University of New Haven
COLLEGE OF ARTS AND SCIENCES
Department of Mathematics and Physics

§ I: PHYS 1150 Mechanics, Heat & Waves Syllabus

Catalog Description

Prerequisite: MATH 1117. Corequisite: PHYS 1151 – you must enroll in a section of PHYS 1151 before you can enroll in PHYS 1150. Introductory course for physical science and engineering majors. Kinematics, Newton's laws, conservation principles for momentum, energy and angular momentum. Thermal physics. Basic properties of waves, simple harmonic motion, superposition principle, interference phenomena, and sound. Laboratory fee. 4 credits.

Required Textbook

University Physics with Modern Physics, by H. D. Young and R. A. Freedman, Addison-Wesley, 14e, Chapters 1-20, ISBN 9780321973610 (2015).

Course Objectives

This course is a first semester, calculus based physics course for physical science and engineering majors. It introduces basic concepts, theory, and applications of classical mechanics (matter and motion, kinematics and dynamics of particles, rigid and elastic bodies, fluids, waves) and thermal physics (heat, thermodynamic processes). This course:

1. Introduces basic physics concepts in mechanics and thermodynamics;
2. Provides students with the fundamental understanding of the principles and laws of classical physics;
3. Teaches problem solving techniques;
4. Helps to develop analytical thinking;
5. Introduces the applications of differential and integral calculus in physics;
6. Teaches how to apply the physical principles and knowledge to other disciplines; and,
7. Demonstrates how observation, experiment, and theory work together to continue to expand the frontiers of knowledge of the physical Universe.

The emphasis is on improved critical thinking skills, and on developing an ability to approach and solve physics problems.

Student Learning Outcomes

Students passing this course should be able to:

1. Explain the basic concepts and laws in mechanics, CC4.1.1;
2. Use the equations of kinematics, Newton's laws of dynamics, free body diagrams, and conservation laws to determine the motion of physical bodies, CC4.1.2;
3. Explain the basic concepts and laws in thermodynamics, CC4.1.1;
4. Convert a physical situation articulated in English to a mathematical formulation, CC4.1.2;
5. Apply basic mathematical tools, including vectors and calculus, to solve physics problems, CC4.1.2;
6. Exercise the use of physical intuition, including the ability to guess an approximate or conceptual answer to a physics problem;
7. Recognize whether or not the result of a calculation makes physical sense;
8. Apply the physical knowledge to other disciplines, including physical sciences and engineering; and,
9. Illustrate how physical observation, experiment, and theory worked together to develop inventions that advanced our civilization, CC4.1.3.

Students will also achieve the following Core Learning Objectives:

10. the student will be able to articulate structural and/or functional aspects of elements of a portion of the natural world;
11. use discipline-specific methodologies and technologies to draw conclusions about natural phenomena; and
12. illustrate the effects of scientific knowledge and progress on societal issues.

Required Curriculum Content

Key topics covered include:

1. Physical quantities, units, scalars and vectors, components of vectors, vector addition, vector multiplication.
2. Motion in one dimension: displacement, time, average velocity, instantaneous velocity, acceleration, motion with constant acceleration, freely falling bodies, applications of derivatives and integrals in computing the position, velocity, and acceleration functions of a moving object.
3. Motion in two or three dimensions: position, velocity, and acceleration vectors, projectile motion, motion in a circle, relative velocity.
4. Newton's laws of motion: force and interactions, Newton's first law, Newton's second law, mass and weight, Newton's third law, free-body diagrams, particles in equilibrium, dynamics of particles, friction.
5. Energy: work, kinetic energy and the work-energy theorem, varying forces, power, gravitational potential energy, elastic potential energy, conservation of energy, conservative forces, energy gradient.
6. Momentum: momentum and impulse, conservation of momentum, elastic and inelastic collisions, center of mass.
7. Rotation of rigid bodies: angular displacement, velocity and acceleration, rotation with constant angular acceleration, relating linear and angular kinematics, energy in rotational motion, moment of inertia, parallel-axis theorem.
8. Dynamics of rotational motion: torque, angular momentum, conservation of angular momentum, Newton's second law for rotational motion, rigid-body rotation about a moving axis, work and power in rotational motion, precession.
9. Statics: mechanical equilibrium, center of gravity, rigid bodies in equilibrium, strain and stress in elastic bodies.
10. Fluid mechanics: density, pressure in a fluid, buoyancy, fluid flow, Bernoulli's equation.
11. Gravitation: Newton's law of gravitation, weight, gravitational potential energy, Kepler's laws and motion of planets.
12. Periodic motion: oscillations, simple harmonic motion, energy in harmonic motion, simple pendulum, physical pendulum.
13. Mechanical waves: periodic waves, speed of a transverse wave, wave interference, standing waves on a string.
14. Sound: sound waves, speed of sound waves, resonance, beats, Doppler effect.
15. Temperature and heat: temperature and thermal equilibrium, thermal expansion, quantity of heat, phase changes, heat transfer.
16. Thermal properties of matter: equations of state, ideal gas law, kinetic-molecular model of an ideal gas, heat capacities, phases of matter.
17. First law of thermodynamics: thermodynamic work, internal energy, thermodynamic processes, internal energy of an ideal gas, heat capacities of an ideal gas, adiabatic process.
18. Second law of thermodynamics: directions of thermodynamic processes, heat engines, efficiency of engines, entropy.

