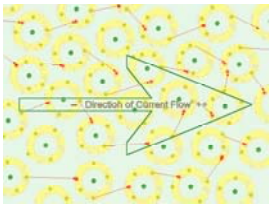
SEA 100: Electronics for non-Engineers

Included in the course, each student receives a **Snap Circuits Pro** electronics experiment kit, test equipment (including both digital and analog multimeters), tools and materials and several books including the **Electronics 101** study guide by Ben Ezzell, **Teach Yourself Electricity and Electronics** by Stan Gibilisco and additional reference materials.

Topic outline for SEA-100

Most of the lessons outlined following conclude with a hands-on electronics lab. Additional guided lab time is scheduled for the first two evenings of the course while the lab materials, tools and instruments remain with the students, allowing further study and experimentation after the conclusion of the course.

Lesson 1: First Principles

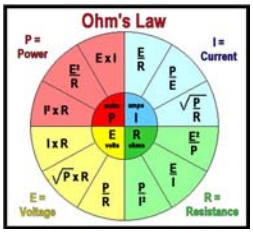


Overview of the nature of electrons and the basic physics of electronics; types of materials and states of matter, rules of conduction and insulation and types of electronic components. Concludes with measuring electrons / electron flow and practical experiments with multimeters.

Lab 1: Testing First Principles

Experiment 1: Using a multimeter
Experiment 2: Conclusions from direct sensory effects
Experiment 3: Forward and reverse biased LEDs

Lesson 2: Conductance

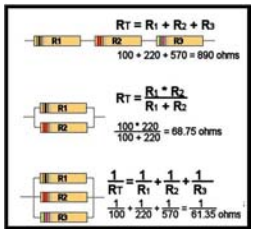


The composition of conductors, materials used relationship between conductance and resistance. The nature of AC and DC currents, introduction to transformers.

Lab 2: Testing conductance

Experiment 1: Conductance versus length
Experiment 2: Power loss via resistance (1)
Experiment 3: Power loss via resistance (2)

Lesson 3: Resistors

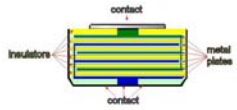


Resistors and power dissipation, types of fixed resistors, variable resistors. The additive laws of resistance for serial and parallel resistors. Identifying resistors; surface mount resistor coding, tolerances, power limits.

Lab 3: Resistors

Experiment 1: A photoresistor voltage divider (1)
Experiment 2: A photoresistor voltage divider (2)
Experiment 3: A photoresistor voltage divider (3)
Experiment 4: Parallel and series resistors

Lesson 4: Capacitors



Introducing capacitors, polar versus non-polar capacitors, dielectrics and insulators in capacitors, variable capacitors. Measuring capacitance, terminology, value markings, how capacitors work. Additive laws for serial and parallel capacitances, uses of capacitors for power storage, power supply filtering, tank circuits and oscillators, signal filters and varicaps.

Lab 4: Capacitors

Experiment 1: Charge / discharge cycles (1)
Experiment 2: Charge / discharge cycles (2)
Experiment 3: RC timing circuit

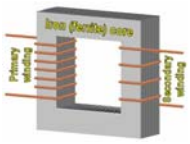
Lesson 5: Batteries

Construction and operation of a battery, types of batteries, materials and construction. Battery limitations, flaws and problems. Arrangements of batteries, using series batteries to increase voltage; using parallel batteries to increase current / amp hours. Limited supply life, recharge life, catastrophic failures and testing batteries.

Lab 5: Batteries

Experiment 1: Use the lemon battery to light up diodes
Experiment 2: Measuring voltages
Experiment 3: Comparing AC / DC voltages

Lesson 6: AC / Transformers / Power Supplies

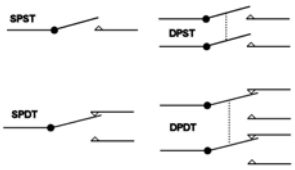


AC versus DC current, transformers, protective devices, power supplies. Transformer-based power with limitations and restrictions; voltage dividers and advantages and limitations. Power supply types, smart (chopping) power supplies, PC power supplies, advantages and limitations. Surge suppressors and transients. DC to DC power adapters, inverters, uninterruptible power supplies and emergency generators. Other power supply considerations, dual power supplies, inputs, outputs and loads.

Lab 6: AC

Experiment 1: Pulsed DC current
Experiment 2: Measuring current

Lesson 7: Switches

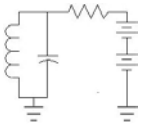


Types of switches (physical and electronic). Physical switch types, latching switches, rotary switches, slide switches, variations on a theme. Electronic switches (non-contact types). Relays and power handling switches.

