Comprehensive Course Syllabus

Course Title: Physics: Calculus Based Electricity and Magnetism

Course Number: SCI412

Prerequisites:

- Successful completion of AB/BC I and II Calculus and Calculus-Based Physics – Mechanics

Course Description: Calculus-based Physics/Electricity and Magnetism follows the typical sequence of a university physics course. Topics will include electrostatics, circuits, magnetism, and induction. The major emphasis of the course is on problem solving and laboratory experiments. Calculus is used throughout. There is a strong overlap with the content on the AP Physics C Electricity and Magnetism exam.

Course Instructors:

Dr. Peter Clancy, Office B104A, 630-907-5986, pclancy@imsa.edu

Office Hours: TBA or as arranged with instructor

Meeting Days, Time and Room(s)

A/C-1/2; A/C-5/6; B/D-7/8
All Calculus Based Physics Classes Meet in B133

Text(s) / Materials:

Textbook: Halliday, D., R. Resnick, and J. Walker. Fundamentals of Physics
Materials: Laptop Computer, Calculator

Essential Content/Measurement Topics

Electrostatics:

1. Methods of charging
2. Coulomb's law
3. Electric Fields, Coulomb's Law
4. Electric Fields, Gauss's Law
5. Electric potential (Voltage)
6. Capacitance

Circuits:

7. Resistivity/Resistance
8. Current/current density/drift velocity
9. Ohm's Law
10. Series and parallel circuits and combinations thereof
11. RC Circuits

Magnestism:

12. Magnetic force and fields
13. Magnetic fields due to current

14. Ampere's Law
15. Induction (Faraday's Law, Lenz's Law)
16. RL circuits

Instructional Design and Approach:

Students encounter the material through a multifaceted approach of classroom discussion, problem-solving, demonstration, laboratory activities and experiments. Both large and small group discussions are used to provide the students the opportunity to learn from each other.

Problem solving is central to the design and implementation of this course. Students work individually, in small groups, and as a class to solve problems. Problems are chosen to integrate concepts throughout the course.

Student Expectations:
Students are expected to follow the attendance and tardy policies of the Academy. They are expected to come to class prepared to participate and collaborate with others solve problems and perform laboratory experiments. Outside of class, students are expected to read from the text, complete problem sets, follow-up on class discussions, prepare occasional presentations, and write lab reports. Students are encouraged to collaborate, but the work turned in for credit must be their own. Refer to the student handbook for more details.

Academic Responsibility

A. Students are expected to arrive in class on time. Unexcused tardies in excess of 10 minutes will be treated as unexcused absences. Please refer to the Attendance and Tardiness Procedures section of the handbook. Work cannot be made up for unexcused absences.
B. Students are expected to bring proper materials to class including.
    1. Calculator
    2. Laptop computer
    3. Pen/pencil and paper
C. Students are expected to submit all assigned work by the designated time.
D. When in class, students are expected to be alert, to listen intently, and to actively participate in class activities scheduled for the day.
E. Students are expected to use their tablet computers to support class instruction.
F. Work missed during a counselor excused absence may or may not be made up at the discretion of the instructor.
G. Students are expected to leave class with notes from the lesson of the day.
H. Students should get help early. Options include:
    1. Office Hours/ Appointment with instructor
    2. Peer Tutor
    3. Email instructor

Laboratory Policies

Laboratory Policies: Students are expected to follow all safety rules as they are working in the laboratory. Each member of the lab group is expected to take an active role in collecting the data and performing the experiment. Raw data may be exchanged between lab partners, but each student is expected to do the analysis individually and answer the analysis questions in their own words. Laboratory reports must be submitted on turnitin.com for credit.

Collaborating on labs:
You may:

- Collect data together.
- Use the same Logger Pro graphs/data tables—and email the Logger Pro data to each other.
- DISCUSS how to answer questions, but write answers in your own words.
- DISCUSS how to do calculations, but write them out yourself.

You may not:

- Copy answers to questions from other people directly.
- Copy calculations from other people directly.
- Email each other a copy of the lab.
- Submit the same document as someone else.

Assessment Practices, Procedures, and Processes:

Assessments such as in class presentations, problem solving activities, laboratory reports, unit exams, quizzes, and a comprehensive final exam provide students opportunities to demonstrate what they have learned. A test will be given at the end of each of the three main units.

An **A** in the course indicates that the student has exceeded the expectations of the course. The student has a thorough understanding of the concepts in the course and can apply them in familiar and novel situations.

A **B** in the course indicates that the student has met the expectations of the course. The student has a good understanding of the concepts in the course and can apply them in a familiar context.

A **C** in the course indicates that the student has an understanding of the basic concepts in the course.

A **D** in the course indicates that the student has not met the minimum expectations of the course.

The assignments are broken into several categories. Within each category, the grade is the average of all the individual assignments. The grades are combined in the following proportion:

45% Unit tests
15% Labs
15% Quizzes
5% Quest assignments
20% Final exam

Sequence of Topics and Activities and Approximate Schedule:

Electrostatics (Chapter 21-25) (13 class days)

- Methods of charging (conduction and induction)
  - Charge lab with electroscope and neon discharge tube.
- Electric Force/Coulomb's law
  - Derivation with Coulomb's Apparatus
- Electric Fields
  - Map electric field with bowling balls (positive and negative) and vectors.
- Gauss's Law
- Electric potential (Voltage)
  - Map equipotential lines with conductive paper and ink.
- Capacitance
  - Determine physical dependence for capacitance.
  - Discuss the possibility of putting capacitors in electric cars.

