Curriculum

Technology Education

ELECTRONICS

Supports Academic Learning Expectation # 3

Students and graduates of Ledyard High School will employ problem-solving skills effectively

Approved by Instructional Council
6/10/08

Course Description:

This is an introductory course designed to acquaint the students with the applications of electronic devises and circuits. Through student projects and lab experiments, the student will study the principles of direct and alternating current, magnetism, transistors, amplifiers, power supplies, and semi conductor circuits. Also included will be hands-on experiences with radio communications and analog electronics

NETS (National Educational Standards) 12th Grade Standards Addressed:

1. Creativity and Innovation
2. Communication and Collaboration
3. Research and Information Fluency
4. Critical Thinking, Problem Solving, and Decision Making
5. Digital Citizenship
6. Technology Operations and Concepts

CT Technology Education Frameworks:

1. **The Nature & Evolution of Technology**
   Students will be able to understand the nature of technology, how it has evolved and its influence on its own evolution
2. **The Impacts of Technology**
   Students will be able to understand the impact that technology has on the personal, social, cultural, economic, political, and environmental aspects of their lives
3. **The Research , Design & Engineering**
   Students will be able to recognize that technology is the result of a creative act, and will be able to apply formal problem-solving strategies to enhance invention and innovation
4. **The Creation & Use of Technology**
   Students will be able to know the origins, properties and process techniques associated with the material building blocks of technology a demonstrated by effective application of the methods producing usable products and by effectively using those products
5. **The Future of Technology**
   Students will be able to demonstrate the ability to take known principles of technological innovation and apply them to hypothetical scenarios effectively

Learning Objectives

Students will know how to:

1.1 Critically analyze a given technology against a perceived need or want
1.3 Describe the transformation and conservation of kinetic and potential energy in mechanical, chemical and electrical systems
1.4 Explore and describe how electricity is generated, transferred and used in modern technologies
1.5 Use the systems model to analyze a complex technological system
2.1 Analyze technologies based on their positive and negative impacts
3.1 Use research techniques to support design development
3.2 Investigate multiple solutions to a design problem
3.3 Use communication technologies to visualize a design idea
3.5 Document a design to facilitate replication
3.6 Select appropriate technical processes and fabricate a prototype
4.3 Experiment with the alteration of material characteristics
4.4 Create a product demonstrating the application of technological processes
4.5 Use tools and procedures safely
4.6 Select appropriate tools and procedures for a given task
5.1 Forecast trends in new and emerging technologies (e.g. Nanotechnology, electromagnetic radiation in communications, bio-related and alternative energy sources) and their potential impacts
5.2 Explore future labor market trends and educational needs
5.5 Identify and explore technological solutions to future global needs and their impacts on individuals

Focus Questions:

- What effect does electronics have on our lives?
- What is electronics?
- How do electronic components apply electrical principles?
- What is an integrated circuit?
- How components work together in a system?
- How systems become sub-systems?
- What are circuits?
- Why do we use printed circuits?
- How has the transistor changed electronics?

At the successful completion of this course the student will have a rudimentary understanding and a working knowledge of:

- standard safety procedures
- soldering principles
- point to point soldering
- printed circuit board fabrication
- printed circuit board soldering and de-soldering
- switches and relays
- resistors, both fixed and variable
- resistor color coding
- power supply operation
- basic multimeter operation
- the use of common test instruments
- basic hand tools used in Electronics
- diodes, LED's
- transistors
- capacitors
- speakers
- amplifiers made from discrete components
- inductors
- timing circuits and timer chips
- radio frequency devices
- integrated circuits
- fiber optics

Instructional Methods:

Demonstrations, laboratory activities, cooperative learning, field experiences, group discussion, individualized tutoring, lectures, peer instruction and mentoring, student presentation.

Instructional Materials:

Instruments and meters, computers and software, Electronics texts, National Electrical Code, high resolution LCD projector, hand tools, miscellaneous materials and components

Topics Covered:

Basic safety with electricity
Standard tools of Electronics and Soldering
The science of electronics

The fundamentals of electrical energy
The Properties of Resistance
Circuit theory and applied mathematics
Essential instruments and measuring tools
Control Devices: Switches and Potentiometers
Capacitors
Transformers, Inductors: coils and speakers
Semiconductor Materials and Diodes
Power supply operation
Transistors
Integrated circuits
Printed circuit board fabrication
Audio Output Devices
Fiber optics
Radio frequency devices

Unit 1 Basic safety with electricity (approximately 1 week)

Essential Questions:

- What effect does electricity have on our lives?
- How is electrical power distributed safely?
- How do we protect ourselves as we use electricity daily?
- What components allow us to control electrical energy?