All sections of PHYS 1150 Mechanics, Heat & Waves will cover, as a minimum, the material from *University Physics with Modern Physics*, by H. D. Young and R. A. Freedman, Addison-Wesley, 14e, Chapters 1-20, ISBN 9780321973610 (2015), as listed:

Section	Textbook Topic
	MECHANICS

Section	Textbook Topic
	Chapter 1 - Units, Physical Quantities, and Vectors
1.1	The Nature of Physics
1.2	Solving Physics Problems
1.3	Standards and Units
1.4	Using and Converting Units
1.7	Vectors and Vector Addition
1.8	Components of Vectors
1.9	Unit Vectors
1.10	Products of Vectors
	Chapter 2 - Motion Along a Straight Line
2.1	Displacement, Time, and Average Velocity
2.2	Instantaneous Velocity
2.3	Average and Instantaneous Acceleration
2.4	Motion with Constant Acceleration
2.5	Freely Falling Bodies
2.6	Velocity and Position by Integration
	Chapter 3 - Motion in Two or Three Dimensions
3.1	Position and Velocity Vectors
3.2	The Acceleration Vector
3.3	Projectile Motion
3.4	Motion in a Circle
3.5	Relative Velocity
	Chapter 4 - Newton's Laws of Motion
4.1	Force and Interactions
4.2	Newton's First Law
4.3	Newton's Second Law
4.4	Mass and Weight
4.5	Newton's Third Law
4.6	Free-Body Diagrams
	Chapter 5 - Applying Newton's Laws
5.1	Using Newton's First Law: Particles in Equilibrium
5.2	Using Newton's Second Law: Dynamics of Particles
5.3	Friction Forces
5.4	Dynamics of Circular Motion
	Chapter 6 - Work and Kinetic Energy
6.1	Work
6.2	Kinetic Energy and the Work-Energy Theorem
6.3	Work and Energy with Varying Forces
6.4	Power
	Chapter 7 - Potential Energy and Energy Conservation
7.1	Gravitational Potential Energy
7.2	Elastic Potential Energy
7.3	Conservative and Nonconservative Forces
7.4	Force and Potential Energy
	Chapter 8 - Momentum, Impulse, and Collisions
8.1	Momentum and Impulse
8.2	Conservation of Momentum

