMENTAL CONTROL and WARNING SYSTEMS</b> .....	<b>731,732,733</b>
* Describe a typical pneumatic system.	
* Describe a typical air conditioning system.	
* Describe a typical pressure control system.	
* Observe the operation of a typical thermostat and trim valve in an air conditioning system.	
* Isolate a fault in a typical thermostat and trim valve in an air conditioning system.	
<b>Z401 - INTRODUCTION TO DATA COMMUNICATIONS</b> .....	<b>265,266,284</b>
* Define terminology commonly used in conjunction with data communication systems.	
* Identify systems & instrumentation including fax, modems, and computers that use data communication.	
* Identify basic operating characteristics involved in data communications.	
* Identify the operational characteristics of protocol.	
* Define protocol terminology to include bit, byte, start, parity, stop, baud and frame.	
* Describe how data communication systems use protocol to transfer data.	
* Describe the relationship between protocol and serial, parallel transmission and reception using the International Standard Organization (ISO) reference model.	
* Observe the transmission and reception of serial data.	
* Monitor, start, parity, baud, and stop bit information during a controlled data transfer.	
* Identify the effects of protocol mismatch on transmitted data.	

## MODEL 1438 AVIONICS continued

<b>Z402 - RS-232-C LINE INTERFACE</b> .....	<b>232 (2)</b>
* Identify RS-232-C Electrical, Mechanical and functional characteristics as they relate to protocol.	
* Identify RS-232-C schematic pin out.	
* Describe the function of a UART and USART.	
* Measure RS-232-C line interface voltages while data is being transferred.	
* Measure RS-232-C line interface voltages while data is being received.	
* Isolate malfunctions in an operational RS-232-C Communication System.	
<b>Z403 - RS-485 LINE INTERFACE</b> .....	<b>232 (2)</b>
* Identify RS-485 electrical characteristics.	
* Describe signal conditioning methods used by RS-485 line driver circuits when transmitting and receiving.	
* Measure RS-485 line interface voltages while data is being transferred.	
* Isolate malfunctions in an operational RS-485 Communication System.	
<b>Z404 - INTRODUCTION TO BUS SYSTEMS</b> .....	<b>284,267,268</b>
* Identify the 4 basic parts of a bus system.	
* Describe the purpose of each part of the bus system.	
* Define terminology used in conjunction with bus system protocol.	
* Describe the operational characteristics of a basic bus system.	
* Describe the operational characteristics of tri-state devices.	
* Measure basic bus system signals.	
* Measure the output of a tri-state device.	
<b>Z405 - IEEE 488 DATA BUS</b> .....	--
* Identify 4 basic operations performed by the 4041 controller.	
* Define program development, instrument control, data processing, and display storage.	
* Describe and interpret different message formats.	
* Describe and interpret different word structures.	
<b>Z406 - ARINC 429 DATA BUS</b> .....	--
* Identify basic principles of operation related to the ARINC 429 data bus system specifications.	
* Describe the ARINC 429 Mark 33 Digital Information.	
* Describe and interpret different message formats.	
* Describe and interpret different word formats.	
<b>Z407 - ARINC 629</b> .....	--
* Describe the different components associated with the ARINC 629 data bus system.	
* Identify basic principles of operation related to the ARINC 629 data bus system specifications.	
* Describe and interpret different data formats.	
* Describe and interpret different word formats.	

<b>SUPPORTING CURRICULUM</b>
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**MATHEMATICS****BASIC MATH****0101 - ADDING and SUBTRACTING** .....

- \* Describe the decimal number system.
- \* Describe the whole number line.
- \* Describe addition and add whole numbers.
- \* Describe subtraction and subtract whole numbers.

**0102 - MULTIPLYING and DIVIDING** .....

- \* Describe multiplication and multiply whole numbers.
- \* Describe division and divide whole numbers.

**0103 - FRACTIONS** .....

- \* Proper fractions.
- \* Improper fractions.
- \* Mixed numbers.
- \* Conversion between improper fractions and whole or mixed numbers.
- \* Conversion between mixed numbers and improper fractions.
- \* Reduction of fractions to the lowest terms.

**0104 - FRACTION OPERATION** .....

- \* Adding fractions.
- \* Subtracting fractions.
- \* Multiplying fractions.
- \* Dividing fractions.

**0105 - DECIMAL FRACTIONS** .....

- \* Description of decimal fractions.
- \* Positional values in decimal fractions.
- \* Conversion between decimal fractions and standard fractions.
- \* Conversion between standard fractions and decimal fractions.
- \* Add, subtract, multiply, and divide decimal fractions.

**0106 - SIGNED NUMBERS** .....

- \* Description of signed numbers.
- \* Description of the signed number line.
- \* Determination of the relationship between two signed numbers.
- \* Add, subtract, multiply, and divide signed numbers.

**0107 - PERCENTS** .....

- \* Description of percents.
- \* Conversion between percents and decimal numbers.
- \* Conversion between decimal numbers and percents.
- \* Calculation of percentage part.
- \* Calculation of percentage rate.
- \* Calculation of percentage base.

**0108 - EXPONENTS and SQUARE ROOTS** .....

- \* Description of exponents.
- \* Calculation of the value of numbers with exponents.
- \* Description of Square Roots.
- \* Calculation of Square Roots.

**0109 - METRIC NOTATION** .....

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

## MATHEMATICS continued

**ALGEBRA****0201 - FUNDAMENTALS of ALGEBRA.....--**

- \* Real numbers.
- \* Four fundamental operations of real numbers.
- \* Real number variables.
- \* Real number order of operations.
- \* Combination of variables.
- \* Real number properties.
- \* Closure property.
- \* Commutative property.
- \* Associative property.
- \* Identity property.
- \* Inverse property.
- \* Distributive property.

**0202 - LINEAR EQUATIONS.....--**

- \* Addition and Subtraction Laws.
- \* Solving  $X+A=B$  type of equations.
- \* Solving  $X-A=B$  type of equations.
- \* Multiplication and Division Laws.
- \* Solving  $X*A=B$  type of equations.
- \* Solving  $X/A=B$  type of equations.
- \* Word problem formulas.
- \* Equations from word problems.
- \* Solving for unknown quantities.

**0203 - SOLVING LINEAR EQUATIONS.....--**

- \* Using basic laws of equations to solve linear equations.
- \* Solve problems in the form of  $AX+B=C$  and  $AX-B=C$ .
- \* Solve problems in the form of  $X/A+B=C$  and  $X/A-B=C$ .
- \* Use the four-step process to solve word problems.
- \* Solve word problems in the format of linear equations.

**0204 - EXPONENTS and MONOMIALS.....--**

- \* Define exponents.
- \* Multiply and divide powers with the same base.
- \* Raise a power to a power.
- \* Raise a product or a quotient to a power.
- \* Description of monomials.
- \* Add, subtract, multiply and divide monomials.
- \* Use the four-step process to solve problems.
- \* Solve word problems that use monomials.

**0205 - POLYNOMIALS.....--**

- \* Definition of polynomials.
- \* Adding and subtracting polynomials.
- \* Multiplying monomials and polynomials.
- \* Multiplying polynomials.
- \* Description of special binomials products.
- \* Dividing polynomials by monomials.

**0206 - FACTORING POLYNOMIALS.....--**

- \* Factor by finding the greatest common factor.
- \* Factor by grouping.
- \* Factoring trinomials.
- \* Factor by recognizing special binomial factors.
- \* Solve polynomial equations by factoring.
- \* Quadratic equations and quadratic formulas.
- \* Solve polynomial equations using the quadratic formula.
- \* Solve word problems.

## MATHEMATICS continued

**ALGEBRA continued****0207 - ROOTS and RADICALS** .....

- \* Factoring radicand terms.
- \* Simplifying radicals using Product Property of Roots and Quotient Property of Roots.
- \* Rationalize denominators.
- \* Multiplication, division, addition, and subtraction of radicals.
- \* Use of the Squaring Property of Equations to solve for the unknown.
- \* Solve equations containing one and two radical expressions.

**0208 - GRAPHS** .....

- \* Description of the rectangular coordinate system.
- \* Location of points on the rectangular coordinate system.
- \* Location of the coordinates of a point on the rectangular coordinate system.
- \* Graphing linear equations.
- \* Finding the slope of a line.
- \* Finding the equation of a line vide powers of ten.

**0209 - SYSTEMS of LINEAR EQUATIONS** .....

- \* Definition of a system of equations.
- \* Solve systems of equations by graphing.
- \* Identification of consistent, inconsistent, and dependent systems by their graphs.
- \* Solve systems of equations by substitution.
- \* Identification of consistent, inconsistent, and dependent systems by the results of substitution.
- \* Solve systems of equations by addition.
- \* Finding the slope of a line.
- \* Identification of consistent, inconsistent, and dependent systems by the results of Addition.

**0210 - 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 various statistical histograms.

**TRIGONOMETRY****0301 - FUNDAMENTALS of TRIGONOMETRY** .....

- \* Positive and negative angles.
- \* Acute, obtuse, complementary, and supplementary angles.
- \* Degrees, minutes, and seconds units of angle measurement.
- \* Addition and subtraction of angles.
- \* Convert degrees to radians and radians to degrees.

**0302 - TRIGONOMETRIC FUNCTIONS** .....

- \* Determine the unknown angle in a right triangle.
- \* Use the Pythagorean Theorem to determine the unknown side of a right triangle.
- \* Find the sine, cosine, tangent, cosecant, secant, and cotangent of a given angle.
- \* Identify the relationship between the unit circle and the trigonometric functions.

**0303 - GRAPHING TRIGONOMETRIC FUNCTIONS** .....

- \* Basic graphs for the six trigonometric functions.
- \* Period and amplitude.
- \* Sine and cosine functions amplitude and period.
- \* Determine the phase shift of a trigonometric function.

**0304 - TRIGONOMETRIC IDENTITIES** .....

- \* Reciprocal and ratio identities.
- \* Trigonometric function of an angle using reciprocal or ratio identities.
- \* Trigonometric function of an angle using the Pythagorean and related identities.

## MATHEMATICS continued

**TRIGONOMETRY continued****0305 - ANGLE FORMULAS**.....--

- \* Sum and difference formulas for sine, cosine, and tangent.
- \* Double angle formulas for sine, cosine, and tangent.
- \* Power reducing formulas for sine, cosine, and tangent.
- \* Half angle formulas for sine, cosine, and tangent.

**0306 - INVERSE TRIGONOMETRIC FUNCTIONS**.....--

- \* Methods for finding the inverse trigonometric functions.
- \* Domains, ranges, and graphs of arcsine, arccosine, and arctangent.

**0307 - APPLICATIONS of TRIGONOMETRY**.....--

- \* Use of the Law of Sines to find the missing parts of oblique triangles.
- \* Understanding the four possibilities resulting from the ambiguous case.

**0308 - GRAPHING POLAR EQUATIONS**.....--

- \* Definition of the polar coordinate pair.
- \* Graphing polar coordinates.

**0309 - CONIC SECTIONS: CIRCLES and PARABOLAS**.....--

- \* General equation of a circle.
- \* Determining the center and radius of a circle from a given equation.
- \* Determining the equation of a circle given the center and radius.
- \* General equation for a parabola.
- \* Determining the focus, vertex, and directrix of a parabola from a given equation.
- \* Determining the equation of a parabola given the focus, vertex, and/or directrix.

**0310 - CONIC SECTIONS: ELLIPSES and HYPERBOLAS**.....--

- \* General equation of an ellipse.
- \* Determining the center, vertices, and foci of an ellipse from a given equation.
- \* Determining the equation for an ellipse given the center, vertices, and foci.
- \* General equation for hyperbolas.
- \* Determining the center, vertices, foci, and asymptotes of a Hyperbola from a given equation.
- \* Determining the equation of a hyperbola given the center, vertices, and foci.

