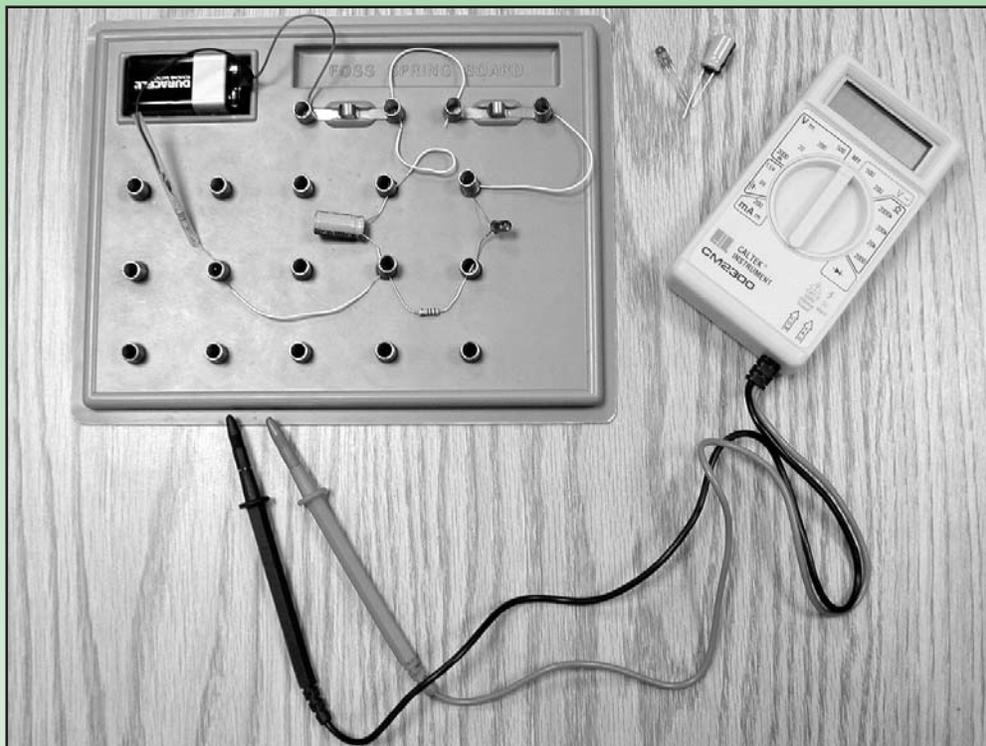


# OVERVIEW

## *ELECTRONICS COURSE*



### ***ELECTRONICS—PLAYING WITH THE FORCE***

Today we know of four forces: electromagnetism, gravity, the strong nuclear force, and the weak nuclear force. That's it. Today four forces make a universe.

Human beings love to tinker with things and push back the boundaries of limitation. Forces are fair game for this impulse to explore. We have learned how to manage and modify our environment to a remarkable degree: fire, tools, explosives, architecture, optics, navigation, metallurgy, internal combustion, flight, frozen food, nylon, television, atomic energy, space travel...Awesome accomplishments, and just about all of them, with the exception of technologies

that split or fuse atoms or use radioactivity, involve the manipulation of the electric force in some manner. The electric force provides structure to everyday objects, energy for most of our activities, and the flexibility to create complex circuitry to contour, manage, and exploit electrons to make them do our bidding.

That's what this course is all about. Students work slowly and systematically with electronic components and meters to build circuits, measure and monitor electric properties, and construct meaningful explanations for the powerful interactions taking place in their systems.

## FOSS AND NATIONAL STANDARDS

The **Electronics Course** for grades 7–8 emphasizes the use of knowledge and evidence to construct explanations for electric energy and its use in technology. This course supports the following National Science Education Standards.

### SCIENCE AS INQUIRY

Develop students' abilities to do and understand scientific inquiry.

- Identify questions that can be answered through scientific investigations and design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Communicate scientific procedures and explanations.
- Use mathematics in scientific inquiry.
- Understand that scientific explanations emphasize evidence.

### CONTENT: PHYSICAL SCIENCE

Develop students' understanding of energy and energy transfer.

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
- Electric circuits provide a means of transferring electric energy when heat, light, sound, and chemical changes are produced.

### SCIENCE AND TECHNOLOGY

Develop students' ability in technological design and understanding of science and technology.