Section	Textbook Topic
8.3	Momentum Conservation and Collisions
8.4	Elastic Collisions
8.5	Center of Mass
	Chapter 9 - Rotation of Rigid Bodies
9.1	Angular Velocity and Acceleration
9.2	Rotation with Constant Angular Acceleration
9.3	Relating Linear and Angular Kinematics
9.4	Energy in Rotational Motion
9.5	Parallel-Axis Theorem
9.6	Moment-of-Inertia Calculations
	Chapter 10 - Dynamics of Rotational Motion
10.1	Torque
10.2	Torque and Angular Acceleration for a Rigid Body
10.3	Rigid-Body Rotation About a Moving Axis
10.4	Work and Power in Rotational Motion
10.5	Angular Momentum
10.6	Conservation of Angular Momentum
	Chapter 11 - Equilibrium and Elasticity
11.1	Conditions for Equilibrium
11.2	Center of Gravity
11.3	Solving Rigid-Body Equilibrium Problems
	Chapter 12 - Fluid Mechanics
12.1	Gases, Liquids, and Density
12.2	Pressure in a Fluid
12.3	Buoyancy
12.4	Fluid Flow
12.5	Bernoulli's Equation
	Chapter 13 - Gravitation
13.1	Newton's Law of Gravitation
13.2	Weight
13.3	Gravitational Potential Energy
13.4	The Motion of Satellites
13.5	Kepler's Laws and the Motion of Planets
	Chapter 14 - Periodic Motion
14.1	Describing Oscillation
14.2	Simple Harmonic Motion
14.3	Energy in Simple Harmonic Motion
14.4	Applications of Simple Harmonic Motion
14.5	The Simple Pendulum
14.6	The Physical Pendulum
	WAVES/ACOUSTICS
	Chapter 15 - Mechanical Waves
15.1	Types of Mechanical Waves
15.2	Periodic Waves
15.3	Mathematical Description of a Wave
15.4	Speed of Transverse Wave
15.6	Wave Interference, Boundary Conditions, and Superposition

Section	Textbook Topic
15.7	Standing Waves on a String (in Lab)
15.8	Normal Modes of a String (in Lab)
	Chapter 16 - Sound and Hearing
16.1	Sound Waves
16.3	Sound Intensity
16.5	Resonance and Sound
16.8	The Doppler Effect
	THERMODYNAMICS
	Chapter 17 - Temperature and Heat
17.1	Temperature and Thermal Equilibrium
17.2	Thermometers and Temperature Scales
17.3	Gas Thermometers and the Kelvin Scale
17.4	Thermal Expansion
17.5	Quantity of Heat
17.6	Calorimetry and Phase Changes (in Lab)
17.7	Mechanisms of Heat Transfer
	Chapter 18 - Thermal Properties of Matter
18.1	Equations of State
18.2	Molecular Properties of Matter
18.3	Kinetic-Molecular Model of an Ideal Gas
18.4	Heat Capacities
	Chapter 19 - The First Law of Thermodynamics
19.1	Thermodynamic Systems
19.2	Work Done During Volume Changes
19.3	Paths Between Thermodynamic States
19.4	Internal Energy and the First Law of Thermodynamics
19.5	Kinds of Thermodynamic Processes
19.6	Internal Energy of an Ideal Gas
19.8	Adiabatic Processes for an Ideal Gas
	Chapter 20 - The Second Law of Thermodynamics
20.1	Directions of Thermodynamic Processes
20.2	Heat Engines
20.4	Refrigerators
20.5	The Second Law of Thermodynamics
20.6	The Carnot Cycle
20.7	Entropy
20.8	Microscopic Interpretation of Entropy

Common Department Requirements for PHYS 1150

While students in each section of PHYS 1150 are assessed by the course instructor, there are general guidelines that apply to all sections of PHYS 1150. These include:

- All students registered for PHYS 1150 must be registered for a section of the laboratory course PHYS 1151.
- 25% of the course grade is based on the laboratory PHYS 1151. The Department requires that at least 60% of the course grade be based on in-class exams, i.e., homework and out-of-class projects must

constitute no more than 15% of the final grade.

- A passing grade in the laboratory PHYS 1151 is required to pass PHYS 1150.
- Withdrawal from PHYS 1150 results in withdrawal from PHYS 1151, and vice versa. Students repeating PHYS 1150 must also repeat PHYS 1151, and vice versa.
- The final examination constitutes 25% of the course grade. All sections of PHYS 1150 which run at the same time give the same final exam. A final exam assesses Student Learning Outcomes 1–5.
- Electronic devices are not allowed on any exams, except calculators provided by the Department.

Department, College and University Expectations and Policies

It is important that students familiarize themselves with a range of policies and guidelines that have been established by the Department of Mathematics and Physics, the College of Arts and Sciences, and the University of New Haven. These are an integral part of the syllabus for this course.

Adding/Dropping a Class

The final day to drop this course without it appearing on your transcript is discussed on the **Academic Schedules and Registration** web page. After the first week of class, self-service registration will not be enabled for students to directly add or drop classes. Students should contact the Registrar's office directly or the Academic Success Center for assistance with adding and dropping courses during this time.