**CALCULUS****0401 - FUNDAMENTALS of CALCULUS**.....--

- \* Apply the slope formula to particles moving along straight paths.
- \* Recognize functions and identify the domain and range.
- \* Find the composite of two given functions.
- \* Find the average rate of change of a function.
- \* Understand the transition as a secant line becomes a tangent line when delta goes to 0.
- \* Find the slope at a given point on a curve.

**0402 - LIMITS**.....--

- \* The concept of limits.
- \* Right- and left-hand limits.
- \* Find limit values.
- \* Sandwich property and its application to finding limits of trigonometric functions.

**0403 - LIMITS: CONTINUITY and INFINITY**.....--

- \* Identification of continuous functions.
- \* Continuity at a point and an interval.
- \* Infinity as a limit.
- \* Identify the limit form as the variable approaches infinity.
- \* Find limits involving infinity.

## MATHEMATICS continued

**CALCULUS continued****0404 - DERIVATIVES** .....

- \* Definition of a derivative.
- \* Find derivatives using the constant rule, power rule, and sum rule.
- \* Find derivative of the product and quotient of two functions.
- \* Find derivatives using the chain rule.
- \* Identification of derivatives of the six trigonometric functions.
- \* Find derivatives of functions using trigonometric expressions.

**0405 - 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.

**0406 - ADDITIONAL DIFFERENTIATION METHODS** .....

- \* Implicit functions.
- \* Find derivatives using implicit differentiation.
- \* Higher order derivatives.
- \* Find second and third derivatives of functions.
- \* Find the velocity and acceleration functions given the position functions.

**0407 - APPLICATIONS of DERIVATIVES** .....

- \* Sketch curves using the first and second order derivatives.
- \* Identify intervals where the function is increasing or decreasing.
- \* Locate local maximum or minimum points.
- \* Determine concavity.
- \* Determine inflection points.
- \* Develop strategy for solving maxima-minima word problems.
- \* Solve min-max problems.

**0408 - INTEGRATION** .....

- \* The relationship between integration and differentiation.
- \* Integrate simple algebraic and trigonometric indefinite integrals.
- \* Identify integrals resulting from use of the chain rule.
- \* Integrate indefinite integrals using the u substitution method.

**0409 - DEFINITE INTEGRALS** .....

- \* Relationship between the limits of integration and an interval of x values.
- \* Upper and lower limits of integration.
- \* Definite integrals and solving for the area involving only positive regions.
- \* The area of positive and negative regions using definite integrals.

**0410 - APPLICATIONS OF DEFINITE INTEGRALS** .....

- \* The area of a region bounded by two curves.
- \* The area of a region bounded by two curves and the x-axis.
- \* The theory of rotation about the x-axis.
- \* The volume of an object formed by rotating  $y=f(x)$  about the x-axis.

**COMPUTER MATH****0501 - FUNDAMENTALS of COMPUTER MATH** .....

- \* Number systems other than base 10.
- \* Addition and subtraction of numbers of base N.
- \* Convert between base 10 and base N number systems.
- \* Construct a base N multiplication table.
- \* Multiply and divide base N numbers.

**0502 - THE BINARY SYSTEM** .....

- \* Add and subtract binary numbers.
- \* Convert binary numbers to decimal numbers.
- \* Convert decimal numbers to binary numbers.
- \* Use BCD, Gray, ASCII, and EBCDIC codes.

## MATHEMATICS continued

**COMPUTER MATH continued****0503 - 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.

**0504 - LOGIC EXPRESSIONS .....**

- \* The concept of ones and zeros.
- \* Truth tables.
- \* Basic logic expressions; AND, OR and NOT, NAND, NOR, XOR and XNOR.
- \* Logic problem solving using truth tables.

**0505 - BOOLEAN ALGEBRA .....**

- \* The concept of Boolean algebra as a form of digital shorthand.
- \* The Boolean AND and OR expressions.
- \* Boolean inversions.
- \* The derivation of Boolean expressions from truth tables.
- \* Boolean equation manipulation, combination, and simplification.

**0506 - 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.

**0507 - 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.

**0508 - KARNAUGH MAPS .....**

- \* Describe Karnaugh maps.
- \* Develop a Karnaugh map for two, three, and four variables.
- \* Simplify Boolean algebra equations using Karnaugh maps.

**0509 - ALGORITHMS and FLOW CHARTS .....**

- \* Describe the three basic computer operations (input, process, output).
- \* Describe algorithms.
- \* Describe flowcharts.
- \* Recognize flowchart symbols.

**0510 - SEQUENCES and MATRICES .....**

- \* Define sequences.
- \* Solve sequence problems.
- \* Define matrices.
- \* Solve matrix problems.

**MATHEMATICS continued**

**MEASUREMENTS**

**0601 - 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: standard ruler, micrometer, and vernier caliper.
- \* Define linear measurement.
- \* Describe how the following measurement tools are used: standard ruler, micrometer, and vernier caliper.

**0602 - METRIC AND SCIENTIFIC CONVERSIONS .....**

- \* Convert between Metric and British measurement systems.
- \* Convert between British and Metric measurement systems.
- \* Convert numbers to scientific notation.

**0603 - ANGULAR and CIRCULAR MEASUREMENTS .....**

- \* Use of the T-square, micrometer, and vernier calipers.
- \* Measurements of angles.
- \* Measurement of radii and diameters of circles.

**0604 - AREA MEASUREMENTS .....**

- \* Characteristics of area measurements.
- \* Measurement of the area of rectangles.
- \* Measurement of the area of squares.
- \* Measurement of the area of parallelograms.
- \* Measurement of the area of triangles.
- \* Measurement of the area of trapezoids.
- \* Measurement of the area of circles.

**0605 - VOLUME MEASUREMENTS .....**

- \* Characteristics of volume measurements.
- \* Measurement of the volume of rectangular solids.
- \* Measurement of the volume of cubes.
- \* Measurement of the volume of prisms.
- \* Measurement of the volume of pyramids.
- \* Measurement of the volume of cylinders, cones and spheres.
- \* The relationship between liter and cubic centimeter measurements.

**0606 - VELOCITY AND ACCELERATION .....**

- \* Vector quantities: values with magnitude and direction.
- \* Vector characteristics applied to problem solving.
- \* Velocity and acceleration measurements.

**0607 - FORCE MEASUREMENTS .....**

- \* Principles of force.
- \* The relationship between velocity, acceleration and mass.
- \* Measurement of Force.

**0608 - WORK AND POWER MEASUREMENTS .....**

- \* The relationship between work and power.
- \* Units of measure: Newtons and Joules.
- \* Measurement of work and power.

**RESIDENTIAL WIRING**

**Q101 - ELECTRICAL SUPPLY SYSTEMS AND INSTALLATIONS .....**

- \* Describe the three parts of an electrical supply system.
- \* Describe typical voltages in an electrical supply system.
- \* Describe how electrical wiring information is conveyed to the electrician using symbols and how specifications are used.
- \* Describe the agencies that are responsible for establishing electrical codes and standards.

## RESIDENTIAL WIRING continued

**Q102 - ELECTRICAL SYMBOLS AND CONDUCTORS.....--**

- \* Describe outlets and recognize their symbols.
- \* Describe switches and recognize their symbols.
- \* Describe conductors and recognize their symbols.
- \* Recognize miscellaneous symbols.
- \* Describe conductors and their sizes and types.
- \* Describe the types of conductor insulation.
- \* Describe conductor color code.

**Q103 - ELECTRICAL WIRING SYSTEMS AND BOXES .....--**

- \* Describe how power is brought into a house how the protection devices are used.
- \* Describe two and three conductor wiring methods.
- \* Describe electrical boxes and how they are used.
- \* Describe how boxes are installed.
- \* Describe how boxes are wired for outlets, switches, and connections.

**Q104 - ELECTRICAL SWITCHES, INTERRUPTERS AND SUPPRESSORS.....--**

- \* Describe standard 1-pole switch wiring.
- \* Describe three way switch wiring.
- \* Describe four way switch wiring.
- \* Describe 2-pole switch wiring.
- \* Describe Ground-Fault Circuit Interrupters, GFCI.
- \* Describe Immersion Detection Circuit Interrupters, IDCI.
- \* Describe Transient Voltage Surge Suppressors, TVSS.
- \* Describe Isolated Ground Receptacles, IG.

**Q105 - RECESSED LIGHTING AND BALLAST .....--**

- \* Describe the voltages used for residential lighting and the factors to consider before installation.
- \* Describe recessed lighting installation.
- \* Describe ballasts.
- \* Describe ballast installation.

**Q106 - BRANCH CIRCUITS AND CONDUCTOR SIZING .....--**

- \* Describe how the number of branch circuits is determined.
- \* Describe how the number of outlets per branch circuit is determined.
- \* Use NEC Table 310-16 to determine allowable amperage of conductors.
- \* Describe the de-rating factors and restrictions on amperage for NEC Table 310-16.

**Q201 - BEDROOM/MASTER BEDROOM CIRCUITS .....--**

- \* Describe the methods used to group outlets.
- \* Describe the general wiring methods for bedrooms and how receptacles are placed.
- \* Describe how lighting fixtures are used in closets to meet NEC requirements.
- \* Describe the general wiring methods for master bedrooms.
- \* Describe the use of two circuit receptacles.
- \* Describe NEC requirements for paddle fans.

**Q202 - BATH, HALLWAY, FRONT PORCH, and ENTRY CIRCUITS.....--**

- \* Define a bathroom according to the NEC.
- \* Describe the wiring of receptacles in bathrooms.
- \* Describe the lighting requirements in bathrooms.
- \* Describe equipment grounding requirements in bathrooms.
- \* Describe hallway circuits including three way switches.
- \* Describe front entry-porch circuits.

**Q203 - KITCHEN, DINING AREA AND LIVING ROOM CIRCUITS .....--**

- \* Describe receptacle requirements for small appliance circuits in kitchens, dining rooms, breakfast rooms, and pantries.
- \* Describe split circuit applications used in kitchens.
- \* Describe the lighting requirements for kitchens, dining rooms, breakfast rooms, and pantries.
- \* Describe receptacle requirements in living rooms.
- \* Describe lighting requirements for living rooms.
- \* Describe the use of track lighting and dimmer controls used in living rooms.

## RESIDENTIAL WIRING continued

**Q204 - LAUNDRY, STUDY, REAR ENTRANCE AND ATTIC CIRCUITS .....**

- \* Describe receptacle and lighting requirements for laundry rooms.
- \* Describe electric dryer connection methods to include circuit sizing.
- \* Describe electric dryer frame grounding requirements.
- \* Describe receptacle and lighting requirements for study rooms to include valance lighting and the use of surge protectors.
- \* Describe receptacle and lighting requirements for rear entries.
- \* Describe receptacle and lighting requirements for attics (crawl spaces, rooftops, and equipment rooms).

**Q205 - FAMILY ROOM AND GARAGE CIRCUITS.....**

- \* Describe receptacle and lighting requirements for family rooms.
- \* Describe the use and precautions for multiwire circuits.
- \* Describe receptacle and lighting requirements for garage circuits.
- \* Describe the use and NEC regulations for outdoor outlets and wiring.

**Q206 - WORKSHOP CIRCUITS AND BASEMENT CIRCUITS .....**

- \* Describe receptacle and lighting requirements for workshops.
- \* Describe the use of multi-outlet assemblies.
- \* Describe receptacle and lighting requirements for basements.