- Design, implement, and evaluate a technological design or product.
- Scientific inquiry and technological design have similarities and differences. Scientists propose explanations for questions about the nature of the world, and engineers propose solutions relating to human problems, needs, and aspirations.
- Science helps drive technology as it addresses questions that demand more sophisticated tools and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable. Science and technology are reciprocal.

### SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

Develop an understanding of science and technology in society.

- Technology influences society—the quality of life and the ways people act and interact—through its products and processes.
- Technology advances through the contributions of many different people.

## FOSS MIDDLE SCHOOL PROGRAM COMPONENTS

FOSS Middle School is a general science curriculum for students and their teachers in grades 6–8. The curriculum is organized into topical courses under three strands: **Earth and Space Science**, **Life Science**, and **Physical Science and Technology**. Each course is an in-depth curriculum unit requiring 9–12 weeks to teach. This course, designed for students in grades 7–8, includes the following interconnected components:

- A detailed **Electronics Teacher Guide** in a three-ring binder, including overview, materials preparation, goals and objectives, at-a-glance investigation chart, science background, lesson plans, transparency masters, teacher answer sheets, assessments with masters and scoring guides, CD-ROM user guide, and references (books, multimedia, websites). Each chapter of the teacher guide is separated by tabs for easy use. **Electronics** has nine investigations, each with two to five parts.
- **Kit of student laboratory equipment** packaged for multiple classes of 32 students each. Each course is designed for one teacher working with five sections of students per day. The kit also includes **40 transparencies** for the investigations.
- **FOSS Electronics Resources book** containing data and readings for each student.
- **FOSS Electronics Lab Notebook** containing 48 pages of student sheets and organizers for the investigations. This can be a consumable book for each student or serve as a set of duplication masters for the teacher. Student sheets are three-hole punched and perforated so students can remove a page to put it in a binder. The backs of some of the pages are printed with a grid where students can take notes, draw schematics, work out calculations, or graph results.
- **FOSS Electronics CD-ROM** for use as a whole-class demonstration tool as well as an individual or small-group interactive instructional tool. The CD-ROM is woven into the instruction for many of the investigations.

# ELECTRONICS COURSE MATRIX

<i><b>SYNOPSIS</b></i>	<i><b>SCIENCE CONCEPTS</b></i>	<i><b>THINKING PROCESSES</b></i>
<b>1. CIRCUITS (5 sessions)</b> Students learn the basics of circuits, using 9-V batteries, lamps, and a spring board to discover open and closed circuits, series and parallel circuits, conductors, insulators, and shorts. They learn to represent their circuits with schematic drawings.	<ul style="list-style-type: none"><li>• A circuit is a pathway through which electric current can flow.</li><li>• Current from a battery flows in one direction only.</li><li>• Electric current flows through conductors; current does not flow through insulators.</li></ul>	<ul style="list-style-type: none"><li>• Conduct investigations comparing intensity of lights in parallel and series.</li><li>• Record observations.</li><li>• Develop models.</li><li>• Communicate circuit designs and components using symbolic representations.</li></ul>
<b>2. RESISTORS 1 (4 sessions)</b> Students explore resistors to discover their effect in circuits. They decode the color bands to quantify resistors and observe that greater resistance reduces the brightness of lamps. They use an ohmmeter to measure resistance.	<ul style="list-style-type: none"><li>• Resistance is the property of materials that opposes or impedes the flow of electric current.</li><li>• An ohmmeter is used to measure resistance in ohms.</li><li>• A potentiometer is a variable resistor.</li></ul>	<ul style="list-style-type: none"><li>• Conduct a systematic investigation of resistors in series with a lamp.</li><li>• Make observations using senses and tools (direct and indirect evidence).</li><li>• Organize evidence.</li><li>• Build conceptual models.</li><li>• Conduct an experiment to test a model.</li></ul>
<b>3. VOLTAGE (4–5 sessions)</b> Students use a voltmeter to measure voltage drops across different resistors. They discover voltage drop across a component is directly proportional to its resistance, and the sum of the voltage drops across the components equals source voltage.	<ul style="list-style-type: none"><li>• Voltage is the push that moves current through a circuit.</li><li>• Voltage drop is the amount of voltage “used” by a component.</li><li>• The sum of the voltage drops in a circuit is equal to the source’s voltage.</li><li>• Voltage drop is proportional to the resistance of a component.</li></ul>	<ul style="list-style-type: none"><li>• Conduct investigations using tools.</li><li>• Use logic to develop a proportional relationship.</li><li>• Organize data mathematically.</li><li>• Use inference to construct a model of voltage drop.</li></ul>
<b>4. ELECTRONIC DISSECTION (3 sessions)</b> Students open and inventory broken electronic devices to look for familiar components and discover new components and printed circuits. They view a video of the history of television and ponder its influence on American society.	<ul style="list-style-type: none"><li>• Common consumer devices include resistors, capacitors, diodes, LEDs, transistors, and integrated circuits.</li><li>• Metallic lines can replace wires in printed circuits.</li><li>• Electronic devices have a strong influence on the way we live and relate to one another.</li></ul>	<ul style="list-style-type: none"><li>• Observe and compare the design and components in consumer electronic devices.</li><li>• Explore the relationship among science, technology, and society.</li></ul>
<b>5. RESISTORS 2 (3 sessions)</b> Students explore the total resistance imposed by resistors in series and parallel. They use formulas to calculate total resistances of resistors in series and parallel to solve problems.	<ul style="list-style-type: none"><li>• Resistance is an opposition to the flow of electric current.</li><li>• Resistances in series add directly; resistances in parallel add inversely.</li><li>• The total resistance of two or more resistors in parallel will be less than the smallest resistor in the set.</li></ul>	<ul style="list-style-type: none"><li>• Design and conduct investigations.</li><li>• Analyze data to discover relationships.</li><li>• Communicate relationships mathematically.</li><li>• Compare results obtained from estimation, measurement, and calculation.</li></ul>