Attendance Regulations

University attendance policy guidelines require that:

> Students are expected to attend regularly and promptly all their classes, appointments, and exercises. While the university recognizes that some absences may occasionally be necessary, these should be held to a minimum. A maximum of two weeks of absences will be permitted for illness and emergencies. The instructor has the right to dismiss from class any student who has been absent more than the maximum allowed. A dismissed student will receive a withdrawal (W) from the course if they are still eligible for a withdrawal per the university Withdrawal from a Course policy, or a failure (F), if not. A student who is not officially registered in the course is not permitted to attend classes or take part in any other course activities. Students absent from any class meeting are responsible for making up missed assignments and examinations at the discretion of the instructor.

Students are to adhere to the policy attendance policy guidelines outlined in the University Catalog under the heading, *Attendance Regulations*, found online in the **Undergradaduate Catalog** or alternatively found in the **Student Handbook** on **pp.48-49**.

Religious Observance Policy for Students

The University of New Haven respects the right of its students to observe religious holidays that may necessitate their absence from class or from other required university-sponsored activities. Students who wish to observe such holidays should not be penalized for their absence, although in academic courses they are responsible for making up missed work. The College provides that,

> Instructors should try to avoid scheduling exams or quizzes on religious holidays, but where such conflicts occur should provide reasonable accommodations for missed assignment deadlines or exams. If a class, an assignment due date, or exam interferes with the observance of such a religious holiday, it is the student's responsibility to notify their instructor, preferably at the beginning of the term, but otherwise at least two weeks before the holiday.

More information about religious observance policies can be found in the Student Handbook on **pp.48-49** under the heading, *Attendance Policies: Religious Observance Policy for Students*.

Withdrawal from a Course

Students wishing to withdraw must submit a request for an official course withdrawal in writing using the online **Course Withdrawal Form**, or alternatively complete and hand in the pdf based **Course Withdrawal Form**. The final date to request a withdrawal is listed in the **Academic Calendar**. This request must be submitted to the Registrar's Office and signed by the International Office if you are an international student. The grade of W will be recorded, but the course will not affect the GPA. [1]

Incomplete Grade Policy

A grade of Incomplete (INC) is given only in special circumstances and indicates that the student has been given permission by the instructor to complete required course work (with the same instructor) after the end

[1] Please note that it is the responsibility of the student to assure that the required paperwork and documentation is completed by the deadline.

of the term. In the absence of the instructor a student should contact the Department Chair. Students need to examine carefully the **changed guidelines** pertaining to INC grades, specifically:

> To remove the INC grade, the student must complete all required course work in timely fashion as stipulated by the instructor but no later than the end of the following term. Fall and intersession course incomplete grades must be completed no later than the last day of the spring term. Spring and summer course incomplete grades must be completed no later than the last day of the fall term.
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> If the course work is not submitted within the allotted time, the INC grade will be changed to an F shortly after the deadline by the Office of the University Registrar. Students will be notified via campus email at least two weeks prior to the change of grade process.

The University policy on incomplete grades is discussed in the **Academic Catalog** under the heading, *Incomplete (INC) Grade Policy*.

Academic Integrity Policy and Procedures

The University of New Haven expects its students to maintain the highest standards of academic conduct. Academic dishonesty is not tolerated at the University. To know what it is expected, students are responsible for reading and understanding the statement regarding academic honesty in the Student Handbook. Specifically, students are required to adhere to the Academic Integrity Policies specified in the **Student Handbook**, i.e., on **pp.66-73**.

Please ask your instructor about their expectations regarding permissible or encouraged forms of student collaboration if there is any confusion about this topic. The Department of Mathematics and Physics fully adheres to the Academic Integrity Policy:

> Academic integrity is a core university value that ensures respect for the academic reputation of the University, its students, faculty and staff, and the degrees it confers. The University expects that students will conduct themselves in an honest and ethical manner and respect the intellectual work of others. Please be familiar with the University's policy on Academic Integrity. Please ask about expectations regarding permissible or encouraged forms of student collaboration if they are unclear.