**Q301 - WATER PUMP AND HEATER CIRCUITS.....**

- \* Describe the operation of jet pumps and submersible pumps.
- \* Describe wiring for jet pumps and submersible pumps.
- \* Describe conductor and overcurrent device sizing for jet pumps and submersible pumps.
- \* Describe the operation of water heaters.
- \* Describe wiring for water heaters.
- \* Describe conductor and overcurrent device sizing for water heaters.

**Q302 - LARGE KITCHEN APPLIANCE CIRCUITS.....**

- \* Describe the operation of ovens and stoves.
- \* Describe the wiring of ovens and stoves.
- \* Describe conductor and overcurrent device sizing for ovens and stoves.
- \* Describe the operation of garbage disposals and dishwashers.
- \* Describe the wiring for garbage disposals and dishwashers.
- \* Describe conductor and overcurrent device sizing for garbage disposals and dishwashers.

**Q303 - VENT FAN AND HYDROMASSAGE CIRCUITS .....**

- \* Describe vent fan operation.
- \* Describe the wiring of vent fans.
- \* Describe conductor and overcurrent device sizing for vent fans.
- \* Describe hydromassage tub operation.
- \* Describe the wiring for hydromassage tubs.
- \* Describe conductor and overcurrent device sizing for hydromassage tubs.

**Q304 - ELECTRIC HEATING AND AIR CONDITIONING .....**

- \* Describe the operation of electrical heaters.
- \* Describe the wiring of electrical heating systems.
- \* Describe the operation of air conditioning systems.
- \* Describe the wiring of air conditioning systems.

**Q305 - OIL/GAS HEATING AND HEAT/SMOKE DETECTORS .....**

- \* Describe the operation of oil and gas heaters.
- \* Describe the wiring of oil and gas heater systems.
- \* Describe the operation of heat/smoke detectors.
- \* Describe the wiring of heat/smoke detector systems.

**Q306 – TELEVISION AND TELEPHONE SYSTEMS.....**

- \* Identify the different types of television signal sources.
- \* Describe the wiring of television systems.
- \* Understand the needs of telephone wiring.
- \* Describe the wiring of telephone systems.

**RESIDENTIAL WIRING continued**

**Q307 - SERVICE ENTRANCE EQUIPMENT AND CALCULATIONS .....**

- \* Understand the needs for service entrance equipment.
- \* Describe the wiring of service entrance equipment.
- \* Understand the purpose of service entrance calculations.
- \* Perform service entrance calculations.

**Q308 - POOLS, SPA AND SMART HOUSE WIRING .....**

- \* Understand the dangers of wiring swimming pool equipment.
- \* Describe the wiring of swimming pool equipment.
- \* Understand the danger of wiring spa equipment.
- \* Describe the wiring of spa equipment.

**Q309 - REMOTE CONTROL SYSTEMS.....**

- \* Understand the concepts of remote control systems.
- \* Describe the wiring of remote control systems.
- \* Understand the functionality of SMART HOUSE wiring.
- \* Describe the wiring of SMART HOUSE components.

**COMPUTER TECHNOLOGY**

**COMPUTER PLUS**

**P301 - THE PERSONAL COMPUTER.....**

- \* Identify the components of a basic computer.
- \* Describe the purpose of the monitor, keyboard, and system unit.
- \* Identify and describe the purpose of the four essential components in the system unit.
- \* Identify the Apple system.
- \* Identify IBM systems.
- \* Recognize other systems.

**P302 - OPERATING SYSTEMS.....**

- \* Define the purpose of an operating system.
- \* Recognize the Macintosh operating system.
- \* Recognize MS-DOS.
- \* Recognize OS/2.
- \* Recognize and describe different versions of Microsoft Windows.
- \* Understand what enhancements were made to Windows 98 system.
- \* Know what new hardware is supported by Windows 98.
- \* Understand how to utilize the Windows 98 interface.
- \* Understand how and why to convert a drive to FAT32.

**P303 - THE SYSTEM CASE AND POWER SUPPLY .....**

- \* Identify the six roles of the system case.
- \* Describe the types of system cases.
- \* Describe the function of the personal computer's power supply.
- \* Describe the major power supply form factors.
- \* Understand the standard output voltages and power connectors.
- \* Understand the specifications common to power supplies.

**P304 - THE MOTHERBOARD.....**

- \* Describe the purpose and function of the CPU.
- \* Describe the purpose and function of the Chipset.
- \* Describe the purpose and function of the ROM BIOS.
- \* Describe the purpose and function of the Memory.
- \* Describe the purpose and function of the Input/Output Ports.
- \* Describe Buses.
- \* Define Form Factor.
- \* Describe Legacy Form Factors.
- \* Describe Contemporary Form Factors.

## COMPUTER TECHNOLOGY continued

**COMPUTER PLUS continued****P305 - THE CPU**.....--

- \* Describe the internal components of a CPU.
- \* Understand the functions of the internal components.
- \* Understand RISC processors.
- \* Describe the earliest CPUs and the development of newer CPUs.
- \* Discuss the impact that early choices had on the development of personal computers.
- \* Describe the concept of pipelining and how it impacts CPU operation and speed.
- \* Describe the shapes and functionality of early CPU sockets.
- \* Describe the shapes and functionality of CPU slots.
- \* Describe how CPU naming conventions used to work.
- \* Describe how CPU naming conventions have changed.

**P306 - COMPUTER MEMORY**.....--

- \* Understand and explain ROM.
- \* Understand PROM, EPROM, EAROM and EEPROM.
- \* Understand and explain RAM.
- \* Understand static and dynamic RAM.
- \* Explain conventional memory.
- \* Explain extended memory.
- \* Explain upper memory.
- \* Explain high memory.
- \* Explain expanded memory.
- \* Explain caches.

**P307 - INPUT/OUTPUT AND INTERFACES**.....--

- \* Describe the purpose of the system BIOS.
- \* Understand the purpose of system resources.
- \* Understand the concept of resource conflicts and their resolution.
- \* Understand the purpose and nature of device interfaces.
- \* Recognize the different types of connectors used for device interfaces.
- \* Understand the advantages and limitations of different types of device interfaces.

**P308 - EXPANSION**.....--

- \* Describe the types of expansion buses.
- \* Identify bus type by expansion slot.
- \* Understand the characteristics of different bus types.
- \* Recognize common computer adapter cards.
- \* Describe the purpose of different types of adapter cards.
- \* Identify adapter card compatibility with the expansion bus.

**P311 - APPLICATIONS**.....--

- \* Understand the differences between application software and operating system software.
- \* Understand the different categories of application software.

**P401 - THE NETWORK**.....--

- \* Explain how the network evolved.
- \* Recognize the difference between LAN, MAN, WAN, and Internet.
- \* Identify a Client/Server network.
- \* Identify a Peer-to-Peer network.
- \* Identify common network topologies.
- \* Understand user accounts and access rights.

**INTERNET PLUS****P201 - INTRODUCTION TO THE INTERNET**.....--

- \* Define the Internet.
- \* History of the Internet.
- \* Realize uses of the Internet.

COMPUTER TECHNOLOGY continued

**INTERNET PLUS continued**

**P202 - INTERNET REQUIREMENTS & OPTIONS.....--**

- \* Selecting computer hardware and software.
- \* Internet hardware and software requirements.
- \* Selecting Internet services.

**P203 - THE WORLD WIDE WEB .....--**

- \* Understanding a WWW browser.
- \* Define terms used with Internet browsing.
- \* Know the utilities available on the WWW.
- \* Understanding the concept of a plug-in application.
- \* Know the different tools being used today.
- \* Be aware of CGI scripting and Java.

**P204 - FTP AND TELNET .....--**

- \* Understanding the purpose of FTP.
- \* Understanding how to access FTP.
- \* Define the commands for using FTP.
- \* Understanding the purpose of TELNET.
- \* Understanding how to access TELNET.

**P205 - E-MAIL & INTERNET RELAY CHAT (IRC).....--**

- \* Understand the concept of e-mail.
- \* Understand the components of an e-mail address.
- \* Define options available for use with e-mail.
- \* Understand the concept of IRC.
- \* Know how to access IRC.
- \* Understand the basic functions used within IRC.

**P206 - INTERNET UTILITIES.....--**

- \* Understand the use and operation of Gopher.
- \* Understand the use and operation of Archie.
- \* Understand the use and operation of finger.
- \* Understand the use and operation of whois.
- \* Understand the use and operation of ping.
- \* Understand the use and operation of News clients.

**P207 - CREATING YOUR OWN WEB PAGE.....--**

- \* Understand the use of tags.
- \* Define basic tags used in HTML pages.
- \* Understand the properties of tags.
- \* List of tags for student reference.

TECHNOLOGY EDUCATION

**TECHNOLOGY SYSTEMS**

**J101 - INTRODUCTION TO TECHNOLOGY.....--**

- \* Define Technology.
- \* Discuss the History of Technology.
- \* Define the difference between Science and Technology.
- \* Understand the applications of Technology.

**J102 - MANUFACTURING TECHNOLOGY .....--**

- \* Identify the two applications of Manufacturing Technology.

**J103 - COMMUNICATION TECHNOLOGY .....--**

- \* Identify the make-up of Communications Technology.

**J104 - TRANSPORTATION TECHNOLOGY.....--**

- \* Discuss the progression of Transportation Technology.

**J105 - CONSTRUCTION TECHNOLOGY .....--**

- \* Identify and discuss the primary forms of Construction Technology.

## TECHNOLOGY EDUCATION continued

**ELECTRONICS****E101- INTRODUCTION TO ELECTRICITY .....**

- \* Define the terms electricity and electronics.
- \* Identify how electronics affects your daily life.
- \* State the four groups that comprise the subject of electronics.

**E102 - DC AND AC VOLTAGE .....**

- \* Define the term Direct Current (DC).
- \* Identify how direct current affects a circuit.
- \* Identify applications that might use DC current.
- \* Define alternating current.
- \* Identify an AC sine wave.
- \* Define frequency and cycle and describe Hertz.
- \* Determine wavelength of a sine wave.
- \* Determine the period of a sine wave.

**E103 - OHM'S LAW AND POWER .....**

- \* Learn Ohm's Law and how voltage, current, and resistance are related.
- \* Learn the definition of power and how voltage, current and Ohm's Law are related to power.
- \* Prove, by experimentation, the Ohm's Law relationship of voltage, current, and resistance.

**E104 - RADIOS .....**

- \* Define a typical communications system.
- \* Understand common communications terminology.
- \* Understand the process of sound to audio frequency, audio frequency to sound conversion.

**E105 - INTRODUCTION TO LOGIC FUNCTIONS .....**

- \* Identify AND operation.
- \* Identify AND logic symbols.
- \* Construct an AND gate truth table.
- \* Identify input to output waveforms.
- \* Identify OR operation.
- \* Identify OR logic symbols.
- \* Construct an OR gate truth table.
- \* Identify input to output waveforms.

**E106 - FIBER OPTICS .....**

- \* 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.

**E107 - INTRODUCTION TO LASERS .....**

- \* Describe the basic particle theory of light.
- \* Describe the basic wave theory of light.
- \* Describe the principle behind Quantum Electrodynamics theory of light.
- \* Define the term Laser.
- \* Describe the Quantum Theory of Radiation.
- \* Describe the characteristics of laser light.
- \* Describe the fundamental elements of a laser.
- \* Describe the various uses of lasers.

TECHNOLOGY EDUCATION continued

**ELECTRONICS continued**

**E108- INTRODUCTION TO ROTATING MACHINERY .....--**

- \* Describe the various devices that are called rotating machinery.
- \* Describe speed, torque, counter electromotive force, loads, power, and efficiency in rotating machinery.

**E109 - INTRODUCTION TO COMPUTERS.....--**

- \* Identify Main Chassis.
- \* Identify Monitor.
- \* Identify Keyboard.
- \* Identify CPU.
- \* Identify Memory.
- \* Identify I/O.
- \* Identify Systems.