**FOSS CD-ROM****FOSS READINGS****EXTENSIONS**

- Workbench, Spring Board

- *What's in a Lamp?*
- *Component Symbols and Schematics*

- Compare characteristics of series and parallel circuits.
- Create more-complex switched circuits.
- Explore switches.
- Think about miniature tree lights.
- Look for electricity sources in series and parallel.

- Technical Manual, Procedure Videos, Soldering Techniques
- Technical Manual, Measuring Electrical Properties
- Component Drawer, Resistors

- *Decoding Resistors*
- *What Is Resistance?*

- Research resistors and potentiometers.
- Illustrate resistance.
- Make a resistor-code reference card.
- Make up a mnemonic for the code.
- Explore dimmer switches.

- Technical Manual, Voltage and Batteries

- *The Three Great Truths of Circuitry*

- Research electrical power in foreign countries.

- Dissections

- *Electricity Sources and Safety*
- *Electronic Component ID Guide*

- Demonstrate the soldering iron.
- Research first aid for electrocution.
- Conduct multimedia component research.
- Recycle electronic devices.

- Component Drawers, Resistors
- Technical Manual, Circuits

- *Using Resistors in Combinations*
- *Say Greeeeeen!*

- Revisit resistors on *FOSS Electronics* CD-ROM.
- Consider a poster project.

# ELECTRONICS COURSE MATRIX

## SYNOPSIS

## SCIENCE CONCEPTS

## THINKING PROCESSES

### 6. DIODES (4 sessions)

Students explore diodes to find that they conduct in one direction only. They discover that LEDs behave in a similar manner, but also emit light. Students compare LEDs to lamps and find different voltages to emit light.

- Diodes and light-emitting diodes are solid-state semiconductors.
- Diodes conduct in one direction only.
- LEDs conduct electric current in one direction only and produce light in the process.

- Conduct open-ended investigations to discover what diodes and LEDs do in circuits.
- Investigate voltage drops and record data.
- Use tools to gather data and mathematics to organize data.
- Analyze mystery circuits based on the resistance of the components.
- Use evidence to develop models.

### 7. CAPACITORS (4 sessions)

Students explore capacitors to discover that they can hold an electric charge and later use the charge to do work. Students construct charge/discharge devices, and investigate ways to prolong the discharge of the capacitor using resistance.

- A capacitor is two metal plates, separated by an insulator, that can store electric potential.
- Threshold voltage is the minimum voltage needed to allow a component to conduct current.
- Capacitors can be charged with potential (voltage) equal to the potential in the source charging it.

- Conduct open-ended investigations by building and testing circuits.
- Use tools to collect voltage data.
- Organize evidence.
- Design a charge/discharge device and communicate the design.
- Build a conceptual model to explain how a device functions.

### 8. CURRENT (5 sessions)

Students use an ammeter to explore another quality of electricity—current. They investigate the relationship between current and voltage, and current and resistance. Students are introduced to Ohm's law and use it to calculate unknown values in circuits.

- Current is the amount of charge (number of electrons) moving past a point in a conductor in a unit of time.
- Current is measured in amperes.
- Resistance reduces current.
- Increased voltage results in increased current.
- There is a relationship between resistance, current, and voltage—Ohm's law.

