COLLEGE OF DUPAGE

Physics 2115-003: Physics for Science and Engineering III Spring 2024

Instructor: Dr. David R. Fazzini *Office:* BIC-3E04B

Office Hours: Mon..: 10:20 AM – 11:50 AM & 4:00 PM – 4:30 PM
Tues.: 1:00 PM – 2:00 PM
Wed.: 10:20 AM – 11:50 AM & 1:00 PM – 2:00 PM
Thur.: 1:00 PM – 2:00 PM
Fri: 9:00 AM – 9:50 AM & 10:00 AM – 10:50 AM
(Additional times available by appointment.)

NOTE: During some of my office hours, I may be found in the Physics Lab Preparation Room (BIC-3E06) or in one of the adjoining labs (BIC-3E03, -3E05, or 3E07).

Phone: 630-942-3349 *E-mail:* fazzinid@cod.edu
Mailbox: STEM Division *FAX:* 630-942-2759

Course Description: Semester Credit Hours: 4

Calculus-based study of fluids, thermodynamics, special relativity, introductory quantum mechanics, nuclear physics and particle physics.

Semester Credits: 4 (Weekly: 3 lecture hours + 3 lab hours)

IAI Course Code: PHY-913 or PHY-914

Prerequisite: Physics 2112 (with a grade of "C" or better) or equivalent.
(Proof required.)

Official Text: Physics for Scientists and Engineers, Vol. I & III, 6th ed., authored by P.A. Tipler & G. Mosca, published by Freeman

Lab Manual: (Provided by instructor.)

Keypad: iClicker (Provided by instructor.)

Material: Tipler & Mosca: Chapters 13, 17-20, R, 34-41

Meetings: *Lec.*: MTR: BIC-3H06 *Lec. Time*: 12:00 Noon-12:50 PM
Lab: M: BIC-3F03 *Lab Time*: 1:00 PM-3:50 PM

Course Objectives:

Upon successful completion of this course the student should be able to do the following:

1. Calculate the pressure on an object at any depth in any static fluid
2. Formulate the buoyant force from a static fluid on objects of any size and density
3. Explain the differences among temperature, heat, and internal energy
4. Explain the concept of the ideal gas model and its predictions
5. Predict the amount of energy transferred during different types of phase transitions
6. Interpret and explain the concept of entropy and the 2nd law of thermodynamics
7. Calculate work completed and energy transferred during a thermodynamic cycle
8. Interpret pressure-volume (P-V) diagrams
9. Recognize the constancy of speed of light as the basis for special relativity
10. Calculate time dilations and length contractions for frames in relative motion
11. Calculate the relativistic energy and momentum of particles using the invariance of total energy
12. Explain the importance of photoelectric effect in the basis of quantum theory
13. Recognize the meaning of quantum mechanical wave function in terms of probability
14. Solve the time independent Schrodinger wave equation for simple cases (such as the infinite square well) and use this solution to determine basic attributes of the particle (such as average position)
15. Explain the concept of quantum tunneling using the Schrodinger wave equation
16. Calculate the positions of spectral line frequencies of a hydrogen atom using quantized energy states of the Bohr atomic model
17. Explain the importance of the Pauli exclusion principle and its relationship to the periodic table of elements
18. Explain the fundamental concept of statistical mechanics including Fermi energy and occupancy probabilities
19. Differentiate among conductors, insulators, and semi-conductors using band theory and apply this theory to simple solid-state devices such as p-n junctions
20. Differentiate among the different methods for measuring radioactivity and radiation dosage and explain their appropriate use
21. Use the activity law to calculate the half-life and age of a material
22. Differentiate among the major types of radiation (alpha, beta, and gamma) and explain the effects of each on different materials including the human body
23. Explain the concepts of nuclear binding energy and how it is transformed into useful thermal energy in both fission and fusion processes

24. Explain the fundamental mechanisms involved in nuclear power including electrical power generation, different reactor types, the nuclear fuel cycle, and spent fuel disposal
25. Describe the concepts involved in the creation of nuclear weapons and the effects of their use
26. Organize all elements of matter and force according to the Standard Model
27. Determine allowable and forbidden decays according to conservation laws of the Standard Model
28. Explain how the requirements of the Standard Model effect current cosmological theories

---

Course Logistics:

GENERAL COURSE INFORMATION can be found through the class webpage:

https://cod.edu/faculty/websites/fazzinid/physics-2115.aspx

and the **Blackboard** website:

https://bb.cod.edu/webapps/login/

Check the class webpage and log in to **Blackboard** regularly for general announcements and assignment updates. These sites will provide important announcements and course updates such as reading/online homework assignments and laboratory information. The class webpage will be updated on a regular basis and **Blackboard** will be used for announcements, blanket emails and grade dissemination.