**E110 - INTRODUCTION TO MICROWAVES.....--**

- \* Describe a brief history of microwave inception and explain how microwave communications were initiated.
- \* Identify basic microwave principles and recognize the Radio Frequency spectrum.
- \* Identify microwave frequencies and factors affecting communications.
- \* Identify metric prefixes.
- \* Perform conversions between different metric prefixes.

**PHYSICS**

**F101 - INTRODUCTION TO PHYSICS .....--**

- \* Define physics.
- \* Identify the three states of matter.
- \* Describe the characteristics of each state.
- \* Describe how matter can change from one state to another.

**F102 - MEASUREMENT.....--**

- \* Describe the purpose of measurements.
- \* Describe the different types of measurements used by scientists.
- \* Describe the measurements for length, area, volume, mass, density and time.

**F103 - FORCE .....--**

- \* Define force and torque.
- \* Use vectors to represent forces and find resultant forces.
- \* Define equilibrium of force.
- \* Discuss Newton's Law of Gravitation and define center of gravity.

**F104 - MOTION .....--**

- \* Define motion.
- \* Define and calculate velocity and acceleration.
- \* Discuss Newton's laws of motion.
- \* Define the acceleration due to gravity.

**F105 - WORK AND ENERGY .....--**

- \* Define work and energy.
- \* Calculate the work done on an object.
- \* Define potential and kinetic energy.
- \* Define power.
- \* Describe machines.

**F106 - HEAT .....--**

- \* Define heat and temperature.
- \* Describe temperature scales and measurement.
- \* Describe expansion and contraction.
- \* Discuss heat transfer by conduction, convection and radiation.

## TECHNOLOGY EDUCATION continued

**PHYSICS continued****F107 - SOUND** .....

- \* Describe sound waves.
- \* Describe sound wavelength, frequency and pitch.
- \* Describe the Doppler effect.
- \* Define sound intensity.

**F108 - LIGHT** .....

- \* Define light.
- \* Describe sources of light.
- \* Describe reflection and refraction.
- \* Describe measurements of light.

**F109 - MAGNETISM** .....

- \* Define magnetism.
- \* Describe different types of magnets.
- \* Describe relays, motors and transformers.
- \* Describe generators.

**F110 - ELECTRICITY** .....

- \* Describe electric charges and current.
- \* Discuss the units of measurements for electricity.
- \* Describe electric circuits and batteries.
- \* Describe electrical power.
- \* Describe electrical safety codes.

**CHEMISTRY****G101 - INTRODUCTION TO CHEMISTRY** .....

- \* Define Chemistry
- \* Define DNA & Codons
- \* Describe inorganic and organic compounds
- \* Define the 4 elements
- \* Define Polymers

**G102 - MATTER AND ENERGY** .....

- \* Describe Matter and Energy
- \* Define Density
- \* Define the three classes of Matter
- \* Define an element
- \* Describe the two types of changes of Matter.

**G103 - THE PERIODIC TABLE** .....

- \* Describe the Periodic Table
- \* Define Periodic Law
- \* Define the four categories of the elements

**G104 - SOLID, LIQUIDS AND GASES** .....

- \* Define solid, liquids, and gases
- \* Define Boyle's law
- \* Define Charles' laws
- \* Define Avogadro's principle
- \* Define two types of solids
- \* Define a liquid solution
- \* Describe Exothermic and Endothermic processes.

**G105 - ATOMIC STRUCTURE** .....

- \* Define atom.
- \* Define the three fundamental particles.
- \* Define the different types of atoms.
- \* Define the atomic number of an atom.
- \* Define an isotope.

## TECHNOLOGY EDUCATION continued

**CHEMISTRY continued****G106 - BONDING** .....

- \* Define the 4 Basic types of Bonds.
- \* Describe the electron dot configuration.

**G107 - CHEMICAL QUANTITIES** .....

- \* Define a mole, molarity, molality, and gas law
- \* Define dimensional analysis.

**G108 - CHEMICAL NAMES** .....

- \* Describe how a chemical name is derived.
- \* Describe how a simple binary inorganic compound gets its name.
- \* Define suffixes used when metals have more than one oxidation state
- \* Define Oxoacids.
- \* Define the suffixes that denote saturated alkanes.
- \* Describe the difference between alkenes and alkynes.
- \* Define Cycloalkanes, Aldehydes, and Ketones.

**G109 - CHEMICAL REACTIONS** .....

- \* Define the four basic types of chemical reactions.
- \* Describe the metals and nonmetal activity series.
- \* Define the reaction rate.
- \* Define the major classes of chemical reactions.

**G110 - APPLICATIONS** .....

- \* Describe the many areas in which chemistry is applied.
- \* Describe how energy can be produced.
- \* Describe a nuclear reactor.

**AUTOMOTIVE****L101 - INTRODUCTION TO THE AUTOMOBILE** .....

- \* Understand the history of the automobile.
- \* Identify nine automobile systems.
- \* Identify careers associated with the automobile.

**L102 - ELECTRICAL SYSTEM** .....

- \* Identify an automotive battery.
- \* Identify automobile devices using electricity.
- \* Understand how the devices get electrical energy from the battery.
- \* Understand that a computer can control some systems of the automobile

**L103 - CHARGING AND IGNITION SYSTEM** .....

- \* Understand how the alternator works to recharge a battery.
- \* Understand how the ignition coil works to ignite the fuel in the engine.

**L104 - FUEL SYSTEM** .....

- \* Understand how a carburetor functions.
- \* Understand how fuel injection functions.
- \* Understand how a turbo charger functions.

**L105 - THE ENGINE** .....

- \* Identification of basic engine components
- \* Understand how the engine functions and how engines are classified.

**L106 - THE COOLING SYSTEM** .....

- \* Identify the components of an automobile cooling system and understand its function.
- \* Identify the major components of the air conditioning system.
- \* Understand how the air conditioning system functions.

**L107 - THE HYDRAULIC SYSTEM** .....

- \* Understand the automobile braking system.
- \* Understand the automobile power steering system.

TECHNOLOGY EDUCATION continued

**AUTOMOTIVE continued**

**L108 - AIR CONDITIONING AND HEATING SYSTEM .....**

- \* 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.

**L109 - DRIVE TRAIN AND SUSPENSION .....**

- \* Identify the components of the drive train.
- \* Understand the function of the drive train.
- \* Identify the parts of the suspension.
- \* Understand the function of the suspension.

**L110 - BODY DESIGN .....**

- \* Understand the components of an automobile body.
- \* Understand the function of each body part.

**PROJECTS**

**K101 - NIDA PROBLEM SOLVING MODULE .....**

- \* Identify the three elements of a system process.
- \* Understand the use of feedback in a system process.

**K102 - BRIDGE BUILDING .....**

- \* Discuss the five forces that affect bridges.
- \* Demonstrate bridge building knowledge through a tasking game.
- \* Construct a bridge project.

**K103 - MOUSETRAP CARS .....**

- \* Use process and construction knowledge to construct a mousetrap car.
- \* Demonstrate mousetrap car construction knowledge by challenging computer in cyber task.
- \* Demonstrate the effectiveness and viability of mousetrap car in a race.

**K104 - INTRODUCTION TO THE VIDEO CAMERA .....**

- \* Discuss and understand the seven sections of a video camera.

**ENGINEERING LESSONS**

**0A01 - EQUATIONS I .....**

- \* Define the term equation.
- \* Define terms associated with equations.
- \* Describe equation types.
- \* Define linear equations.
- \* Describe addition and subtraction laws.
- \* Illustrate addition and subtraction laws using examples.
- \* Describe multiplication and division laws.
- \* Illustrate multiplication and division laws using examples.

**0A04 - GRAPHS .....**

- \* Describe the rectangular coordinate system.
- \* Locate points on a rectangular coordinate system.
- \* Find the coordinates of a point in a rectangular coordinate system.
- \* Define "graph of an equation".
- \* Graph linear equations.
- \* Graph non-linear functions.
- \* Graph functions.
- \* Define an asymptote.

## ENGINEERING LESSONS continued

**0A05 - ANGLES AND ANGULAR MEASUREMENT** .....

- \* 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.

**0A06 - 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  $45^\circ$ - $45^\circ$ - $90^\circ$  and  $30^\circ$ - $60^\circ$ - $90^\circ$  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.

**0A07 - REFERENCE ANGLES** .....

- \* Define the term reference angle.
- \* Determine the value of  $\theta$  in each of the four quadrants.

**0A08 - VECTORS** .....

- \* Define vector terms.
- \* Explain vector notation.
- \* Determine the magnitude and direction of a vector.
- \* Determine the horizontal and vertical components of a vector.
- \* Add vectors using the analytical method.

**0A09 - SLOPE** .....

- \* Define the slope of a line.
- \* Calculate the slope of a line.
- \* Practical applications of slope.

**0A10 - EQUATIONS OF STRAIGHT LINES** .....

- \* Determine the equation of a straight line.
- \* Recognize the various forms of an equation of a straight line.
- \* Determine if lines are parallel or perpendicular by comparing their slopes.

**0A11 - LINEAR INTERPOLATION** .....

- \* Explain linear interpolation.
- \* Practical applications of linear interpolation.

**0A12 - SYSTEMS OF EQUATIONS (ALGEBRA)** .....

- \* 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.
- \* Solve systems of equations by elimination.
- \* Solve systems of equations and three unknowns.

**0A13 - SYSTEMS OF EQUATIONS (DETERMINANTS)** .....

- \* Understand what determinants are.
- \* Use determinants to solve a system of two linear equations in two unknowns.
- \* Use determinants to solve a system of three linear equations in three unknowns.

**0A14 - POLYNOMIALS** .....

- \* Define polynomials
- \* Add polynomials
- \* Subtract polynomials
- \* Multiply a monomial and a polynomial.
- \* Multiply polynomials.
- \* Describe special binomial products.
- \* Divide polynomials by monomials.

## ENGINEERING LESSONS continued

**0A15 - FACTORING** .....

- \* Factoring by finding the greatest common factor.
- \* Factor by grouping.
- \* Factor trinomials.
- \* Factor by recognizing special binomial factors.
- \* Factor literal expressions.

**0A16 - FRACTIONS** .....

- \* Learn to simplify fractions.
- \* Multiply fractions.
- \* Divide fractions.
- \* Add fractions.
- \* Subtract fractions.

**0A17 - COMPLEX FRACTIONS** .....

- \* Define a complex fraction.
- \* Simplify complex fractions.

**0A18 - FRACTIONAL EQUATIONS** .....

- \* Define fractional equation.
- \* Learn to solve fractional equations.

**0A19 - RADICALS** .....

- \* Factor radicand terms.
- \* Simplify using Product Property of roots.
- \* Simplify using Product Quotient Property of roots.
- \* Rationalize denominators.
- \* Multiply radicals.
- \* Divide radicals.
- \* Add radicals.
- \* Subtract radicals.
- \* Rationalize denominators.
- \* Use Squaring Property of Equations to solve for the unknown.
- \* Solve equations containing one radical expression.
- \* Solve equations containing two radical expressions.

**0A20 - QUADRATIC EQUATIONS** .....

- \* Define the quadratic equations.
- \* Solve quadratic equations by factoring.
- \* Solve word problems.
- \* Solve quadratic equations using completing the square.
- \* Solve quadratic equations using quadratic formula.
- \* Solve word problems.
- \* Define the quadratic function.
- \* Graph the quadratic function.