- Conduct investigations using tools to measure resistances, voltage drops, and current in circuits.
- Organize data mathematically.
- Use logic to develop a proportional relationship.
- Use mathematics to solve problems involving unknown quantities in electric circuits.

### 9. TRANSISTORS (3-5 sessions)

Students explore transistors to find out how they can work like a switch. They apply all their knowledge and all their components to make a sunrise/sunset device.

- A transistor is a semiconductor that can be turned on and off like a switch.
- Transistors have three leads: the drain, source, and gate.
- The gate in a transistor can be opened with a tiny amount of electric potential; the current flowing from the source to the drain is large.

- Conduct investigations to find out how a transistor can be used as a switch.
- Conduct investigations to find out how to use a transistor and the electric potential in the human body to make a touch switch.
- Explain how resistance affects the performance of a system involving a transistor.

**FOSS CD-ROM****FOSS READINGS****EXTENSIONS**

- Technical Manual, How to Attach a Guardian Resistor
- Technical Manual, Building A Wonder Card
- Wonder-Card Game
- Dissections
- Component Drawers

- *How to Attach a Guardian Resistor*
- *The Tiny Light with the Big Impact*

- Look for LEDs and diodes.
- Defend wonder-card analyses.

- Component Drawers, Capacitors
- Workbench, Spring Board
- Technical Manual, Prepared Circuits

- *Hold That Charge!*

- Investigate disposable cameras.
- View the multimedia on capacitors.
- Create a two-LED charge/discharge device.
- Prolong the discharge time.
- Explore more threshold voltages.

- Technical Manual, Procedure Videos, Replacing the Fuse on Meters
- Technical Manual, How to Measure Current

- *Current Events in Circuits*

- Investigate current and resistors in parallel.
- Calculate current flow in appliances.
- Use Ohm's law to calculate the resistance of home appliances.

- Technical Manual, Procedure Videos, Placing a Transistor in a Socket
- Technical Manual, Prepared Circuits
- Component Drawers, Transistors

- *Transistor: An Electronic Landmark*

- Check conductivity of fingers.
- Explore electronic toys.
- Explore characteristics of the sunrise/sunset device.
- Add art to the sunrise/sunset device.

## FOSS TEACHER GUIDE

The *Electronics Teacher Guide* is just that—a guide. It is designed to be an information and planning tool to help you understand and enjoy your excursion into the world of electronics, much like an interpretive brochure might guide your visit to historic Williamsburg. A good guide will suggest the best path to follow, and will enrich your visit with history, facts, and lore as you proceed. Like any good guide, it will also point out places to rest, where to stop for refreshments, and things to do for a change of pace. You should feel comfortable and confident that you know what you are doing as you go along.

Your teacher guide may be pressed into service less as you become more and more familiar with the territory. On your third visit to Williamsburg, you might head straight for the main street, passing by some of the introductory exhibits, and you might visit your favorite spots in a slightly different order than you did before. You might even leave the trail here and there to drink in some of the historical ambiance in a way quite different from that intended by the preparer of the guide brochure.

The first time you visit the **FOSS Electronics Course**, we hope you will follow our suggested sequence to get the lay of the land. The guide is filled with information to help you have an excellent first experience with the course. It may seem overwhelming at first, but in a short time you will discover how to use it effectively.

Here's what we suggest:

Look at the **Table of Contents** to see how the teacher guide is assembled. You'll notice that the guide is subdivided into 18 chapters. Turn each tab to see how much information there is in each section.

Next read the **Overview** chapter completely. This describes the scope of the course content and discusses issues of instruction, assessment, management, and safety.

Now turn all the pages in the guide, pausing to read the **Goal and Objectives** of each investigation carefully. In this way, you will be able to get a very good sense of the curriculum.

Finally, digest Investigation 1, *Circuits*, thoroughly. Read the science background carefully and study the **investigation at-a-glance chart** to see how the investigation is subdivided. The chart also provides a dissected overview of the several days of classroom actions, including the use of media (CD-ROM, video, and readings) and the assessments. Project the actions you read about into your classroom. Visualize students grappling with the issues and working with materials in small groups. If you have the kit at hand, bring out the materials as you read, and do the investigations. Then read Investigation 2 carefully, then 3, 4, 5, and so forth. *Keep the Electronics Teacher Guide* close at hand (even in hand) during your first trip into the electronic technology to ensure a safe and productive adventure.