Content Outline:

- Laboratory procedures
- Laboratory safety
- General safe practices associated with electricity
- Devices associated with protecting property and persons
- Overloading
- Short circuit
- Fuses, breakers, GFCI, thermal-cutoff, etc.
- Proper use of hand and power tools
- Instrument use

Suggested Activities:

- Review general lab safety rules
- View a video on electrical safety
- Demonstrate soldering safe practices
- Demonstrate safe use of tools
- Demonstrate safe use of meters and electronic components
- Demonstrate the effects of current on various sized conductors
- Demonstrate fuses, circuit breakers and GFCI (ground fault circuit interrupters)

Indicators of Learning:

At completion of this unit, students will be able to:

1. Follow the guidelines and instruction given
2. Use tools safely
3. Select appropriate tools for the task
4. Achieve an 80% or better on a safety test
5. Use approved electrical components (UL)
6. Recognize the UL label as identifying devices tested for safe design
7. Use testing equipment properly
8. Demonstrate practices consistent with OSHA (Occupational Safety and Health Administration) standards
9. Understand the limits of electronic components
10. Recognize and wear proper clothing and/or protective wear for the task

Unit 2 Standard tools of Electronics and Soldering

(approximately 1 week)

Essential Questions:

- Why are there specific hand tools in an electronics lab?
- What are the typical hand tools in the electronics lab?
- How do we correctly use tools in electronics?
- Why do we use circuit boards instead of individual conductors?
- How are electronic components attached to printed circuits?
- Why do we solder electronic connections?
- What is soldering?

Content Outline:

- Identification of hand tools in electronics
- Proper use of hand tools
- Use of circuit boards
- Why solder connections?
- What is solder?
- What different mixtures are used?
- Principles of soldering
- Point to point soldering
- Printed circuit board soldering and de-soldering

Suggested Activities:

- Discuss safety procedures for soldering
- Use hand tools practicing proper techniques
- View a soldering video
- Selection of proper soldering equipment
- Point to point soldering exercises
- Printed circuit board soldering and de-soldering exercise

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Know the proper way to act in an Electronics laboratory environment
2. Use basic hand tools in a safe and appropriate manner
3. Solder point to point
4. Solder and de-solder to a printed circuit board
5. Properly select soldering equipment
6. Follow written and oral directions

Unit 3 The Science of Electricity

(approximately 1 weeks)

Essential Questions:

- What effect does electricity have on our lives?
- Where does electricity come from?
- What causes electrons to move?
- What are the fundamentals of electrical theory?

Content Outline:

- The nature of matter
- Molecule and atoms
- Electrons, Protons, and Neutrons
- Static Electricity
- Law of charges

Suggested Activities:

- Experiments: induction and conduction
- Demonstration on the Law of Charges
- Internet search on electrical charges

Indicators of Learning:

At completion of this unit, students will be able to:

1. Identify the relationship between elements and compounds
2. State the law of charges
3. Recognize the characteristics of electrons
4. Describe the behavior of charges
5. Recognize that electrons move and protons do not

Unit 4 The Fundamentals of Electrical Energy

(approximately 1 week)

Essential Questions:

- How do we practically apply electrical principles?
- How do we control electricity?
- What are the fundamentals of electrical conductance?
- What are the fundamentals of electrical generation?
- What is the difference between DC and AC?

Content Outline:

- Electromotive force
- Characteristics of voltage
- Flow of electrons
- Direct Current
- Alternating current
- Relationship between current and voltage
- Conductors and insulators
- Characteristics resistance
- Introduction to the laws of relationship
- Chemical reaction
    - cells
    - Batteries

Suggested Activities:

- Illustrate the characteristics of electrical flow by illustrating the characteristics of water flow
- Illustrate the characteristics of current flow through a resistance by filling a clear acrylic tube with sponge material (like floral Styrofoam) to restrict water flow through it and compare it to the flow through an open clear acrylic tube.
- Use the clear acrylic tube as an illustration of the "insulation" on a wire
- Vary the input water pressure to the above demonstration to illustrate the relationship between voltage (pressure) and current
- Vary the material within the tube (density) to illustrate the effect of different resistances on current flow with constant pressure (voltage)
- Use the illustration of the faucet valve as a variable resistance
- Experiments: induction and conduction
- Demonstration on the Law of Charges
- Demonstrate various alternative sources such as fuel cells and solar cells

Unit 4 (Continued)