**0A21 - EQUATIONS LEADING TO QUADRATIC EQUATIONS** .....

- \* Fractional Equations
- \* Radical Equations
- \* Equations in Quadratic Form

**0A22 - COMPLEX NUMBERS** .....

- \* The j-operator and complex numbers
- \* The complex plane
- \* Graphing complex numbers
- \* Rectangular and Polar form
- \* Polar to Rectangular conversions
- \* Adding and subtracting complex numbers
- \* Multiplying and dividing complex numbers

## ENGINEERING LESSONS continued

**0A23 - EXPONENTIAL AND LOGARITHMIC FUNCTIONS .....**

- \* Define the exponential function.
- \* Understand the graph of the exponential function.
- \* Evaluate exponential functions.
- \* Define the logarithmic functions.
- \* Understand the relationship between exponential and logarithmic functions.
- \* Understand the graph of the logarithmic functions.
- \* Evaluate logarithmic functions.

**0A24 - PROPERTIES OF LOGARITHMS .....**

- \* Understand how to use properties of logarithms.
- \* Understand and be able to apply the Change of Base Formula.

**0A25 - EXPONENTIAL AND LOGARITHMIC EQUATIONS .....**

- \* Define exponential equations.
- \* Solve exponential equations.
- \* Define logarithmic equations.
- \* Solve logarithmic equations.

**0A26 - SEMILOGARITHMIC AND LOGARITHMIC GRAPHS .....**

- \* Semilogarithmic Graphs
- \* Logarithmic Graphs

**0A27 - 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.

**0A28 - ADDITION OF ORDINATES .....**

- \* Waveform definitions.
- \* Production of complex waveforms from combination of sinusoidal waveforms.
- \* Addition of ordinates.

**0A29 - INVERSE TRIGONOMETRIC FUNCTIONS .....**

- \* Understand the methods for finding the inverse trigonometric functions.
- \* Know the domains, ranges, and graphs of arcsine, arccosine, and arctangent.
- \* Solve problems involving arcsine, arccosine, and arctangent.
- \* Know the domains, ranges, and graphs of arcsecant, arcsecant, and arccotangent.
- \* Solve problems involving arcsecant, arcsecant, and arccotangent.

**0A30 - POLAR COORDINATES .....**

- \* Define the polar coordinate pair.
- \* Graph polar coordinates.
- \* Factor trinomials.
- \* Understand the techniques for graphing polar equations.
- \* Recognize and graph basic polar equations.

**1A02 - 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.

## ENGINEERING LESSONS continued

**1A03 - ENGINEERING UNITS AND 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.

**●● 1A04 - NATURE OF ELECTRICITY** .....--

- \* Describe the parts of the planetary atom.
- \* State the fundamental law of charges.
- \* State Coulomb's Law.
- \* Describe what current flow is.
- \* Describe what a potential difference is and how it can be generated from a voltage cell.
- \* Explain what resistance is and how it relates to current and potential difference.
- \* Become familiar with standard schematic symbols for electrical and electronic diagrams.
- \* Explain the difference between electron current flow and conventional current flow.
- \* Explain the difference between direct current and alternating current.

**●●● 1A05 - CONDUCTORS, INSULATORS AND SEMICONDUCTORS**.....--

- \* Describe the atomic properties of materials that act as conductors.
- \* Explain the relationships between resistance, length, cross-sectional area, and specific resistivity of conductive materials.
- \* Explain the relationship between resistance and temperature.
- \* Describe the atomic properties of materials that act as insulators.
- \* Explain the reasons for insulator breakdown and calculation of breakdown voltage.
- \* Describe the properties of materials that act as semiconductors.
- \* Describe the characteristics of semiconductors.

**1A06 - RESISTORS OR RESISTIVE DEVICES** .....--

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

**1A07 - 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 a charged field.
- \* Identify six ways of producing voltage.
- \* Define current and the ampere as a unit of current.
- \* Describe a conductor and the behavior of charges within a conductor.
- \* Describe an insulator and the behavior of charges within an insulator.
- \* Identify the three basic parts of an electrical circuit.
- \* Describe an electrical circuit load and its relationship to the flow of charges.

**1A08 - 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.

## ENGINEERING LESSONS continued

**1B01 - INTRODUCTION TO MULTIMETERS.....--**

- \* Describe the purpose of a multimeter.
- \* Identify the quantities measured by multimeters.
- \* Identify the two multimeter displays.
- \* Describe the five functional sections of a multimeter.
- \* Describe the purpose of each functional section.

**1B02 - MULTIMETER USE .....--**

- \* Recognize an Analog Multimeter.
- \* Recognize a Digital Multimeter.
- \* Recognize the quantities measured by multimeters.

**1B03 - VOLTAGE MEASUREMENTS .....--**

- \* Describe how to set up a multimeter to measure voltage.
- \* Describe how to read a multimeter's display when measuring voltage.
- \* Describe the correct way to connect a multimeter to a circuit for measuring voltage.

**1B04 - CURRENT MEASUREMENTS .....--**

- \* Describe how to set-up a multimeter to measure current.
- \* Describe how to read a 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.

**1B05 - RESISTANCE MEASUREMENTS .....--**

- \* Describe how to set up a multimeter to measure resistance.
- \* Describe how to read a multimeter's display when measuring resistance.
- \* Describe the correct way to connect a multimeter to a circuit for measuring resistance.
- \* Describe the precautions to observe when making resistance measurements

**1B06 - MAGNETISM .....--**

- \* Define magnetism.
- \* Identify characteristics of magnets.
- \* Define laws of magnetic attraction and repulsion.
- \* Describe properties of magnetic lines of force.
- \* Identify magnetic and non-magnetic materials.
- \* Define electromagnetism.
- \* Identify the characteristics of electromagnetics.
- \* Describe magnetomotive force.
- \* Determine force.
- \* Determine torque.

**●●● 1B07 - MAGNETIC CIRCUITS.....--**

- \* Examine the operation of magnetic circuits.
- \* Effects of magnetic and non-magnetic materials in magnetic circuits.
- \* Magnetization curves for magnetic materials.
- \* Examine step-by-step solutions to numerical examples.
- \* Define solenoids.
- \* Describe the operation of typical solenoid circuits.
- \* Introduce numerical examples of simple solenoid circuits.

**1C01 - OHM'S LAW & POWER .....--**

- \* 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.

**1C02 - SERIES CIRCUITS .....--**

- \* Identify a series circuit.
- \* Calculate total resistance in a series circuit.
- \* Calculate current in a series circuit.
- \* Calculate voltage drops across resistance.
- \* Calculate the power in a series circuit.
- \* Calculate the value for voltage dropping and current limiting resistors.

## ENGINEERING LESSONS continued

- 1C03 - SERIES 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.
- 1C04 - PARALLEL CIRCUITS** .....
- \* 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.
- 1C05 - PARALLEL 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.
- 1C06 - SERIES-PARALLEL CIRCUITS** .....
- \* 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.
- 1C07 - SERIES-PARALLEL 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.
- 1D01 - VOLTAGE DIVIDER CIRCUITS** .....
- \* 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.
  - \* Identify a current divider circuit.
  - \* State the current divider rule.
  - \* Calculate branch currents using the current divider rule.
- 1D02 - BRIDGE CIRCUITS** .....
- \* State the purpose of a bridge circuit.
  - \* Identify a bridge circuit.
  - \* Solve for voltage outputs.
  - \* Solve for unknown resistance.
  - \* Perform output current calculations.
- 1D03 - KIRCHHOFF'S LAWS** .....
- \* Identify a complex circuit.
  - \* State Kirchhoff's current law.
  - \* State Kirchhoff's voltage law.
  - \* Calculate current using Kirchhoff's laws.
  - \* Calculate voltage using Kirchhoff's laws.
- 1D04 - NORTON'S THEOREM** .....
- \* Describe the purpose of Norton's Theorem.
  - \* Describe the procedure in solving circuits using Norton's Theorem.
  - \* Nortonize series-parallel circuits.
- 1D05 - 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.
- 1D06 - METER LOADING** .....
- \* Describe the circuit loading effect of multimeters.
  - \* Describe how the multimeter loading is reduced.
  - \* Describe the ohms-per-volt rating of analog multimeters.

## ENGINEERING LESSONS continued

- **1E01 - VOLTAGE SOURCES & CURRENT SOURCES**.....--
  - \* Describe the ideal and practical electrical characteristics of DC voltage sources.
  - \* Examine the operation of series, parallel, and series-parallel combinations of DC voltage sources.
  - \* Describe the ideal and practical electrical characteristics of DC current sources.
  - \* Examine the operation of series, parallel, and series-parallel combinations of DC current sources.
  - \* Describe the process of converting a DC voltage source to its equivalent DC current source.
  - \* Describe the process of converting a DC current source to its equivalent DC voltage source.
- **1E02 - MESH ANALYSIS** .....--
  - \* Describe the six-step process for applying Mesh Analysis in solving complex, multi-source resistive networks.
  - \* Apply Mesh Analysis to series-parallel resistive networks sourced by two current sources.
  - \* Apply Mesh Analysis to series-parallel resistive networks sourced by one voltage source and one current source.
- **1E03 - NODAL ANALYSIS** .....--
  - \* Describe the five-step process for applying Nodal Analysis in solving complex, multi-source resistive networks.
  - \* Apply Nodal Analysis to series-parallel resistive networks sourced by two current sources.
  - \* Apply Nodal Analysis to series-parallel resistive networks sourced by one voltage sources and one current source.
- **1E04 - SUPERPOSITION THEOREM** .....--
  - \* Describe the purpose of the Superposition Theorem.
  - \* Describe the four-step process for applying the Superposition Theorem in solving complex resistive networks.
  - \* Apply the Superposition Theorem to series-parallel resistive networks sourced by one voltage source and one current source.
  - \* Apply the Superposition Theorem to series-parallel resistive networks sourced by two current sources.
- **1E05 - MAXIMUM POWER TRANSFER THEOREM** .....--
  - \* Describe the purpose of the Maximum Power Transfer Theorem.
  - \* Describe the process for applying the Maximum Power Transfer Theorem to a voltage source or a current source.
  - \* Apply the Maximum Power Transfer Theorem in a Thevenin equivalent circuit.
  - \* Apply the Maximum Power Transfer Theorem in a Norton equivalent circuit.
- **1E06 - MILLMAN'S THEOREM** .....--
  - \* Describe the three-step process for applying Millman's theorem.
  - \* Apply Millman's theorem to circuits containing voltage sources, current sources, and combinations of these source types.
  
- 2A01 - CAPACITANCE AND CAPACITORS** .....--
  - \* To introduce students to the concept of electrical capacitance and to study various types of capacitors and their physical appearance.
- 2A02 - RC SERIES CIRCUITS AND TIME CONSTANTS** .....--
  - \* Sketch the voltage across a capacitor or the current through it in an RC circuit as the capacitor charges or discharges.
  - \* Determine the instantaneous current through or voltage across a capacitor in an RC circuit given an input signal.
- 2A03 - RC SERIES CIRCUITS** .....--
  - \* Calculate the total capacitance in a series circuit.
  - \* Calculate the total capacitive reactance in a series circuit.
  - \* Calculate the total impedance in an RC circuit.
- 2A04 - RC PARALLEL CIRCUITS** .....--
  - \* Calculate total capacitance in a parallel circuit.
  - \* Calculate total capacitive reactance in a parallel circuit.
  - \* Calculate total impedance in a parallel circuit.

