PHYS 121

Integrated Science - Physics

Fall 2025, Session 2

Days/meeting time:

MoTuWeTh 10:00 AM-11:15 AM	IB 1046, class meetings
Mo 2:45 PM - 4:00 PM	IB 1047, recitation
WeTh 2:45 PM - 5:45 PM	IB 2046, lab (once per week)

Course format: lecture + recitation+ lab

Instructor's Information

Dr. Changcheng Zheng, Associate Professor of Physics, Duke Kunshan University.
Office: WDR3012.
Office hours: Mon. 1:30 PM – 2:30 PM; Fri. 1:30-3:15 (tentative). (tentative).
Personal Zoom meeting ID: 955 391 1684
Email: changcheng.zheng@dukekunshan.edu.cn
Website: https://scholars.duke.edu/person/changcheng.zheng

My research interests include: Optical properties of semiconductors and nanostructures; Exciton dynamics in bulk and low-dimensional systems under different excitation conditions; Nonlinear optical properties of novel luminescent/fluorescent materials. The experiments carried out in my lab use various kinds of lasers as the excitation source, which are advanced topics that will be discussed in future courses. I am very excited to explore the world around us through classic physics together with students.

What is this course about?

This course is about how to view the world from the perspective of classical mechanics, based on an understanding of the core concepts and theoretical laws. As a science foundation course, it helps students appreciate the elegant simplicity of the universal laws governing the complex systems surrounding us, from a particle to a star, and it teaches an important approach to identifying, formulating, and solving problems encountered in the physical world.

The course begins with the core concepts of classical mechanics–time, space, mass, force, work, energy, and momentum–and the physical laws that link them with each other. Students first learn Newton's laws and the universal law of gravitation as they apply to point mass systems. Subsequently, basic concepts of oscillation and waves, rigid body motion, fluid mechanics, thermodynamics, and statistical mechanics are introduced, illustrated with real-life examples (e.g., physics of cooking, biosphere as a thermal engine) to help students integrate different science foundation courses by themselves.

Throughout the course, lecture, homework, and other activities reinforce understanding by requiring the formulation of mathematical descriptions of the systems of interest and the scientific interpretation of the

mathematical analysis. In the lab component of the course, concepts introduced in lectures are illustrated and explored in hands-on experiments where students learn both classical lab skills and computer-assisted techniques for data acquisition and analysis in groups of 2-3 students.

What background knowledge do I need before taking this course?

Prerequisite: MATH 101 or 105.

What will I learn in this course?

General, overarching learning objectives for the course.

By the end of this course, you are expected to:

- Demonstrate the capability of discovery-based learning through questioning and verifying the established theoretical framework with experiments.
- Write solutions to problems in a manner that clearly displays the reasoning leading to precisely specified answers.
- Collaborate and communicate effectively on the reasoning process.
- Implement the core concepts of physics in understanding, predicting, and controlling complex systems (such as chemical and biological systems) surrounding us.

Specific foundations of science knowledge learned in the course.

By the end of this course, you should be able to:

1. Describe point mass movement in three-dimensional space.
2. Apply Newton's laws for understanding, predicting, and controlling point mass movements.
3. Apply energy and momentum conservation laws to describe point mass movements in inertial systems.
4. Predict energy loss using simple models of friction or viscous drag forces.
5. Describe the trajectories of two colliding bodies in a point-mass system.
6. Analyze un-damped, damped, and forced oscillations of spring-mass systems and apply to other oscillatory systems.
7. Describe and perform basic calculations about behaviors of mechanical waves in a rope or air (sound).
8. Apply the balance of force and torque to describe the static equilibrium of a rigid body.
9. Describe the dynamic behavior of a rigid body.
10. Describe the state of matter qualitatively.
11. Describe the static and dynamic behavior of fluid.
12. Interpret thermodynamic laws from a microscopic perspective with the help of kinetic gas theory.

What will I do in this course?

- Pre-class concept learning followed by a short quiz to be answered in a weekly/daily manner.
- In-class discussions and peer-instruction activities in recitations.
- After-class assignments (weekly homework).
- Hands-on experiments in the labs, lab reports writing.
- Presentation about lab work or other topics in the course and peer evaluation of others' presentations.
- Mid-term and final written exams.

How can I prepare for the class sessions to be successful?