Indicators of Learning:

At completion of this unit, students will be able to:

1. Describe the characteristics of electromotive force
    a. Polarity
    b. Electrical pressure
    c. Potential difference
    d. The force that moves free electrons
2. Characterize voltage as electromotive force
3. Recognize that current represents the flow of electrons
4. Describe direct current as electron flow of constant intensity in one direction
5. Describe alternating current as electron flow of varying intensity in both directions
6. Describe the direct relationship between current and voltage when resistance remains the same
7. When given specific selections, determine whether the materials are conductors or insulators
8. Distinguish characteristics of resistance
    a. opposition to electron flow
    b. electrical "friction"
9. Describe the indirect relationship between current and resistance when voltage remains the same
10. Describe the indirect relationship between voltage and resistance when current remains the same
11. Describe the chemical action within a cell that produces electric current
12. Define polarization
13. Explain the difference between primary and secondary cells
14. Distinguish between cells and batteries

Unit 5 The Properties of Resistance

(approximately 1 week)

Essential Questions:

- What is resistance?
- What materials are associated with resistance?
- Can you explain the characteristics of discrete resistors?
- How do you measure resistance?
- How are resistor values represented?

Content Outline:

- Characteristics of resistance
- Relationship of element structure and electrical resistance
- Typical materials used as electrical resistors
- Common carbon resistors
- Introduction to measuring instruments
- Measuring electrical resistance
- Units of resistance and their symbols
- Resistor color coding

Suggested Activities:

- Exercises in reading the resistor color code chart
- Interpreting the value of a resistor using the color code chart
- Measuring the value of resistance using the ohmmeter
    - Measuring discrete resistors
    - Measuring resistance of other electrical components such as lamps or diodes
- Comparing the measured value with the coded value of resistors

Indicators of Learning:

At the completion of this unit the student will be able to:

1. List the factors affecting resistance
2. Determine the value of a color coded resistor
3. Identify different types of resistors
4. Measure resistance using analog and digital ohmmeters

Unit 6 Electrical Circuit Theory and Applied Mathematics

(approximately 1 week)

Essential Questions:

- How do we practically apply electrical principles?
- What components allow us to control electrical energy?
- How are circuits designed?
- What are the fundamentals of electrical theory?
- How is mathematics important to understanding electrical relationships?

Content Outline:

- Introduction to Ohm's law
- Introduction to the Law of Power
- Common electrical terms and symbols
- Numeric prefixes
- abbreviations
- Mathematical representation of electrical relationships
- Mathematical applications of fractions, decimals and conversions
- Basic circuit theory
- Series
- Parallel
- Complex circuits

Suggested Activities:

- Using solderless bread boards wire LED's and resistors to test and demonstrate the principles of a series circuit.
- Using solderless bread boards wire LED's and resistors to test and demonstrate the principles of a parallel circuit.
- Using solderless bread boards wire LED's and resistors to test and demonstrate the principles of a complex circuit.
- Take measurements of resistance to collect data for mathematical calculations
- Apply mathematic practices to illustrate electrical principles
- Practice basic math conversions

Unit 6 (Continued)

Indicators of Learning:
At completion of this unit, students will be able to:

1. Recognize the relationships between voltage, current and resistance can be defined mathematically
2. Recall the mathematic relationship between voltage, current and resistance is described by Ohm's Law
3. Appropriately place given values within the Ohm's law formula
4. Use the Ohm's law formula to solve simple electrical problems
5. Recognize typical numeric prefixes and their mathematical representations
    a. kilo (k), mega (M) & Milli (m)
6. Recognize typical word abbreviations and their letter representations
    a. Ohm (Ω), Resistance (R), Current (I), Voltage (E), Power (P), Watts (w) & Volts (v)
7. Describe the basic parts of a circuit as source, load, conductor and control
8. Recognize a series circuit as one in which there is only one path of electron flow
9. Recognize a parallel circuit as one in which there are multiple paths of electron flow
10. Electrical power is the outcome of working voltage and current and is measured in watts
11. Review the concept that power is the ability to do work

Unit 7 Essential Instruments and Measuring Tools

(approximately 1-2 weeks)

Essential Questions:

- What devices are used to gather data from electrical circuits?
- How are these devices properly used?
- What is the relationship between data and mathematical calculations?

