Course:	Electricity and Magnetism
PEIMS Code:	N1120043
Abbreviation:	ELECMAG
Grade Level(s):	11 - 12
Number of Credits:	0.5

Course description:

This course is patterned after the first electrical engineering course encountered in a traditional engineering college program. The course is designed to provide an in-depth introduction to the concepts of electricity and electronics for the student who plans to major in an engineering discipline at the university level. With a concentrated and extended study of electricity and magnetism, the student will be aptly prepared to enter the highly competitive university environment.

This course is designed to extend concepts and skills found in AP level physics classes. During this semester course, students receive a firm and thorough background in all areas of electricity; electrostatics, direct current circuits, circuit analysis using reduction methods and Kirchoff's laws, capacitors, electromagnetism, and alternating current circuits. The course involves students participating in more than 40% field/laboratory experiences and continues to re-enforce and develop higher order thinking skills necessary for successful completion of the rigorous course requirements.

Essential knowledge and skills:

Essential Knowledge and Skills for Electricity and Magnetism

(a) General Requirements. Students shall be awarded one half credit for completion of this course. Required prerequisites: successful completion or concurrent enrollment in AP Physics and AP Calculus AB. Recommended prerequisites: successful completion or concurrent enrollment AP Calculus BC. This course is recommended for students in grade 11 or 12.

(b) Introduction.
In Electricity and Magnetism, students study a variety of topics including electricity, circuits and magnetism through the use of student conducted laboratory, field investigations, and scientific methods as well as practice in making informed decisions using critical thinking and problem solving. The nature of science, scientific inquiry as well as the application of scientific information is used to distinguish between scientific decision-making methods and ethical and social decisions involving the application of electricity and magnetism scientific information.

(c) Knowledge and Skills.

(1) Scientific processes. The student conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices. These investigations must involve actively

obtaining and analyzing data with physical equipment, but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials; and

(C) know specific hazards of electricity and electrical equipment.

(2) Scientific processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of the Texas Essential Knowledge and Skills for science;

(B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;

(C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) design and implement investigative procedures, including making observations, asking well-defined questions, formulating testable hypotheses, identifying variables, selecting appropriate equipment and technology, and evaluating numerical answers for reasonableness;

(F) demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), triple beam balances, batteries, clamps, data acquisition probes, discharge tubes with power supply (H, He, Ne, Ar), hand-held visual spectroscopes, hot plates, slotted and hooked lab masses, bar magnets, horseshoe magnets, plane mirrors, convex lenses, power supply, ring clamps, ring stands, stopwatches,, graph paper, magnetic compasses, polarized film, prisms, protractors, resistors, minilamps (bulbs) and sockets, electrostatics kits, metric rulers, knife blade switches, Celsius thermometers, meter sticks, scientific calculators, graphing technology, computers, cathode ray tubes with horseshoe magnets, resonance tubes, spools of nylon thread or string, containers of iron filings, copper wire, Periodic Table, electromagnetic spectrum charts, slinky springs, wave motion ropes, and laser pointers;

(G) use a wide variety of additional course apparatus, equipment, techniques, materials, and procedures as appropriate such aselectroscope, optics bench, optics kit, and stroboscope.

(H) make measurements with accuracy and precision and record data using scientific notation and International System (SI) units;

(I) identify and quantify causes and effects of uncertainties in measured data;

(J) organize and evaluate data and make inferences from data, including the use of tables, charts, and graphs;

(K) communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and

(L) express and manipulate relationships among physical variables quantitatively, including the use of graphs, charts, and equations.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

(C) draw inferences based on data related to promotional materials for products and services;

(E) research and describe the connections between physics and future careers; and

(F) express and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically, including problems requiring proportional reasoning and graphical vector addition.

(4) Science concepts. The student knows and understands the nature of electrostatics. The student is expected to:

(A) understand and discuss Coulomb's Law as the fundamental law of force between any two charged particles;

(B) identify the effects of electric fields and electric potential;

(C) understand Gauss's Law and apply the knowledge to explain the net electric flux through Gaussian surface; and

(D) quantify the idea of electric potential in describing electrostatic phenomena.

(5) Science concepts. The student knows and understands the applications of conductors, capacitors, and dielectrics. The student is expected to:

(A) apply knowledge of electrostatics to the practical applications of Van de Graff electrostatic generators;

(B) calculate the capacitance values for a variety of different capacitors, including parallel plate, spherical, and cylindrical capacitors; and

(C) explore and understand the increasing effect dielectric materials on capacitors.

(6) Science concepts. The student knows and understands the simple and complex components of circuits. The student is expected to:

(A) understand the nature of electric current as being the fate of flow of charge through some region of space;

(B) identify the relationships between electric current, resistance, and power;

(C) evaluate and explore steady-state direct current circuits with batteries and resistors only; and

(D) understand the effects of capacitors in circuits, such as steady state and transients in RC circuits.

(7) Science concepts. The student knows and understands the idea of the applications of magnetic fields. The student is expected to:

(A) explain the effects of the forces on moving charges in magnetic fields;

(B) understand the forces on current-carrying wires in magnetic fields;

(C) explain the fields of long current-carrying conductor; and

(D) apply the Biot-Savart Law and Ampere's Law to magnetic fields.

(8) Science concepts. The student studies and learns the concept of electromagnetism. The student is expected to:

(A) understand the principals behind electromagnetic induction and electromagnetic force using Faraday's Law and Lenz's Law;

(B) relate the concepts of inductance to LR and LC circuits; and

(C) understand the interrelationship between Maxwell's Equations and electric flux, magnetism, induction, and magnet fields.

Description of specific student needs this course is designed to meet:

The Electricity and Magnetism course is designed to meet the foundational, upper-level science background that is beneficial to students that plan to pursue a degree in engineering or physics. This course has been an integral part of our past 15 to 20 years within the magnet/special interest engineering program and will also be important as we implement new STEM programs this year and next as part of our new Gold Seal Programs of Choice.

Major resources and materials:

Textbook: Any state adopted Physics textbook and an inquiry-based Physics lab manual.

Current equipment and materials used in physics will also be used.

Required activities and sample optional activities to be used:

Laboratory experiences, written reports, independent research opportunities, problem-solving applications, and observation of the applications of electrical energy in the world around us provide a varied learning environment for the student. Building circuits, direct current motor kits, and radio controlled robots provide the student with practical applications of the theory and laboratory experience gained in the course.

Methods for evaluating student outcomes:

The student will be evaluated in terms of:

- Mastery of teacher-formulated examinations
- Individually defined rubrics for written reports and projects
- Teacher observation of skills and techniques demonstrated
- Performance of laboratory experiments

Teacher qualifications:

Physics, Composite Science, Legacy Master Science Teacher, or Mathematics/Physical Science/ Engineering Certification; a degree in Physics or Engineering also preferred

Additional information:

This course has existed for 15 to 20 years as a magnet/special interest course previously named Electricity and has been used successfully as a supplemental course to AP Physics, providing more in-depth studies for students preparing for advanced work in an engineering program.