Coursework Expectations

This course will require significant in-class and out-of-class commitment from each student. The University estimates that a student should expect to spend two hours outside of class for each hour they are in a class. For example, a three credit course would average six [6] hours of additional work outside of class.[2] Coursework expectations are detailed in the **Academic Catalog** under the heading, *Course Work Expectations*.

Please note, that PHYS 1150 is a 4-credit course, and as such requires a total of 12 hours per week invested in study and homework for the average student.

Commitment to Positive Learning Environment

The University adheres to the philosophy that all community members should enjoy an environment free of any form of harassment, sexual misconduct, discrimination, or intimate partner violence. If you have been the victim of sexual misconduct we encourage you to report this. If you report this to a faculty/staff member, they must notify our college's Title IX coordinator about the basic facts of the incident (you may choose to request confidentiality from the University). If you encounter sexual harassment, sexual misconduct, sexual assault, or discrimination based on race, color, religion, age, national origin, ancestry, sex, sexual orientation, gender identity, or disability please contact the Title IX Coordinator, Caroline Koziatek at (203)-932-7479 or **CKoziatek@newhaven.edu**. Further online information about is available at **Title IX**.

Reporting Bias Incidents

At the University of New Haven, there is an expectation that all community members are committed to creating and supporting a climate which promotes civility, mutual respect, and open-mindedness. There also exists an understanding that with the freedom of expression comes the responsibility to support community

[2] Please note that study guidelines are important, i.e., there is substantial evidence that shows that the pass rates for students in math courses decrease dramatically as the time spent on outside study falls below 2 hours of homework per credit per week.

members' right to live and work in an environment free from harassment and fear. It is expected that all members of the University community will engage in anti-bias behavior and refrain from actions that intimidate, humiliate, or demean persons or groups or that undermine their security or self-esteem.

If you have witnessed or are the target of a bias-motivated incident, please contact the Office of the Dean of Students at 203-932-7432 or Campus Police at 203-932-7014. Further information about this and other reporting options may be found at **Report It**.

University Support Services

The University recognizes students often can use some help outside of class and offers academic assistance through several offices. In addition to discussing any academic issues you may have with your instructor, advisor, or with the the courses or department coordinator or chair, the University provides these additional resources for students:

The Center for Academic Success and Advising (CASA)

The **Academic Success Center** is located in Maxcy 208 for help with your academic studies, or call 203-932-7234 to set up an appointment.

University Writing Center

The mission of the Writing Center (an expansion of the **Writer to Writer** peer-tutoring program) is to provide high-quality tutoring to undergraduate and graduate students as they write for a wide range of purposes and audiences. Tutors are undergraduate and graduate students and they work with students at any stage in the writing process; Bring in your assignment, your ideas, and any writing done so far. To make an appointment, register for an account at **https://newhaven.mywconline.com**.

The Math Zone

Please contact the **Math Zone** if you wish to challenge your Math Placement by taking a Math Challenge Exam or by taking a Math Post Placement Exam. These are discussed more extensively at **http://math.newhaven.edu/mathphysics/placement_html**. The Math Zone also provides a range of tutoring and classroom support service for students taking development math classes.

The Center for Learning Resources (CLR)

The **Center for Learning Resources** located in Peterson Library, provides academic content support to the students of the University of New Haven using metacognitive strategies that help students become aware of and learn to apply optimal learning processes in the pursuit of creating independent learners CLR tutors focus sessions on discussions of concepts and processes and typically use external examples to help students grasp and apply the material.

Accessibility Resources Center

Students with disabilities are encouraged to share, in confidence, information about needed specific course accommodations. The **Accessibility Resources Center** (ARC) provides comprehensive services and support that serve to promote educational equity and ensure that students are able to participate in the opportunities available at the University of New Haven. Accommodations cannot be made without written documentation from the ARC. The ARC is located on the ground floor in the rear of Sheffield Hall. Sheffield Hall is located in the Residential Quad area, and can be contacted at 203-932-7332. The ADA/Section 504 Compliance Officer is Rebecca Johnson, **RJohnson@newhaven.edu**, and can be reached by phone at 203-932-7238. Information on the ARC can be found at

Counseling and Psychological Services

The Counseling Center offers a variety of services aimed at helping students resolve personal difficulties and acquire the balance, skills, and knowledge that will enable them to take full advantage of their experience at the University of New Haven. Information about the, **Counseling and Psychological Services**, is available online.