Content Outline:

- Reading scales
- Digital/analog
- Voltmeters
- Amp meters
- Ohmmeters
- Oscilloscopes
- Frequency counters
- Audio generators

Suggested Activities:

- Complete worksheet on interpreting analog meter readings to an accuracy of two decimal places on various scales and various meters (amps, ohms and volts)
- Practice setting up meters to read amps and volts in circuits.
- Practice setting up meters to read resistance of components
- Practice setting up an ohmmeter to check for continuity
- Practice reading a digital multimeter

Indicators of Learning:

At completion of this unit, students will be able to:

1. Demonstrate proper use of each meter
2. Demonstrate safe practices during meter use on live circuits
3. Read digital scales
4. Interpolate readings
5. Determine the appropriate scale and numeric representation of a value measured

Unit 8 **Control Devices: Switches and Potentiometers**

(approximately 1 week)

Essential Questions:

- How do we control the flow of electricity?
- What are the characteristics of basic switches?
- How are switches activated?
- How are sensors types of switches?
- What are potentiometers?

Content Outline:

- Basic switch types (NO, NC, etc.)
- Various switch configurations and operations
- Types of sensors
- Switch ratings
- Function of a variable resistor
- Construction of variable resistors
- Applications of variable resistors

Suggested Activities:

- Build a simple circuits using switches and loads
- Troubleshoot switch and resistor faults
- Use a variety of switch types in circuits
- Demonstrate various configurations and types of switches
    - Single pole, double pole, micro, mercury, thermal, photo, etc.
- Testing switches
- Selecting appropriate switches for the application
- Identify potentiometers in circuits

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Recognize and install switches of various configurations and ratings
2. Recognize and install potentiometers of various types and ratings
3. Select appropriate switches for the application

Unit 9 Capacitors

(approximately 1 week)

Essential Questions:

- What is capacitance?
- What are capacitors?
- Where do we use capacitors?
- What is there function or purpose in a circuit?

Content Outline:

- Construction and uses of capacitors
- Discuss action in DC and AC circuits
- Connecting in series and parallel
- Units of measuring capacitance
- Rating capacitors
- Capacitive reactance

Suggested Activities:

- Perform computer software lab experiment on capacitance
- Build a circuit using capacitor to calculate time constant
- Install and recognize ratings of capacitors
- Troubleshoot faults caused by bad capacitors

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Define capacitance
2. Define capacitor
3. Identify the types of capacitors
4. Explain how a capacitor works in a DC circuit
5. Discuss the effect of a capacitor in an AC circuit

Unit 10 Transformers, Inductors: Coils and Speakers

(approximately 1 week)

Essential Questions:

- What are Transformers?
- Where do we use Transformers?
- What is the function or purpose of Transformers in a circuit?
- What are Inductors?
- Where do we use Inductors?
- What is the function or purpose of Inductors in a circuit?

Content Outline:

- Operation of a transformer
- The relationship mutual between inductance and transformers
- Effect of self inductance
- Calculating values of currents and voltage in transformer circuits
- Three types of transformer losses
- Troubleshooting procedures for transformers
- Inductor and inductance
- How inductance affects current
- Mutual inductance
- Effect of inductance in AC circuits

Suggested Activities:

- Test configurations by applying voltage to transformers and measuring outputs
- Construct a power supply
- Use a speaker to demonstrate inductance
- Use AC adapters as an example of an transformer

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Explain the operation of a transformer
2. Discuss the relationship mutual between inductance and transformers
3. Describe the effect of self inductance
4. Calculate the various values of currents and voltage in transformer circuits
5. List three types of transformer losses
6. Explain troubleshooting procedures for transformers
7. Explain the terms inductor and inductance
8. Explain how inductance affects current
9. Define mutual inductance
10. Describe the effect of inductance in ac circuits

Unit 11 **Semiconductor Materials and Diodes**

(approximately 1-2 weeks)

Essential Questions:

- What is a semiconductor?
- How does semiconductor junction work?
- What is a diode?
- What is an LED?

Content Outline:

- Conducting by "holes"
- The doping process
- How N-type and P-type materials are made
- How N-type and P-type materials conduct electrical energy
- Forward and reverse biasing
- The semiconductor diode
- Types of diodes
- Rectification
- Light emitting diode (LED)

Suggested Activities:

- Investigate semiconductor diode behavior
- Test for forward and reverse bias
- Build and test a half-wave rectifier
- Build and test a full-wave rectifier
- LED used as indicator of current

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Explain the doping process
2. Explain how N-type and P-type materials are made
3. Discuss how N-type and P-type materials conduct electrical energy
4. Explain forward and reverses biasing
5. Discuss the operation of a semiconductor diode
6. Explain the operation of half and full-wave rectifiers
7. Explain the principle of rectification

Unit 12 Power supply operation

(approximately 1-2 weeks)

Essential Questions:

- How do power supplies create DC from AC?
- How do power supplies change voltage?
- How do power supplies maintain a voltage under load?