READING assignments will be from the Tipler & Mosca's text: Physics for Scientist and Engineers, 6th ed. If you prefer, you may refer to any other calculus-based introductory physics textbook for the assigned reading material or to the Openstax series (available for free online). It is assumed that you have read the assigned material prior to class on the due date.

HOMEWORK assignments will be provided online using the *Expert TA* homework system. You will need to subscribe to *Expert TA* at a nominal cost. You will also need the following access link:

http://goeta.link/USG15IL-5C1F3E-340

The homework set for this course are in the process of being input into the platform. It is expected that the entire semester will be programmed into the platform with the first four weeks of the term. You can expect assignments to open one week before they are due. Check the class webpage regularly for assignment updates.

Any part of any homework problem that is submitted within 24 hours after the initial cut-off time of the due date will receive a 50% credit. After 24 hours from the initial cut-off time, you can no longer submit answers to exercises & problems for credit.

In addition to the homework described above, short in-class exercises are used to monitor conceptual understanding. (See IN-CLASS POLLING.) These can typically be answered by keeping up with the reading assignments and class discussions. These are designed to surface possible misconceptions and uncover some of the common pitfalls that confuse many students.

Be aware that it is very important that you make an honest attempt to work through the questions, exercises, calculations and problems since doing the homework is a primary technique for learning the material. It is also very important that you be able to understand the solutions conceptually rather than just memorizing formulas since the exam questions and problems generally require you to demonstrate applications of the assessed concepts. Be sure that you can answer any assigned question or solve any assigned problem since they may appear on an exam. It is your responsibility to seek assistance from your instructor and/or other resources if you are having difficulties.

EXAMS will consist of two "1-hour" exams and a "2-hour" comprehensive final exam. Each 1-hour exams typically consists of about 5-6 problems and is worth 150 points. The 2-hour final exam typically consists of about 10-11 problems (although there may be a multiple-choice component in lieu of problems) and is worth 250 points. The problems are derived from homework sets, sample problems from the text and examples worked in class or the laboratory. All exams are closed book and closed note. However, you will be provided with a sheet of "possibly useful information" with formulas, constants, etc.

Tentative Exam Schedule:

Exam I:	Monday, March 4th	(during lab session)	Chapters 13, 17-20
Exam II:	Monday, April 8th	(during lab session)	Chapters R, 39, 34-35
Final Exam:	Tuesday, May 14th	Noon-1:50PM	Chapters 13, 17-20, R, 34-41

QUIZZES consisting of a few short questions based upon material covered in the previous unit/chapter will be administered on occasion with warning or without warning. These questions are used to monitor conceptual understanding. Quiz questions are typically in a multiple–choice format and answered by conceptual reasoning or with a few short lines of algebra/explanation. All quizzes are closed book and closed note. No equation sheets will be provided for the quizzes.

IN-CLASS POLLING (iClickers) will be administered to each student during the lectures. The system will allow you to further interact with the instructor during the lecture. You will be able to respond to questions and give feedback as the course progresses. For instance, short in-class exercises used to monitor conceptual understanding will be administered from time to time. The questions typically consist of surveys, conceptual questions or short calculations and are designed to surface possible misconceptions and

uncover some of the common pitfalls that confuse many students. These questions can generally be answered by keeping up with the reading assignments and class discussions. Responses are recorded and scored. The scoring is used to measure class participation and can be used to determine grades in borderline situations.

LABORATORY sessions meet once per week and are required for this course. The laboratory section is designed to provide you with hands-on experiences related to the topics that are discussed during the lectures. Laboratory handouts are provided for all sessions. During the lab, you will make predictions, answer questions, and record observations. Throughout the session and upon successful completion of the lab, the instructor will "stamp" your work and record attendance. Laboratory homework assignments are to be completed over the week and submitted at the beginning (that is, 1:00 PM) of the next laboratory session. Only officially stamped work will be accepted for credit. Each lab is graded in two parts: 1) completion of the requirement measurements and "in-lab" questions and 2) completion of the laboratory homework. Each piece is worth 50% of the total grade for that laboratory session.

PARTICIPATION in the course can have a reflection in the overall final grade. Items such as attendance, attitude, sincerity, changes in performance, iClickers, etc. will be considered in borderline situations.

GRADING is tentatively based on the following breakdown:

Homework:	200 pts.	A:	> 900 pts.
Laboratory*:	150 pts.	B:	> 800 pts.
Quizzes/Clickers:	100 pts.	C:	> 700 pts.
2 Hourly Exams:	150 pts. each	D:	> 600 pts.
Final Exam:	250 pts.	F:	< 600 pts.

Depending on other factors involved with the course, it is possible for the grade cut-offs to be lowered by up to 5%, but do not count on it.

*Laboratory attendance is a required part of the course. Your final grade will drop one full letter for every two sessions that are missed regardless of exam/homework/quiz scores. As there are no make-ups, you are strongly advised to perform AND submit all lab activities.