## ENGINEERING LESSONS continued

- 2B01 - INDUCTANCE AND INDUCTORS** .....
- \* Familiarize students with the various types of inductors including their physical appearance while introducing some basic electrical responses.
  - \* Introduce students to the concept of electrical inductance.
- 2B02 - CURRENT AND VOLTAGE IN INDUCTIVE CIRCUITS** .....
- \* Introduce students to the instantaneous voltage and current waveforms in a simple RL circuit.
- 2B03 - SERIES INDUCTORS**.....
- \* Calculate total inductance, inductive reactance, and impedance in series inductive circuits.
  - \* Calculate the amount of energy stored in an inductive circuit and investigate the concept of stray inductance.
- 2B04 - PARALLEL AND SERIES-PARALLEL INDUCTORS**.....
- \* Calculate total inductance, inductive reactance, and impedance in a parallel inductive circuit.
  - \* Calculate total inductance, inductive reactance, impedance, and energy stored in a series-parallel inductive circuit.
- 2C01 - SINUSOIDAL AC VOLTAGE GENERATION** .....
- \* Introduce the student to the concept of AC voltage, its characteristics, and its generation.
  - \* Examine the operation of a resistive circuit when supplied by an AC source and to introduce the RMS conversion ratio.
- 2C02 - OSCILLOSCOPE MEASUREMENTS** .....
- \* Review oscilloscope operation.
  - \* Review how to read the oscilloscope display.
  - \* Describe the procedures for taking DC and AC voltage measurements.
  - \* Identify the four major functional sections of an oscilloscope.
  - \* Describe the operation of the oscilloscope front panel controls.
  - \* Describe the procedure for making accurate signal amplitude measurements.
  - \* Describe the procedure for making accurate time and frequency measurements.
  - \* Describe the procedure for making accurate phase shift measurements.
- 2C03 - FUNCTION GENERATOR CONTROLS** .....
- \* Describe the purpose of a function generator.
  - \* Identify the types of output signals available.
  - \* Identify the operational sections of a function generator.
  - \* Describe the purpose of controls and switches found on a typical function generator.
- 2C04 - FREQUENCY COUNTER CONTROLS**.....
- \* Describe the purpose of a frequency counter.
  - \* Describe five measurements performed with a frequency counter.
  - \* Identify typical operational sections of a frequency counter.
  - \* Identify the controls found on a typical frequency counter and describe their usage.
- 2D01 - AC VOLTAGE APPLIED TO R, L, AND C ELEMENTS** .....
- \* Investigate the basic electrical characteristics of R, L, and C elements in AC circuits.
  - \* Investigate the sinusoidal voltage characteristics of R, L, and C elements in AC circuits.
  - \* Investigate the sinusoidal current characteristics of R, L, and C elements in AC circuits.
  - \* Investigate the frequency characteristics of R, L, and C elements in AC circuits.
- 2D02 - AC CIRCUIT PHASORS**.....
- \* Explain what the term phasor means.
  - \* Explain how phasors can be used to represent AC sine waves.
  - \* Convert phasor values between polar and rectangular forms.
  - \* Perform addition and subtraction of phasor quantities.
  - \* Perform multiplication and division of phasor quantities.
- 2D03 - AC IMPEDANCE AND PHASOR DIAGRAMS** .....
- \* Introduce the student to the concept of AC impedance, inductive reactance, capacitive reactance and how AC impedance networks can be represented with phasor diagrams.

## ENGINEERING LESSONS continued

**2D04 - RC, RL, AND LCR SERIES CIRCUITS.....--**

- \* Calculate the total capacitance in a series circuit.
- \* Calculate the total capacitive reactance in a series circuit.
- \* Calculate the total impedance in an RC circuit.
- \* Calculate the circuit values in an RC circuit.
- \* Calculate the total inductance in a series circuit.
- \* Calculate the total inductive reactance in a series circuit.
- \* Calculate the total impedance in an RL circuit.
- \* Calculate the circuit values in an RL circuit.
- \* Calculate the total impedance in an LCR series circuit.
- \* Calculate the circuit values in an LCR circuit.

**2D05 - PARALLEL RL, RC, AND LCR IMPEDANCE .....--**

- \* Examine circuits containing parallel resistors, inductors, and capacitors.
- \* Examine circuits containing parallel impedances.

**2E01 - VOLTAGE AND CURRENT DIVIDER RULES IN AC.....--**

- \* Calculate the voltage drops in a series AC circuit using the voltage divider rule.
- \* Calculate the current through each branch in a parallel AC circuit.

**2E02 - SERIES-PARALLEL CIRCUITS IN AC .....--**

- \* Introduce the student to the methods for calculating the currents and voltage drops in series-parallel AC circuits.

**2E03 - VOLTAGE AND CURRENT SOURCES IN AC .....--**

- \* Recognize the schematic symbols of AC current and voltage sources.
- \* Convert between AC current and AC voltage sources or vice versa to simplify the analysis of AC impedance networks.
- \* Explain the difference between independent and dependent (controlled) sources.
- \* Explain Kirchhoff's Current and Voltage Laws as they apply to AC impedance networks.

**2E04 - AC MESH ANALYSIS.....--**

- \* Describe the six-step process for applying Mesh Analysis in solving complex, multi-source AC networks.

**2E05 - AC NODAL ANALYSIS .....--**

- \* Describe the five-step process for applying Nodal Analysis in solving complex, multi-source AC networks.

**2E06 - AC BRIDGE NETWORKS .....--**

- \* Describe the operation and use of AC Bridge Networks.
- \* Describe the process of simplifying AC Bridge Networks.
- \* Analyze and determine the value of unknown components in an AC Bridge Network.

**2E07 - AC SUPERPOSITION THEOREM.....--**

- \* Describe the four-step process for applying the AC Superposition Theorem in solving complex RL, RC, and LCR AC networks.
- \* Apply the AC Superposition Theorem to complex series-parallel RL, RC, and LCR AC networks sourced by multiple AC voltage sources.

**2E08 - AC THEVENIN'S THEOREM.....--**

- \* Describe the purpose of Thevenin's Theorem.
- \* Describe the six-step process in solving circuits using Thevenin's Theorem.
- \* Thevenize a series-parallel AC circuit.
- \* Thevenize a complex ac circuit.

**2E09 - NORTON'S THEOREM IN AC CIRCUITS.....--**

- \* Describe the purpose of Norton's Theorem.
- \* Describe the procedure for producing a Norton Equivalent Circuit.
- \* Nortonize an AC series-parallel circuit.

**2E10 - MAXIMUM POWER TRANSFER THEOREM IN AC.....--**

- \* Describe the purpose of the Maximum Power Transfer Theorem.
- \* Describe the process for applying the Maximum Power Transfer Theorem to a Thevenin or Norton circuit representing a complex AC circuit.

## ENGINEERING LESSONS continued

- 2E11 - AC MILLMAN'S THEOREM** .....
- \* Describe the three-step process for applying Millman's theorem.
  - \* Apply Millman's theorem to circuits containing voltage sources, current sources, and combinations of these source types.
- 2F01 - POWER IN AC CIRCUITS** .....
- \* Examine the electrical properties of AC power in purely resistive circuits.
  - \* Examine the electrical properties of AC power in purely inductive circuits.
  - \* Examine the electrical properties of AC power in purely capacitive circuits.
  - \* Examine the electrical properties of AC power in RL, RC, and LCR circuits.
  - \* Calculate power level changes in decibels.
- 2F02 - POWER FACTOR AND POWER FACTOR CORRECTION** .....
- \* Introduce the concept of power factor and power factor correction.
  - \* Determine the value of a power factor correction capacitor required to correct for inductive loads.
- 2F03 - SERIES RESONANT CIRCUITS** .....
- \* Describe series resonance.
  - \* Calculate the resonant frequency of an LCR series circuit.
  - \* Describe LCR series circuit values at resonance.
  - \* Calculate the Q and bandwidth of a series resonant circuit.
- 2F04 - PARALLEL RESONANT CIRCUITS** .....
- \* Describe parallel resonance.
  - \* Calculate the resonant frequency of the LCR parallel circuit.
  - \* Describe LCR parallel circuit values at resonance.
- 2F05 - LCR FILTERS** .....
- \* Examine electronic filter circuits containing resistors and inductors, and filter circuits containing resistors and capacitors.
  - \* Examine series and parallel tuned circuits.
- 2G01 - 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.
- 2G02 - TRANSFORMER CIRCUIT ANALYSIS** .....
- \* Examine the loaded and unloaded characteristics of a transformer.
  - \* Examine the referred resistance and reactance characteristics of a transformer.
- 2G03 - TROUBLESHOOTING TRANSFORMERS** .....
- \* Describe typical faults in transformer circuits.
  - \* Describe transformer troubleshooting procedures.
  - \* Describe the procedures for conducting open and short circuit transformer tests.
- 3A01 - INTRODUCTION TO DIODES** .....
- \* Explain the characteristics of conductors and semiconductors at the atomic level.
  - \* Explain semiconductor doping, and current flow through the PN junction.
  - \* Explain breakdown voltages and energy levels of electrons in semiconductor material.
- 3A02 - DIODES AND DIODE CIRCUITS** .....
- \* Describe the purpose of a junction diode.
  - \* Identify the schematic symbol for a junction diode.
  - \* Describe forward and reverse bias.
  - \* Calculate circuit current based on the knee voltage of the diode.
  - \* Learn to draw and recognize the characteristic curve for a diode.
  - \* Analyze the diode resistance under the forward and reverse bias conditions.
  - \* Introduce the concept of the Load line.

## ENGINEERING LESSONS continued

- 3B01 - INTRODUCTION TO POWER SUPPLIES AND RECTIFIERS**.....--
- \* Describe the purpose of power supplies.
  - \* Describe the sections of a typical power supply.
  - \* Identify half wave rectifiers.
  - \* Identify full wave rectifiers.
  - \* Identify bridge rectifiers.
- 3B02 - FULL AND HALF WAVE RECTIFIERS** .....
- \* Identify full and half wave rectifier circuits.
  - \* Identify the purpose of individual rectifier components.
  - \* Describe rectifier operating characteristics.
- 3B03 - BRIDGE RECTIFIER CIRCUITS** .....
- \* Identify bridge rectifier circuits.
  - \* Identify the purpose of individual bridge rectifier components.
  - \* Describe bridge rectifier operating characteristics.
- 3B04 - POWER SUPPLY FILTERS** .....
- \* Describe the purpose of a capacitor input filter.
  - \* Explain how the size of the capacitor affects the output ripple voltage.
  - \* Explain how a load resistor will affect the output ripple voltage.
  - \* Calculate the filtered output from a rectifier circuit.
- 3B05 - POWER SUPPLY DESIGN** .....
- \* Explain how a power supply is designed.
  - \* Explain how the components of a power supply are chosen.
- 3B06 - POWER SUPPLY TROUBLESHOOTING** .....
- \* Identify and properly diagnose common DC power supply faults.
- 3B07 - VOLTAGE MULTIPLIER OPERATION**.....--
- \* Identify the purpose of a voltage multiplier.
  - \* Describe operation of half and full-wave voltage multipliers.
  - \* Describe advantages and disadvantages of half and full-wave voltage multipliers.
  - \* Describe the operation of voltage triplers and quadruplers.
- 3B08 - DIODE LIMITER OPERATION** .....
- \* Describe the purpose of diode limiters.
  - \* Identify the two different types of diode limiter circuits.
  - \* Describe diode limiter operation.
  - \* Describe the operation of diode limiter circuits using the second diode approximation.
- 3B09 - DIODE CLAMPER OPERATION**.....--
- \* Describe the purpose of diode clammers.
  - \* Identify the two different types of diode clamper circuits.
  - \* Describe diode clamper operation.
  - \* Describe the operation of diode clamper circuits using the second diode approximation.
- 3B10 - ZENER DIODE OPERATION** .....
- \* 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.
- 3C01 - 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.
- 3C02 - ZENER VOLTAGE REGULATORS** .....
- \* Examine the design and operation of practical zener voltage regulator circuits.
- 3C03 - OPTOELECTRONICS** .....
- \* Introduce the schematic symbols and to explain the operation of LEDs, seven-segment displays, photodiodes, and optocouplers.