- ✓ Learn the core concepts by means of pre-class reading of the textbook (try to summarize each session with one or two key points for each chapter), check the outcome with the short quiz.
- ✓ Check from the 1st week your progress in key concept learning, particularly whether the questions you had in mind are resolved or not.
- ✓ Come to class meetings with an engaging attitude and participate in 'in-class' activities; work independently and also collaborate with your peers; and take the initiative to present your work to others.
- ✓ Work independently on the assignment (weekly homework, etc.), before consulting the others.
- ✓ Take the initiative to answer questions raised by your peers during 'in- and out-class' activities.
- ✓ Practice how to work collaboratively while conducting the lab experiments.
- ✓ Start the assignments once they are published.

What required texts, materials, and equipment will I need?

University Physics (volume 1), https://openstax.org/books/university-physics-volume-1/pages/1-introduction
(volume 2, first 4 chapters) https://openstax.org/details/books/university-physics-volume-2
Other reading materials will be provided online via the Canvas platform.

What optional texts or resources might be helpful?

The following textbooks and websites are particularly useful:

- Halliday D., Resnick R. & Walker, J. *Fundamentals of physics*. (Wiley, 2014).
- Douglas C. Giancoli, Physics for Scientists & Engineers with Modern Physics, (Pearson, 2008)
- Feynman Lectures on Physics, Vol. 1 (http://www.feynmanlectures.caltech.edu/I_toc.html)
- Nelson P. Biological Physics (Macmillan 2013)
  [Author's website: http://www.physics.upenn.edu/biophys/BP/]
- Hyperphysics (http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)
- Phet (https://phet.colorado.edu/en/simulations/category/physics)
- The PhyPhox App for making measurements with your smartphone: https://phyphox.org/
- Wikipedia

How will my grade be determined?

ACTIVITIES	PERCENTAGES	DETAILS
Pre-topic quizzes	10%	Mainly multiple-choice questions
Homework	20% + bonus	Weekly, bonus from students' presentations/discussions.
Lab practice	15%	1 mini lab+1 training lab+2 full lab reports.
Presentation	8%	Report and presentation about a DIY lab.
Mid-term exam	15%	
Final exam	32%	

The course grade (letter) is determined by your overall numerical score using a standard 10-point scale, following the standard of DKU (below).

A+= 98% - 100% **A** = 97% - 93%; **A-** = 90% - 92%; **B+** = 87% - 89%; **B** = 83% - 86%; **B-** = 80% - 82%; **C+** = 77% - 79%; **C** = 73% - 76%; **C-** = 70% - 72%; **D+** = 67% - 69%; **D** = 63% - 66%; **D-** = 60% - 62% **F** = 59% and below

What are the course policies?

Specific policy for PHYS 121 (to be updated):

- Pre-topic quizzes will be published online before a new topic starts (typically the 1st lecture of each week).
- Lecture notes will be published on Canvas (mostly in PPT slides).
- Homework will also be published on Canvas as usual. It should be submitted via Gradescope. While grading, more individual feedback will be provided, and details will be discussed during recitations (attendance is highly recommended).
- Problems in each assignment should be worked out by yourself. Every student should present at least once his|her solution to the others during recitations. You are encouraged to form learning groups to discuss the 'question of the week' (open question, if any).
- You will work in a small group during the lab course and prepare one report for each student. In addition to the report, you are required to hand in your lab notebook (both to Gradescope) for grading. Guidelines will be provided in Week 1.
- You are expected to check Canvas site and your email frequently (at least daily) to get course updates, including course materials, organizational news, etc.
- Office hours will be arranged as shown at the beginning of this document or per Email arrangement. You need to include a list of questions in your email to facilitate communications.
- You may bring one A4-sized *self-written* sheet of notes to the final exam (TBC).

Grading rubrics:

As much as possible, the instructor will focus on a **holistic approach to grading**. This means that your grade will be worked down into four basic categories, and you will be allocated a percentage according to how well you performed in a category. Note that specific grading rubrics for lab report and DIY lab presentation will be shared with you at the beginning of relevant sessions. The following breakdowns give you a brief idea about how this is arranged:

