Comprehensive Course Syllabus

Course Title: Physics: Calculus Based Mechanics

Course Number: SCI411

Prerequisite:
- Scientific Inquiries - Physics or equivalent
- Successful completion of AB/BC I Calculus and concurrent enrollment in AB/BC II Calculus

Course Description: Calculus-based Physics/Mechanics follows the typical sequence of a university physics course. The semester is devoted to topics in classical mechanics including Newton's laws of motion, conservation of momentum and conservation of energy as they apply to both translational and rotational motion. The major emphasis of the course is on problem-solving including hands-on projects, labs, and theoretical problems. There is strong overlap between the curriculum and the AP Physics C Mechanics exam.

Course Instructors:

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Office Hours: TBA or as arranged with instructor

Meeting Days, Time and Room(s)

All Calculus Based Physics Classes Meet in B133

Text(s) / Materials:

Textbook: Halliday, D., R. Resnick, and J. Walker (1997). Fundamentals of Physics - Extended (9th Edition). Wiley & Sons Inc., NY.
Materials: Laptop Computer, Calculator

Essential Content/Learning Objectives

Kinematics:
- Solve multi-object, multi-interval problems.
- Understand the calculus derivation of the equations of motion.
- Use calculus to solve kinematics problems.
- Resolve a vector into its components and add vectors together to find the resultant.
- Understand that for motion in more than one dimension, the components of the velocity, acceleration and force vectors act independently of each other.

- Perform calculations for projectile motion under ideal conditions (no air resistance.)

Momentum
- Apply the concept of center of mass for systems of particles.
- Apply conservation of momentum concepts to the motion of one or more objects.
- Calculate the impulse due to a variable force.

Forces:
- Apply the concept of friction to a mechanical system.
- Determine the tension in a system that is accelerating.
- Solve problems on inclined planes.
- Apply Newton's second law to circular motion

Dynamic Systems with Rotational Motion
- Understand and apply rotational and translational equations of motion to an object.
- Solve for the center of mass of collection of discrete particles and a continuous distribution of mass using integral techniques.
- Solve for the rotational inertia of discrete particles and a continuous distribution of mass using integral techniques.
- Understand how to solve for the equations of motion in an Atwood's like machine involving tension where the pulley has mass.
- Resolve the internal forces and torques in a system in static equilibrium.
- Design a complicated structure to be in static equilibrium. (project)

Energy/Conservation Laws with Rotational Motion
- Solve problems with Hooke's Law
- Apply conservation of energy concepts to the motion of one or more objects.
- Calculate the work done by a variable force.
- Solve a launcher problem where the rod of the launcher has mass.
- Apply work, power, and energy concepts to the motion of an object in rotational and translational motion.
- Understand the physics involved with an object rolling with or without slipping
- Solve the ballistic pendulum problem where the rod of the pendulum has mass.

Gravitation:
- Know and be able to apply Newton's Universal Law of Gravitation
- Solve for the orbital velocity of an object orbiting in a circle.
- Solve for the gravitational potential energy of a system of objects.
- Apply the law of conservation of energy to a system of particles.
- Apply the law of conservation of energy to an object in orbit.
- Solve for the escape velocity of an object in orbit.
- Solve for the gravitation force acting on an object inside of the earth.

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, 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

1. 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.
2. Students are expected to bring proper materials to class including.
    a. Calculator
    b. Laptop computer
    c. Pen/pencil and paper
3. Students are expected to submit all assigned work by the designated time. Late work will receive penalties as determined by each instructor.
4. When in class, students are expected to be alert, to listen intently, and to actively participate in class activities scheduled for the day.
5. Students are expected to leave class with notes from the lesson of the day.
6. Students are expected to use their laptop computers to support class instruction.
7. Work missed during a counselor excused absence may or may not be made up at the discretion of the instructor.
8. Students should get help early.
    1. Office Hours/ Appointment with instructor
    2. Peer Tutor
    3. Email instructor

Laboratory Policies

Violating safety rules may result in penalties or students may not receive credit for that activity/experiment.

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:

- Use only one self-check spreadsheet per group.
- 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 problem solving activities, laboratory reports, quizzes, unit tests, and a comprehensive final exam provide students opportunities to demonstrate what they have learned. Tests will be given at the end of each unit.

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.

Scale:	93-100	A,	90-92	A-		
	87-89	B+,	83-86	B,	80-82	B-,
	77-79	C+,	73-76	C,	70-72	C-,
	Below 70	D				

Grading

The assignments are broken into several categories. Within each category, the grade is the based on the point value of 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: (See Moodle course page)

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.

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**