## ENGINEERING LESSONS continued

- 3C04 - VARACTOR DIODES**.....--
- \* Identify the schematic symbol for a varactor diode.
  - \* Describe the operating characteristics of a varactor diode.
  - \* Identify typical applications for varactor diodes.
- 3C05 - VARISTOR DIODES**.....--
- \* Identify the schematic symbol for a varistor diode.
  - \* Describe the operating characteristics of a varistor diode.
  - \* Identify typical applications for varistor diodes.
- 3C06 - SCHOTTKY DIODES**.....--
- \* Identify the schematic symbol for a schottky diode.
  - \* Describe the operating characteristics of a schottky diode.
  - \* Identify typical applications for schottky diodes.
- 3C07 - DIODE SWITCHES**.....--
- \* Explain how a diode operates as a switch.
  - \* Explain diode characteristics at high switching speeds.
- 3D01 - INTRODUCTION TO BIPOLAR TRANSISTORS**.....--
- \* Sketch the construction and explain electron flow through a correctly labeled transistor circuit.
- 3D02 - BIPOLAR TRANSISTOR OPERATION**.....--
- \* Describe the terms  $\alpha$  and  $\beta_{dc}$  and explain how they relate to the currents  $I_E$ ,  $I_C$ , and  $I_B$ .
  - \* Describe how a transistor is biased.
- 3D03 - BIPOLAR TRANSISTOR CURVES**.....--
- \* Draw, label, and describe the transistor base curves.
  - \* Draw, label, and describe the transistor collector curves.
- 3D04 - BIPOLAR TRANSISTOR MODELS**.....--
- \* Determine the DC power dissipation in transistors.
  - \* Sketch and explain various models of the transistor.
  - \* Determine transistor voltages and currents using the various models of the transistor.
- 3D05 - THE TRANSISTOR SWITCH & TRANSISTOR LOAD LINES**.....--
- \* Understand and design a base bias circuit to create an effective switch of the transistor.
  - \* Understand where the operating points of a transistor switch are on a load line.
- 3D06 - TRANSISTOR TESTING**.....--
- \* Understand and determine transistor faults based on in-circuit tests.
  - \* Understand and determine transistor faults based on out-of-circuit tests.
- 3D07 - EMITTER BIASING**.....--
- \* Describe an emitter biased circuit.
  - \* Analyze the DC operating point (Q-point).
  - \* Describe how a change in temperature, and beta will affect the circuit.
- 3D08 - VOLTAGE DIVIDER BIASING**.....--
- \* Describe voltage divider biasing circuits.
  - \* Analyze the DC operating point (Q-point).
  - \* Describe the stability of the voltage divider circuit.
- 3D09 - EMITTER FEEDBACK BIASING**.....--
- \* Describe Emitter Feedback Biasing circuits.
  - \* Analyze the DC operating point (Q-point).
  - \* Describe the effects of change in the Emitter Feedback Biasing circuits.
- 3D10 - COLLECTOR FEEDBACK BIASING**.....--
- \* Describe Collector Feedback Biasing Circuits.
  - \* Analyze the DC operating point (Q-point).
  - \* To describe the effects of a change in on the Collector Feedback Biasing Circuit.
- 3D11 - TRANSISTOR BIASING CIRCUIT REVIEW**.....--
- \* Identify the different types of DC biasing circuits.
  - \* To describe the operation of the DC biasing circuits.
- 3D12 - PNP TRANSISTOR BIASING**.....--
- \* Explain PNP transistor current flow.
  - \* Analyze the DC operating point of a PNP voltage divider biased circuit.

## ENGINEERING LESSONS continued

- 3D13 - TROUBLESHOOTING BIASING CIRCUITS** .....--
- \* Explain the effects of opens, shorts, and changed component values on transistor voltages.
- 3D14 - AC MODELS**.....--
- \* Explain the purpose of coupling and bypass capacitors.
- 3E01 - INTRODUCTION TO THE TRANSISTOR AMPLIFIER**.....--
- \* Identify the basic transistor amplifier configurations (Common Emitter, Common Collector, and Common Base) and state their typical characteristics.
- 3E02 - HYBRID PARAMETERS** .....--
- \* Explain the meaning of each h-parameter:  $h_i$ ,  $h_r$ ,  $h_f$ ,  $h_o$ .
  - \* Draw the h-parameter model of a bipolar transistor.
  - \* Use the h-parameter model to draw the AC equivalent of a BJT amplifier.
  - \* Use the h-parameters to calculate the gain, input impedance, and output impedance values for basic BJT amplifier configurations.
- 3E03 - COMMON EMITTER AMPLIFIER** .....--
- \* Common emitter input circuit.
  - \* Amplifier gain calculations and stabilization.
  - \* Cascade amplifiers.
- 3E04 - COMMON COLLECTOR AMPLIFIER**.....--
- \* Explain the operation of the common collector amplifier.
  - \* Conduct a DC analysis of the common collector amplifier.
  - \* Conduct an AC analysis of the common collector amplifier.
  - \* Examine the operation of a cascaded common emitter/common collector amplifier.
- 3E05 - COMMON BASE AMPLIFIER** .....--
- \* Explain the operation of the common base amplifier.
  - \* Conduct a DC analysis of the common base amplifier.
  - \* Conduct an AC analysis of the common base amplifier.
- 3E06 - RC COUPLED TRANSISTOR AMPLIFIER**.....--
- \* State the purpose of cascade amplifiers.
  - \* Calculate total gain of a cascade amplifier.
- 3E07 - MULTISTAGE TRANSISTOR AMPLIFIER** .....--
- \* 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.
- 3E08 - TROUBLESHOOTING AMPLIFIER CIRCUITS** .....--
- \* Examine the effects of the DC operating point on the AC signal in single stage transistor amplifiers.
  - \* Examine the effects of open and shorted capacitors on the AC signal in single and multi-stage transistor amplifier circuits.
  - \* Apply basic troubleshooting techniques in the fault finding and repair of single and multi-stage transistor amplifier circuits.
- 3F01 - INTRODUCTION TO POWER AMPLIFICATION** .....--
- \* Explain how the DC load, AC load line, and Q point are determined for a common emitter amplifier.
  - \* Calculate the maximum peak-to-peak unclipped AC voltage possible for a given common emitter amplifier.
  - \* Describe the characteristics of a Class A amplifier.
  - \* Discuss the factors that limit the power rating of a transistor and what can be done to improve the power rating.
- 3F02 - CLASS B OPERATION AND THE PUSH-PULL AMPLIFIER** .....--
- \* Describe the operating characteristics of a Class B power amplifier.
  - \* Describe the construction of a Push-Pull amplifier.
  - \* Perform DC calculations associated with the Push- Pull amplifier.
  - \* Describe the AC operation of a Push-Pull amplifier.
  - \* Calculate efficiency and other AC parameters for the Push-Pull amplifier.
  - \* Describe some of the advantages and disadvantages of the Push-Pull amplifier.

## ENGINEERING LESSONS continued

**3F03 - DARLINGTON TRANSISTORS**.....--

- \* Examine the electrical characteristics of the Darlington Transistor configuration.

**3F04 - TRANSISTOR VOLTAGE REGULATORS**.....--

- \* Examine the operation and electrical characteristics of discrete transistor voltage regulators.

**4A01 - INTRODUCTION TO DIGITAL TECHNOLOGY**.....--

- \* 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.
- \* Identify the characteristics of analog, digital and hybrid systems.

**4A03 - BUFFERS AND INVERTERS**.....--

- \* Describe the purpose of a buffer.
- \* Describe the purpose of an inverter.
- \* Describe input threshold voltages.
- \* Describe output threshold voltages.
- \* Describe noise margins.

**4A04 - DIGITAL 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.

**4A05 - DIGITAL CODES**.....--

- \* Binary Coded Decimal
- \* Gray Code
- \* ASCII Code
- \* Parity Error Detection
- \* Even/Odd Parity

**4B01 - THE LOGICAL OR FUNCTION**.....--

- \* Identify OR operation and logic symbol.
- \* Identify an OR Boolean equation.
- \* Construct an OR timing diagram.
- \* Construct an OR gate truth table.
- \* Identify input and output waveforms.

**4B02 - THE LOGICAL AND FUNCTION**.....--

- \* Identify AND operation and logic symbol.
- \* Identify an AND Boolean equation.
- \* Construct an AND timing diagram.
- \* Construct an AND gate truth table.
- \* Identify input and output waveforms.

## ENGINEERING LESSONS continued

**4B03 - THE LOGICAL NOT FUNCTION.....--**

- \* Identify NOT operation and logic symbol.
- \* Identify NOT Boolean symbol.
- \* Construct a NOT timing diagram.
- \* Construct a NOT truth table.
- \* Identify input and output waveforms.

**4B04 - THE LOGICAL NAND FUNCTION.....--**

- \* Identify NAND operation and logic symbol.
- \* Identify NAND Boolean equation.
- \* Construct a NAND timing diagram.
- \* Construct a NAND gate truth table.
- \* Identify input to output waveforms.

**4B05 - THE LOGICAL NOR FUNCTION.....--**

- \* Identify NOR operation and logic symbol.
- \* Identify a NOR Boolean equation.
- \* Construct a NOR timing diagram.
- \* Construct a NOR gate truth table.
- \* Identify input to output waveforms.

**4B06 - EXCLUSIVE OR & EXCLUSIVE NOR LOGIC & CIRCUITS.....--**

- \* Identify the operation, logic symbols and logic schematic representation for the XOR and XNOR logic circuits.
- \* Investigate their usage as parity generators and checkers.
- \* Construct XOR and XNOR truth tables.

**4C01 - IMPLEMENTING LOGIC CIRCUITS FROM BOOLEAN EXPRESSIONS.....--**

- \* Outline procedures for describing logic gates and circuits algebraically.
- \* Evaluate the output of logic circuits.
- \* Implement logic circuits given the Boolean expressions.

**4C02 - ALTERNATE LOGIC GATE REPRESENTATION; IEEE/ANSI STANDARD LOGIC SYMBOLOGY.....--**

- \* Introduce an alternate set of logic symbology which is equivalent to that previously studied.
- \* Look at the advantages of using the alternate logic gate symbology.
- \* Describe the concepts of active logic levels.
- \* Modify a logic circuit diagram using alternate gate symbology so that it more effectively represents the circuit operation.

**4C03 - SIMPLIFICATION OF COMBINATIONAL LOGIC CIRCUITS.....--**

- \* Convert logic expressions into sum-of-products or product-of-sums form.
- \* Minimize logic expressions using the rules of Boolean algebra.
- \* Implement a combinational logic circuit in its simplest form.

**4C04 - KARNAUGH MAPS.....--**

- \* Describe Karnaugh maps.
- \* Develop a Karnaugh map for two, three and four variables.
- \* Simplify Boolean algebra equations and using Karnaugh maps.

**4D01 - 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.

## ENGINEERING LESSONS continued

**4D02 - 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.

**4D03 - TROUBLESHOOTING DIGITAL SYSTEMS** .....

- \* Introduce students to the common types and symptoms of digital IC faults.
- \* Provide students with the basic troubleshooting procedures and skills necessary to troubleshoot digital systems.

**4D04 - INTRODUCTION TO FLIP-FLOPS** .....

- \* Identify the purpose of feedback.
- \* Recognize a Q and Q(NOT) condition.
- \* Recognize a SET and RESET condition.
- \* Identify basic flip-flop operation.
- \* Recognize a single gate flip-flop.
- \* Recognize a double gate flip-flop.

**4D05 - RS FLIP-FLOP** .....

- \* Identify the purpose of an RS flip-flop.
- \* Describe an RS flip-flop circuit.