1. Starting point (25%)
    a. Uses good foundational physics/reasoning to set up the problem 25%
    b. Reasonable, but incorrect physics foundations 20%
    c. Starting point has good physics, but won't lead to a solution 15%
    d. No clear starting point 0%
2. Solution path (30%)
    a. Clearly communicates how the solution is derived from the starting point to the ending point 30%
    b. Uses some words or pictures to show the path of the solution, but not always clear 25%
    c. Correct path, though missing important steps 20%
    d. Incorrect but consistent path, steps are clearly presented 20%

    e. Incomplete steps made without clear derivation 10%
    f. No reasonable solution path 0%
3. Solution Techniques (25%)
    a. Completely correct solution 25%
    b. Solid math, approximation, and derivations, with no more than one minor math error 20%
    c. Strong derivation, but with more than one minor math error 15%
    d. Strong derivation, but with some significant math errors 10%
    e. Poor derivation, but some sparks of potential 5%
    f. No derivation 0%
4. The Final Answer(s) (20%)
    a. Arrives at the accepted answer with a particularly creative or simple solution 20%
    b. Arrives at the accepted answer with brute force solution 17%
    c. Arrives at an incorrect but reasonable answer, given the approach and original assumptions 15%
    d. Incorrect answer that is inconsistent with own assumptions 10%
    e. No final answer that could reasonably be derived from any work on page 0%

You should expect to get one entry selected in each of the four categories, based on your work. There could be adjustments: it might be possible that your approach merits more points, or your transgressions are more severe.

Creativity is encouraged: If you solve a problem with a unique method that is simpler and clearer than the posted technique, you will get all points. If you think that your solution is not properly assessed, then ask for a regrade, pointing out why you think that you should get a different assessment, but all the while referring to the rubric above. **Gradescope** will be the method of submission for graded work; it naturally allows for feedback using the above rubric and has provisions for changes and adjustments as necessary!

Late submissions are not accepted unless a compelling response is provided in advance (before the original deadline), which needs to be confirmed with the instructor.

Communications:
Email communication with the course instructor is preferred and will be answered in a timely manner. When asking questions about the example/quiz/homework etc., please describe the question with details and your initial thoughts (picture or screenshot, if possible).

Discussion Guidelines:
Civility is an essential ingredient for academic discourse. All communications for this course should be conducted constructively, civilly, and respectfully. Differences in beliefs, opinions, and approaches are to be expected. Please bring any communications you believe to be in violation of this class policy to the

attention of your instructor. Active interaction with peers and your instructor is essential to success in this course, paying particular attention to the following:

- Be respectful of others and their opinions, valuing diversity in backgrounds, abilities, and experiences.
- Challenging the ideas held by others is an integral aspect of critical thinking and the academic process. Please word your responses carefully, and recognize that others are expected to challenge your ideas. A positive atmosphere of healthy debate is encouraged.
- Read your online discussion posts carefully before submitting them.

Academic Integrity:

As a student, you should abide by the academic honesty standard of Duke Kunshan University. The DKU Community Standard states: "Duke Kunshan University is a community comprised of individuals from diverse cultures and backgrounds. We are dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Members of this community commit to reflecting upon and upholding these principles in all academic and non-academic endeavors, and to protecting and promoting a culture of integrity and trust." For all graded work, students should pledge that they have neither given nor received any unacknowledged aid (including AI technologies).

You are encouraged to discuss with each other about questions in the quiz/homework/lab report. However, you should write your final solutions/answers by yourself which demonstrates your own thoughts. Direct copy-paste is not acceptable.

Generative AI:

As a student, you are encouraged to make your best effort to solve all homework and project problems on your own before seeking any outside assistance. After you have attempted the work independently, you may consult AI tools, discuss with peers, or ask the instructor for guidance. However, the solutions you submit must always be written in your own words and reflect your own understanding. To promote transparency and academic integrity, every assignment should include a short statement describing how AI tools (if any) were used—for example, whether you asked an AI tool for hints, checked a derivation, generated a plot, or compared approaches. This ensures that AI assistance supports your learning without replacing the essential process of working through the material yourself.

Academic Policy & Procedures:

You are responsible for knowing and adhering to academic policy and procedures as published in the University Bulletin and Student Handbook. Please note, an incident of behavioral infraction or academic dishonesty (cheating on a test, plagiarizing, use of online tools prohibited by the instructor at the course or assignment level, etc.) will result in immediate action from me, in consultation with university administration (e.g., Dean or Associate Dean of Undergraduate Studies, Student Conduct, Academic

Advising). Please visit the Undergraduate Studies website for additional guidance related to academic policy and procedures. Academic integrity is everyone's responsibility.

Academic Disruptive Behavior and Community Standard:

Please avoid all forms of disruptive behavior, including but not limited to: verbal or physical threats, repeated obscenities, unreasonable interference with class discussion, making/receiving personal phone calls, text messages or pages during class, excessive tardiness, leaving and entering class frequently without notice of illness or other extenuating circumstances, and persisting in disruptive personal conversations with other class members. Please turn off phones, pagers, etc. during class unless instructed otherwise. Laptop computers may be used for class activities allowed by the instructor during synchronous sessions. If you choose not to adhere to these standards, I will take action in consultation with university administration (e.g., Dean of Undergraduate Studies, Student Conduct, Academic Advising).

