PHYSICS AP - C Electricity and Magnetism
EASTERN REGIONAL HIGH SCHOOLS

COURSE OUTLINE

Class Time: The class meets 7 periods a week. Two double periods are allotted for Laboratory work.

Lab Time: The class involves 2 periods a week for laboratory experience. **Emphasis is placed on students creating and designing their own experiments from available materials. Most labs do not come with instructions. Students are given a problem and a set of available materials. Students set up an experiment, collect their data, analyze the data and support their conclusions. For most labs, students are required to discuss and defend their methods and results with the class. Students write a formal lab report that is kept in a portfolio.**

Course Materials:
Text

Serway and Beichner, *Physics for Scientists and Engineers,* Fifth Edition

2nd SEMESTER - 16 Weeks - ELECTRICITY AND MAGNETISM

1. Electric Fields
    a. Properties of electric charges
    b. insulators and conductors
    c. Coulomb's Law
    d. Electric fields
        - point charges
        - continuous charge distributions
    e. Electric field lines
    f. Motion of charged particles in electric fields

    LABS:
        1. Electrostatics experiments
            - Franklin's Early Experiments
                - students are given simple materials and must set up experiments that will determine the behavior of charges in conductors and insulators.
        2. Measuring charge using pith balls

2. Gauss's Law
    a. Electric flux
    b. Gauss's Law
        - integrating Gaussian surfaces
    c. Charged insulators
    d. Conductors in electrostatic equilibrium

    LABS:
        1. Measuring Electric fields inside and outside of conductors and insulators using computer sensors.

3. Electric Potential
    a. Potential Difference
    b. Electric Potential - integrating electric fields
    c. Potential Difference in a uniform electric field
    d. Electric potential energy

e. Derivative of electric potential
f. Electric potential due to continuous charge distributions
g. Electric potential of a charged conductor

LABS:

1. Potential line mapping and Electric fields due to charged conductors
   - Students map equipotential lines between 2 charged electrodes in a tray of water and use them to map an electric field. Students must determine the relationship between the geometry of electric potential and electric field lines.

4. Capacitance and Dielectrics
   a. Calculating capacitance
   b. Combining capacitors
   c. Energy in a capacitor
   d. Dielectrics

   LABS:

   1. Building and charging a capacitor
      - Students build their own capacitors using ordinary materials such as aluminum foil, plastic cups and plates. They apply their knowledge of capacitance to create the best capacitor and predict its capacitance, maximum charge and dielectric breakdown voltage.
   2. Measuring Energy, charge, and potential for capacitors in series and parallel. Students use their results to determine how capacitors combine in series and parallel and what effect it has on total capacitance, charge and energy

5. Electric Currents
   a. Microscopic model of current
   b. Ohm's law
   c. Resistance and temperature
   d. electric energy and power
   e. conductivity and resistivity

   LABS:

   1. Effect of temperature on resistance

6. Direct Current Circuits
   a. Electromotive Force
   b. Resistors in series

c. Resistors in parallel
d. Kirchoff's Rules
e. RC circuits
- Applying differential equations
- time constants

LABS:

1. RC Circuits: Measuring time constants
- Students determine an RC time constant using: capacitors, LEDs, multimeters, and a stopwatch.
- Students combine circuit elements and determine what data is needed. They determine how to collect and organize it on a graph so as to determine the time constant of their circuits.
2. Measuring current and voltage in DC circuits. Students set up compound circuits and predict the current in each branch. They then test their predictions for accuracy.

7. Magnetic Fields
a. Defining magnetic fields
b. Relating Magnetic and Electric fields using Special Relativity
c. Magnetic force on a conductor
d. Torque on a current loop
e. Motion of a charged particle in a uniform magnetic field
f. Lorentz force
g. Velocity selector
h. Mass spectrometer
I. The Hall Effect

LABS:

1. Measuring Magnetic fields: deflecting cathode beam
2. Measuring Magnetic fields: Students are given: a magnet, a loop of wire, a battery, a multimeter, and a protractor. They use the given materials to set up an experiment that will determine the strength of the given magnets using F= IlB.

8. Sources of Magnetic Fields
a. Biot-Savart Law
b. Ampere's Law
c. Force between conductors
d. Magnetic field of: solenoid, toroid, and infinite current sheet
e. Magnetic Flux

f. Gauss' Law applied to magnetism
g. Ampere's Law and Displacement current
h. magnetic moments

LABS:

1. Mapping the magnetic fields of current carrying conductors.

9. Faraday's Law
   a. Faraday's Law of induction
   b. Motional EMF
   c. Lenz's Law
   d. Induced EMF and Electric fields
   e. Electric Generators and Motors
   f. Maxwell's equations

   LABS:

   1. Constructing electric motors
   2. Measuring magnetic fields using the rotation of a current carrying coil and a magnet

      - Students are given wire, magnets, and a voltage sensor. They must apply Faraday's law and set up an experiment that uses induction to determine the strength of a magnet. They will relate the induced EMF to the changing flux.

10. Inductance
    a. Self-Inductance
    b. RL Circuits
       - Applying differential equations
    c. Energy in a magnetic field
    d. Coaxial cable
    e. Mutual Inductance
    f. Oscillations in an LC Circuit
    g. RLC Circuits

    LABS:

    1. Measuring frequency in LC circuits:
       Students set up basic LC circuits. The use an oscilloscope to determine, the frequency of the circuit and the value of the inductance.

11. Alternating-Current Circuits
    a. Phasors
    b. Resistors in AC Circuits
    c. rms voltage

d. Inductors in AC circuits
e. Capacitors in AC circuits
f. Power in AC circuits
g. Resonance in AC RLC circuits

LABS:

1. Analyzing voltage and current in an AC circuit