Circuits (Chapters 26&27) (7.5 class days)

- Resistivity/Resistance
  - Determine physical dependence for resistance using conductive strips.
- Current/current density/drift velocity
- Ohm's Law
  - Determine whether or not a device is Ohmic using light bulb and resistor.
- Series and parallel circuits and combinations thereof
  - Derive relationships for capacitors and resistors in series and parallel.
  - Challenge lab with 2-pole, 3-pole, and 4-pole switches.
- RC Circuits
  - RC circuit lab

Magnetism and Electromagnetic Induction (Chapters 28,29,&30) (7 class days)

- Magnetic force and fields
  - Map magnetic field around various permanent magnets and moving charge.
- Fields due to current
  - Demonstration of field around current carrying wire and force on current carrying wire from another current carrying wire.
- Ampere's Law
- Induction (Faraday's Law, Lenz's Law)

    - Demonstrations, set up as stations, with moving magnet through a solenoid.
- RL circuits

Science Learning Standards

A. Students studying science at IMSA engage in the process of scientific inquiry by:
A.1 applying the skills of observation (describe, compare, and contrast characteristics; identify parameters, precisely observe phenomena).
A.3 carrying out investigations that develop skills, concepts, and processes that support and enable complex thought.
A.4 using appropriate technologies to collect, analyze and present information.
A.5 accurately recording findings.
A.7 employing scientific reasoning to evaluate the soundness and relevance of information.
A.8 constructing and supporting judgments based on evidence.
A.9 sharing results by communicating orally, in writing, and through display with power, economy, and elegance.

B. Students studying science at IMSA demonstrate understanding of energy and matter by:

B.3 applying the principles of conservation of mass, conservation of charge, and conservation of energy to a variety of problems and situations.
B.5 applying the relationships between work, heat and energy to analyze the behavior of systems.

C. Students studying science at IMSA demonstrate understanding of force and motion by:
C.1 using graphical and mathematical representations to analyze and predict the motion of objects.
C.2 using Newton's Laws to relate force and motion.
C.3 using the concept of a field to explain the transmission of force.

D. Students studying science at IMSA demonstrate understanding of our Universe, Solar System and Planet by:
D.4 examining the dynamics interactions within a planet.

Standards of Significant Learning and Outcomes:
The principal standards of significant learning addressed in this course are:
IA. Students expected to demonstrate automaticity in skills, concepts, and processes that enable complex thought by

- completing assigned problem sets. **FA**
- demonstrating proper use of laboratory equipment. **IA**
- demonstrating competence on quizzes and exams. **FA**

IB. Students expected to construct questions which further understanding, forge connections and deepen meaning by

- setting up laboratory experiments appropriately. **FA**

- analyzing data to draw conclusions. **FA**
- discussing labs and problem sets with peers. **NA**
- modeling systems supported by data/observations. **FA**

IC. Students expected to precisely observe phenomena and accurately record findings through
- data collection and observations. **FA**
- analysis of data generated from experiments. **FA**

ID. Students expected to evaluate the soundness and relevance of information and reasoning by
- drawing conclusions from laboratory data. **FA**
- evaluating the reasonableness of answers. **FA**
- evaluating models created from data/observations. **FA**

IIA. Students identify unexamined personal assumptions and misconceptions that impede and skew inquiry
- by completing pre-assessments and/or practice problems to solicit misconceptions. **IA**
- by reconciling data/observations and preconceptions. **FA**
- through assessment questions targeted at misconceptions. **FA**

IIIA. Students use appropriate technologies as extensions of the mind through
- daily use of tablets for completing work and referencing resources. **NA**
- use of calculators for problem solving. **NA**
- use of computer to collect and analyze data. **IA/FA**
- use of laboratory equipment for data analysis. **NA/IA**

IIIB. Students recognize, pursue, and explain substantive connections within and among areas of knowledge by
- connecting previous concepts in physics to current concepts through work in lab and problem sets. **IA/FA**
- applying content knowledge to alternative scenarios and/or new problems. **FA**

IIIC. Students recreate beautiful conceptions that give coherence to structures of thought by
- exploring the development of models (mathematical and conceptual). **NA**
- connecting concepts in physics to real world scenarios. **NA**

IVA. Students construct and support judgments based on evidence by
- drawing appropriate conclusions in lab work supported by data/analysis. **FA**

IVB. Students write and speak with power, economy, and elegance by
- communicating effectively in lab work/reports. **IA**
- explaining problems and asking questions during group discussions. **NA**
- showing work to clearly communicate problem solutions. **IA**

IVC. Students identify and characterize composing elements of systems
- through effectively laboratory set-ups to collect data appropriate to question. **IA**
- by breaking down a complicated problem in order to solve it. **IA**

VB. In order for students to make reasoned decisions which reflect ethical standards, and act in accordance with those decisions, students by
- accurately reporting data even if it seems problematic. **IA**
- submitting lab work and problem sets representing individual student work. **IA**