Academic Accommodations:

Duke Kunshan University makes reasonable academic accommodations for qualified students with disabilities. All undergraduate accommodations must be approved through the Student Accommodation Services. Students requesting accommodations for this course should forward their official accommodation letter to the instructor and ask to schedule a time to meet and discuss the implementation of their accommodation(s). It is the student's responsibility to meet, discuss, and provide an electronic copy of the Instructor Accommodation Letter to each instructor. Accommodations will not be granted retroactively. Accommodations for test, quiz, or exam taking must be arranged with the professor at least a week before the date of the quiz, test or exam, including finals.

What campus resources can help me during this course?

Academic Advising and Student Support

Please consult with me about appropriate course preparation and readiness strategies, as needed. Consult your academic advisors on course performance (i.e., poor grades) and academic decisions (e.g., course changes, incompletes, withdrawals) to ensure you stay on track with degree and graduation requirements. In addition to advisors, staff in the Academic Resource Center can provide recommendations on academic success strategies (e.g., tutoring, coaching, student learning preferences). Please visit the Office of Undergraduate Advising website for additional information related to academic advising and student support services.

Writing and Language Studio

For additional help with academic writing—and more generally with language learning—you are welcome to make an appointment with the Writing and Language Studio (WLS). You can register for an account, make an appointment, and learn more about WLS services, policies, and events on the WLS website.

IT Support

If you are experiencing technical difficulties, please contact IT:

- China-based faculty/staff/students 400-816-7100, (+86) 0512- 3665-7100
- US-based faculty/staff/students (+1) 919-660-1810
- International-based faculty/staff/students can use either telephone option (recommend using tools like Skype calling)
- Live Chat: https://oit.duke.edu/help
- Email: service-desk@dukekunshan.edu.cn

What is the expected course schedule?

(Topics and schedules are subject to change. Refer to the course website for the actual progress.)

Week 1: Mechanics			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Units, Vectors Motion in one, two and three dimensions Newton's laws Force and mass Friction	**1,2,4 (part)**	**Reading, review short videos, (a)synchronous discussion, homework** **Lab arrangement. Mini-lab about projectile motion.**	Openstax University Physics Vol. 1, **Chapters 1-5 and 6.2**
Week 2: Mechanics, cont.			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Energy and work Conservation of energy Conservation of linear momentum	**3,4,5**	**Reading, review short videos, (a)synchronous discussion, homework** **Lab A about viscosity.**	**Chapters 6-9 and 13**

Inertial vs. non-inertial system Gravitation			
Week 3: Oscillations and waves (may move to week 2, before linear momentum)			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Harmonic oscillator Damped and forced oscillations From oscillations to waves	**6,7**	**Reading, review short videos, (a)synchronous discussion, homework** **Midterm exam (tbc)**	**Chapters 15-17**
Week 4: Rigid bodies			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Basic concepts: Rotation, torque, angular momentum Static equilibrium Dynamics: Physical pendulum	**8,9,10**	**Reading, review short videos, (a)synchronous discussion, homework** **Lab B about Pohl's pendulum**	**Chapters 10-12**
Week 5: Fluids			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Basic concepts: Pressure, Density, Viscosity Statics: Buoyancy, Archimedes' principle Dynamics: Laminar vs. turbulent flow, Bernoulli equation, Drag force	**4 (part), 11**	**Reading, review short videos, (a)synchronous discussion, homework** **Lab C about sound speed**	**Chapters 14**
Week 6: Thermodynamics			

Topics	Learning Outcomes	Assignments/activities	Materials needed
Thermal equilibrium, a microscopic view of ideal gas laws. Heat, 1st law of thermodynamics. Entropy, 2nd law of thermodynamics	**12**	**Reading, review short videos, (a)synchronous discussion, homework** **DIY lab**	Openstax University Physics Vol. 2, **Vol.2, chapters 1-4.**
Week 7: Optional topic and review			
Topics	**Learning Outcomes**	**Assignments/activities**	**Materials needed**
Synthesized topics For example: 'Self-assembly at all scales', 'Bio-sphere as a thermal engine', special relativity, gravitational wave, etc. **Overall review**	**n.a.**	**Review of the course, DIY lab presentation**	**n.a.**
Week 8: Final exam			