Lab 7: Switches and Relays

Experiment 1: Relay switching
Experiment 2: Timer circuits
Experiment 3: A photocontroller
Experiment 4: An alarm circuit

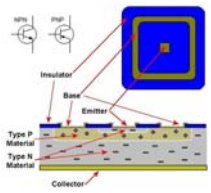
Lesson 8: Magnetics, Inductors, Chokes



Inductors and chokes, construction, PI filters revisited, other uses of inductors.

Evening Lab 1

Lesson 9: Diodes and Transistors



Manufacture of transistors / diodes, semiconductor types, advantages and disadvantages of transistors, specialized diode semiconductors, other specialty devices, light sensors, CCD image chips, CMOS image chips. Integrated circuits.

Lab 9: Transistor Circuits

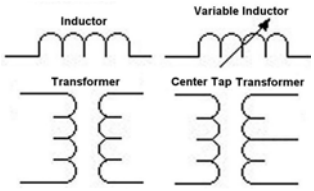
Experiment 1: Comparing PNP and NPN transistors

Experiment 2: Using an SCR switch

Lesson 10: Circuits and Circuit Diagrams

The nature of a circuit / circuit diagram, component symbols, wires / connections, switches, resistors, capacitors, inductors and transformers, diodes and transistors, crystals, miscellaneous components, ICs and assemblies, designing IC circuits. Relating diagrams to physical boards / constructs, other elements.

Lab 10: Simple Circuits



The focus of this lab is to construct circuits from circuit diagrams, not from component (assembly) illustrations.

Experiment 1: Adjustable light control

Experiment 2: Time delay circuit

Experiment 3: Transistor timer

Lesson 11: ICs and Circuit Diagrams Continued

Growing integrated circuits, internal circuit diagrams.

Lab 11: Integrated Circuits

The focus of this lab is to construct circuits from circuit diagrams, not from component (assembly) illustrations.

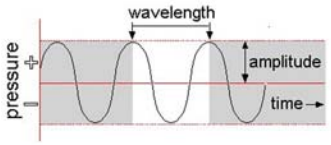
Experiment 1: Trombone sound effect generator

Experiment 2: Light Controlled Siren

Experiment 3: Audio recorder

Lesson 12: Audio / Amplifiers

The nature of sound, speakers, converting sounds to signals, microphones, analog amplifiers and analog recording, digital recording, amplifier types, audio data transmissions.



Lab 12: Amplifiers

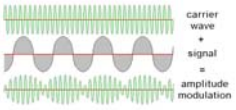
Experiment 1: Audio recorder

Experiment 2: Signal strength meter

Experiment 3: Light organ circuit

Evening Lab 2

Lesson 13: RF Circuits



The nature of RF, AM Radio, FM Radio, SSB Radio, Pulse-Coded Modulation (PCM). RF data transmission schemes, other transmission systems. The uses of RF signals, RF limitations, RF handling requirements, RF noise. Antennas, bandwidth / frequencies and low power RF. Amplifier Types

Lab 13: RF Circuits

Experiment 1: Construct a functional AM radio receiver

Experiment 2: Construct a functional FM radio receiver

Lesson 14: Digital Operations 1

There are 10 kinds of people in the world …

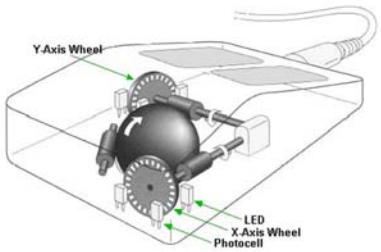
… those who understand binary and those who don't.

The basics of digital operations, binary counting, binary numbers, number systems. Binary logic, AND gates, NAND (Not AND) operations, OR operations, XOR (eXclusive OR) operations, NOR gates. Binary mathematics, a binary calculator, simple math: addition, subtraction, multiplication and division. Other algorithms, other data types.

Lab 14: Digital Operations 1

Binary Math Test

Lesson 15: Digital Operations 2



Machine control operations, more about ADCs, using ADCs, the flipside of ADCs, stepping motors, servo motors. Digital sensors, thin-film sensors, strain gauges, temperature probes, inertial sensors. Displaying information.

Lesson 16: Computers and Computer Components

Principal components of computers, memory, RAM, ROM and static RAM, the CPU, storage, peripherals, communications with peripherals. The soft side of computers, operating systems, function libraries, programs, and viruses.

Lesson 17: Data Storage and Transmission

Data storage mediums, organization, file formats, data transmission, specialized transmissions.

Final Quiz (self-grading and keyed for topic review)