**4D06 - CLOCKED RS FLIP-FLOP** .....

- \* Identify the purpose of a Clocked RS flip-flop.
- \* Describe a Clocked RS flip-flop circuit.

**4D07 - TYPE D FLIP-FLOP** .....

- \* Identify the purpose of a Type D flip-flop.
- \* Describe a Type D flip-flop circuit.

**4D08 - JK FLIP-FLOP** .....

- \* Identify the purpose of a JK flip-flop.
- \* Recognize a JK flip-flop.

**4D09 - FLIP-FLOP TIMING AND SYNCHRONIZATION** .....

- \* 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.

**4E01 - 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.

**4E02 - 4-BIT STORAGE REGISTER** .....

- \* Identify the purpose of a 4 bit storage register.
- \* Recognize 4 bit storage register circuits.

**4E03 - 4-BIT SHIFT REGISTER** .....

- \* Identify the purpose of a 4 bit shift register.
- \* Describe right and left shifts.
- \* Recognize 4 bit shift register circuits.

**4E04 - 8-BIT SHIFT REGISTER** .....

- \* Identify the purpose of a 8 bit shift register.
- \* Describe synchronous and asynchronous data transfer.
- \* Recognize 4 bit shift register circuits.

## ENGINEERING LESSONS continued

- 4E05 - DIGITAL COUNTING AND FREQUENCY DIVISION** -----
- \* Review of counting in base 2.
  - \* Review of the J-K flip-flop.
  - \* Asynchronous counter operation.
  - \* Understanding timing diagrams.
  - \* Understanding state transition diagrams.
  - \* Understanding how frequency division takes place in a digital counter.
- 4E06 - TROUBLESHOOTING FLIP-FLOP CIRCUITS** -----
- \* Provide students with the basic troubleshooting procedures and skills necessary to troubleshoot flip-flop circuits.
- 4F01 - BCD ADDITION & HEXADECIMAL ARITHMETIC** -----
- \* Perform addition of BCD numbers.
  - \* Perform addition of hexadecimal numbers.
  - \* Perform subtraction of hexadecimal numbers.
- 4F02 - INTRODUCTION TO BINARY ARITHMETIC CIRCUITS** -----
- \* Review the principles of binary addition and subtraction.
  - \* Review the principles of binary multiplication and division.
  - \* Identify the purpose of an adder.
  - \* Describe how adders are used in addition, subtraction, multiplication, and division.
  - \* Identify the purpose of a subtractor.
  - \* Describe half and full subtractors.
  - \* Describe how half and full subtractors operate.
- 4F03 - 4-BIT ADDERS** -----
- \* Identify the purpose of a 4-bit adder.
  - \* Describe adder circuits.
  - \* Recognize serial and parallel full adder circuits.
- 4F04 - 4-BIT SUBTRACTORS** -----
- \* Identify the purpose of a 4 bit subtractor.
  - \* Describe two's complement.
  - \* Recognize serial and parallel full subtractor circuits.
- 4G01 - ASYNCHRONOUS (RIPPLE) COUNTERS** -----
- \* Introduce the student to operation and characteristics of asynchronous counters.
- 4G03 - SHIFT REGISTER COUNTERS** -----
- \* Introduce the student to the operation and characteristics of Ring Counters.
  - \* Introduce the student to the operation and characteristics of Johnson Counters.
- 4G04 - COUNTER APPLICATIONS** -----
- \* Analyze the implementation and operation of a digital counter circuit as a frequency counter.
  - \* Analyze the implementation and operation of a digital counter circuit as a digital clock.
- 4G05 - INTEGRATED-CIRCUIT REGISTERS** -----
- \* Introduce the student to the operation and characteristics of Parallel In/Parallel Out Registers.
  - \* Introduce the student to the operation and characteristics of Serial In/Serial Out Registers.
  - \* Introduce the student to the operation and characteristics of Parallel In/Serial Out Registers.
  - \* Introduce the student to the operation and characteristics of Serial In/Parallel Out Registers.
- 4G06 - TROUBLESHOOTING SEQUENTIAL LOGIC SYSTEMS** -----
- \* Introduce the student to the procedures and practices for effective troubleshooting of sequential logic systems.
- 4H01 - DECODERS** -----
- \* Introduce the student to the operation and characteristics of digital decoders.
  - \* Recognize the IEEE/ANSI symbols for digital decoders.
  - \* Analyze and explain the operation of digital decoder circuits.
  - \* Introduce the student to the operation and characteristics of LED and LCD segmented displays.

## ENGINEERING LESSONS continued

**4H02 - ENCODERS** .....

- \* Introduce the student to operation and characteristics of digital encoders.
- \* Recognize the IEEE/ANSI symbols for digital encoders.
- \* Analyze and explain the operation of digital encoder circuits.

**4H03 - MULTIPLEXERS** .....

- \* Introduce the student to the operation and characteristics of digital multiplexers.
- \* Recognize the IEEE/ANSI symbols for digital multiplexers.
- \* Analyze and explain the operation of digital multiplexer circuits.
- \* Troubleshoot digital multiplexer circuits.

**4H04 - DEMULTIPLEXERS** .....

- \* Introduce the student to the operation and characteristics of digital demultiplexers.
- \* Recognize the IEEE/ANSI symbols for digital demultiplexers.
- \* Analyze and explain the operation of digital demultiplexer circuits.
- \* Troubleshoot digital demultiplexer circuits.

**4H05 - MAGNITUDE COMPARATORS** .....

- \* Identify the operation and characteristics of digital magnitude comparators.
- \* Recognize the IEEE/ANSI symbols for digital magnitude comparators.
- \* Analyze and explain the operation of digital magnitude comparators.
- \* Troubleshoot digital magnitude comparator circuits.

**4H06 - DATA BUSING AND TRI-STATE REGISTERS** .....

- \* Introduce the basic concepts of open-collector and tri-state digital devices.
- \* Introduce the operation and characteristics of tri-state registers.
- \* Introduce the operation and characteristics of data busing.

**CA03 - ELECTROSTATIC DISCHARGE (ESD)** .....

- \* Introduce the student to the concept of electrostatic discharge (ESD) and its causes.
- \* Introduce the student to the proper and safe handling of electrostatic discharge sensitive devices.
- \* Introduce the student to the methods of controlling and minimizing the damage caused by electrostatic discharge.

**CB01 - MEASUREMENTS AND MEASUREMENT ERRORS** .....

- \* Errors in Measurements
- \* Accuracy and Errors
- \* Accumulation of Errors

**CB03 - 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 electromagnets.
- \* Describe the operation of a relay.
- \* Describe the operation of a magnetic circuit breaker.
- \* Describe the operation of a meter.

**CB05 - CATHODE RAY OSCILLOSCOPES** .....

- \* Sections
- \* Controls
- \* Period
- \* Pulse width

## ENGINEERING LESSONS continued

**CC01 - INTRODUCTION TO TOOLS AND SAFETY.....--**

- \* Identify the common types of hand tools
- \* Introduce the correct use of common hand tools.
- \* Introduce proper care, maintenance, and safety procedures for common hand tools.
- \* Identify the common types of power tools.
- \* Introduce the correct use of power tools.
- \* Introduce proper care, maintenance, and safety procedures for common power tools.
- \* Identify the common tools used for electrical and electronic soldering.
- \* Explain the correct use of soldering tools.
- \* Introduce the use and maintenance of the PACE soldering system.

**CC02 - BASIC SOLDERING TECHNIQUES .....--**

- \* Identify different types of solder.
- \* Identify different types of flux.
- \* Be able to select the correct soldering iron for a particular task.
- \* State the proper method of wire preparation for soldering.
- \* State how to make a "Western Union" wire splice.
- \* Identify different types of wire terminals and their connection methods.
- \* Reemphasize the methods for making reliable solder connections.
- \* Describe how to correct poor solder connections.

**CC03 - BASIC PCB COMPONENT INSERTION AND 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 printed circuit boards.
- \* Identify common faults which may occur when installing components on printed circuit boards.
- \* Identify the general techniques for extracting components from printed circuit boards.
- \* Identify general techniques for repairing printed circuit board traces and pads.

**CC04 - BASIC CONNECTOR TERMINATION TECHNIQUES .....--**

- \* Introduce the student to standard wire gauges.
- \* Show the common types of wire and cable.
- \* Introduce the typical uses of common wire and cable types.
- \* Introduce the student to basic connector termination techniques.
- \* Show the correct method of terminating banana plugs, crimp connectors, and BNC connectors.
- \* Develop the skills required to effect routine repairs to electronic equipment.

**CC05 - BASIC WIRE WRAPPING TECHNIQUES.....--**

- \* Introduce wire wrapping terminology.
- \* Describe common types of wire wraps.
- \* Introduce common wire wrap tools.
- \* Describe the characteristics of good wire wrap connections.
- \* Describe the procedure for making good wire wrap connections.
- \* Recognize common wire wrapping faults.

**CD01 - SIGNAL GENERATORS.....--**

- \* Describe the operation of a sine wave oscillator.
- \* Explain the block diagram of a sine wave generator.
- \* Explain the differences between low frequency and radio frequency sine wave generators.
- \* Explain the operation of a frequency synthesizer.
- \* Describe the operation of a function generator.
- \* Explain the block diagram of a pulse generator.
- \* Explain the operation of a pulse generator.

## ENGINEERING LESSONS continued

**CD02 - FREQUENCY COUNTERS AND TIMERS .....**

- \* Explain the block diagram of a counter/timer.
- \* Describe the internal operation of a counter/timer.
- \* Describe how a counter/timer measures frequency.
- \* Describe how a counter/timer measures period.
- \* Describe how a counter/timer measures time interval.
- \* Describe how a counter/timer measures frequency ratio.

**CD03 - DIGITAL INSTRUMENTS .....**

- \* Explain the block diagram of a digital multimeter.
- \* Describe the internal operation of a digital multimeter.
- \* Describe the advantages of a digital multimeter.
- \* Describe how voltage is measured using a digital multimeter.
- \* Describe how current is measured using a digital multimeter.
- \* Describe how resistance is measured using a digital multimeter.

**CE01 - DIAGNOSTIC TROUBLESHOOTING.....**

- \* Effective use of functional block diagrams.
- \* Signal tracing techniques.
- \* Signal injection techniques.

**CE02 - INTRODUCTION TO TELEVISION.....**

- \* Provide an overview of video transmission and reception techniques.
- \* Provide an overview of television scanning techniques.
- \* Examine television scanning frequencies.
- \* Examine television synchronization techniques.
- \* Examine picture quality characteristics.

**CE03 - TELEVISION CAMERA AND PICTURE TUBES.....**

- \* Define photoconduction.
- \* Identify the components of a CRT.
- \* Understand the operations of a CRT.
- \* Understand magnetic and electrostatic deflection.

**CE04 - TELEVISION SCANNING AND SYNCHRONIZING TECHNIQUES .....**

- \* Introduce the student to the basic principles of picture scanning in a television system.
- \* Introduce the student to the basic principles of picture synchronization in a television system.

**CE05 - COMPOSITE VIDEO SIGNAL .....**

- \* Introduce the student to the television composite video signal and its electrical properties.

**CE06 - TELEVISION CARRIER SIGNALS.....**

- \* Introduce the student to the encoding composite video and audio signal onto the carrier signals.

**CE07 - TELEVISION CIRCUIT ANALYSIS.....**

- \* Analyze a Model 13405 TV block diagram.
- \* Understand the purpose of each Model 13405 TV block diagram section.
- \* Analyze television circuits.
- \* Analyze the A/V IF signal processing circuitry.
- \* Understand the purpose of the A/V IF signal processing circuitry.
- \* Analyze the video output circuitry.
- \* Understand the purpose of the video output circuitry.