Content Outline:

- Power supply uses
- Power supply operation
- Fuses
- Transformers
- Rectifiers
- Filters
- Regulators

Suggested Activities:

- Discuss safety precautions
- Build an experimental power supply using a kit
- Use existing power supplies to supply experimental circuits
- Troubleshoot and repair any faults encountered using common electronic instruments

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Build and test simple power supplies
2. Recognize common power supply faults
3. Explain power supply load characteristics
4. Discuss various methods of regulating voltage
5. Explain power supply filtering methods
6. Explain the process of converting AC to DC

Unit 13 Transistors

(approximately 1-2 weeks)

Essential Questions:

- What is a transistor?
- How do transistors amplify?
- What is a transistor made of?
- How are transistors classified?

Content Outline:

- Transistor operation
- NPN and PNP transistors
- Testing of transistors
- Transistors as current amplifiers
- Transistors as switches

Suggested Activities:

- Build an amplifier with transistors
- Build a relay circuit controlled by a transistor used as a switch
- Create an oscillator using transistors

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Recognize and test transistors
2. Properly orient and install transistors
3. Develop a plan to properly troubleshoot a faulty transistor circuit
4. Differentiate between NPN and PNP transistors
5. Discuss different biasing techniques
6. Explain the operation of a transistor as an amplifier
7. Explain the operation of a transistor as a switch

Unit 14 **Audio Output Devices** (approximately 1-2 weeks)

Essential Questions:

- What is a speaker?
- How do speakers produce sound?
- Why are there so many types of speakers?
- How do I know what kind of speaker to select?
- Can I wire my own speakers in a car?

Content Outline:

- Types of speakers (i.e. woofers, tweeters, mid-range, etc.)
- Speaker magnets
- How speakers produce sound waves
- Speaker application
- Speaker polarity
- Speaker rating and amplifier output
- Conductor size

Suggested Activities:

- Demonstrate testing speakers for polarity
- Demonstrate the use of audio generator to produce sound
- Demonstrate various speaker types and sizes against a common source of audio
- Students construct series and parallel speaker connections and compare their performance
- Troubleshooting speakers using meters and an oscilloscope
- Use a frequency counter to measure the oscillation of speakers
- Wire various speakers in real applications

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Distinguish between different types of speakers (i.e. woofers, tweeters, mid-range, etc.)
2. Describe how speakers produce sound waves
3. Choose the appropriate speaker for the application
4. Demonstrate connecting speakers considering polarity
5. Match speaker rating to amplifier output
6. Select proper conductor size for application

Unit 15 Radio frequency devices

(approximately 1 week)

Essential Questions:

- What is FM radio?
- What is AM radio?

Content Outline:

- History of radio transmission
- Characteristics of radio waves
- Producing radio waves
- AM radio transmission
- FM radio transmission

Suggested Activities:

- Demonstrate the characteristics of radio waves using an oscilloscope
- Demonstrate the characteristics of AM radio transmission using an oscilloscope
- Demonstrate the characteristics of FM radio transmission using an oscilloscope
- Demonstrate the characteristics of radio interference using an oscilloscope

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Define what AM refers to in radio transmission
2. Define what FM refers to in radio transmission
3. Describe how radio waves travel in the atmosphere
4. Describe the encoding of sound into radio waves
5. Describe the decoding of radio waves into sound
6. Describe the difference between AM and FM radio transmission

Unit 16 Fiber Optics

(approximately 1 week)

Essential Questions:

- What is fiber optics?
- How is fiber optic transmission different than conventional copper transmission?
- Why do we use fiber optic transmission?
- What are the disadvantages to using fiber?

Content Outline:

- Fiber optic media
- Comparison of fiber to copper media
- Data encoding for fiber optic transmission
- Data decoding for fiber optic receiving
- Interference
- Impervious to water, corrosion or electromagnetic intrusion

Suggested Activities:

- Demonstrate transmitting audio signal through fiber optic
- Create fiber optic cable terminations
- Demonstrate electromagnetic interference of copper transmission of data
- Demonstrate the immunity of fiber optic transmission to electromagnetic interference

Indicators of Learning:

At the completion of this unit the student will be able to:

1. Identify the advantages and disadvantages of fiber optic data transmission
2. Describe data encoding for fiber optic transmission
3. Describe data encoding for traditional copper transmission
4. Contrast data transmission using fiber optic and copper media