ACCOMODATIONS: The College of DuPage is committed to the equitable access of educational opportunities for students with disabilities in accordance with The Americans with Disabilities Act, As Amended and Section 504 of the Rehabilitation Act of 1973. Any student who feels they may need an accommodation on the basis of an illness, injury, medical condition, or disability should contact the Center for Access and Accommodations to determine eligibility for accommodations and to obtain an official Letter of Accommodation. The Center for Access and Accommodations can be reached via email at

access@cod.edu.

Students may also initiate a request for services by going to

www.cod.edu/access

and clicking on the green box labeled "complete form to request accommodations." If you are already registered with the Center for Access and Accommodations, please email me your Letter of Accommodation as soon as possible. Please DO NOT send any private health documentation or Doctor's notes to me.

LATE MATERIAL & MAKE-UPS:
All quizzes and exams must be completed on the scheduled date at the time they are scheduled. There are no make-ups for any reason (except jury service or call to active military duty). If absent for a "1-hour" exam, then the percentage score of the final exam will be applied to one (and only one) missing exam. All online homework must be submitted by the cut-off time and all laboratory homework must be submitted at the beginning (1:00 PM) of next lab session to receive maximum credit. As stated above, any lab submitted after 1:00 PM of the due date lab session but still during that session receive a 10% penalty. After that, the penalty is an additional 10% for every 24 hours past the original due date and time up to one week. After that, the lab will no long be accepted for credit. (Note that you can receive up to 50% credit just from the completion of the data acquisition and "in-lab" questions as long as it was officially stamped by the instructor and submitted on time.)

RETURN POLICY:
In general, every effort will be made to return work/provide feedback in a timely fashion usually within one week after submission. Scores will be updated in Blackboard on a regular basis.

CALCULATORS, LAPTOPS & CELL PHONES:
Only TI-30 non-graphing calculators may be used during exams. These calculators are available for check-out from the Math Assistance Center and/or the Library although students should not depend on them being available during the exam. Students are responsible for bringing the correct calculator to the exam and knowing how to use it. During exams, there is no sharing of calculators and the cover must be removed.

No CELL PHONE CALCULATORS may be used during exams. Students may use laptops or tablets to take notes during lecture only under the following conditions: 1) the screen must be displayed upon request and 2) you show me that day's notes at the conclusion of the class. If these conditions cannot be met, then you may not use the device in class. The proprietors of any cell phone that disrupts the class disruption will guarantee themselves a zero on the next quiz.

COMMUNICATION:
You should use email or phone as methods to communication with me if my office hours conflict with your schedule. You are strongly encouraged to ask questions about the syllabus during class time and office hours. For more in-depth discussions (such as

guidance on assignments) it is possible to set up a one-on-one zoom meeting if a face-to-face meeting is not possible. Such conversations should take place in person or over the phone rather than through email. This allows us to communicate more effectively and fosters a more collegial learning atmosphere.

WITHDRAWAL POLICY:
The last day to withdraw from this course without appeal is Sunday, April 14th, 2024. After that date, students may file a *Petition for Late Withdrawal* through the Registration Office. A *Petition for Late Withdrawal* will be granted for extenuating circumstances only, including student illness, death in the immediate family, family emergencies, call to active duty, or other appropriate extenuating circumstances. The student will be required to provide appropriate documentation for all requests for late withdrawal. Students are strongly encouraged to speak to their instructor prior to withdrawing from this class. Students who have missed 4 or more classes or labs AND are not passing with a grade of "C" or better by Friday, March 15th, 2024 will be considered in "non-pursuit" and risk being administratively dropped from the course. (No refunds!)

INCOMPLETE POLICY:
Under extraordinary circumstances (such as an extended medical emergency or family tragedy) a student currently earning "C" or better may not be able to complete all of the course requirements. In such instances, the student may petition the instructor for an "incomplete" grade. Only if the instructor deems the request as warranted will a contract agreement be made between the student and instructor as to how the course will be completed. After both the student and the instructor sign the contract, the student will receive a grade of "I". Note: The course must be completed with the same instructor and within one calendar year of the end of the term for which the student was enrolled.
If the student does not complete the requirements for the course as prescribed in the agreement, the "I" grade will automatically revert to a grade of "F." It is advised that the students be fully aware of the consequences of receiving an incomplete grade and understand the terms described in the COD Catalog and can be accessed at

https://catalog.cod.edu/academic-policies-procedures/

ATTENDANCE/TARDINESS:
In general, course attendance is recorded by means of polling, submitted quizzes, and punctually submitted laboratory work. As stated earlier, students who have missed 4 or more classes or labs AND are not passing with a grade of "C" or better by Friday, March 15th, 2024 will be considered in "non-pursuit" and may be administratively dropped from the course by the instructor. (No refunds!) Students who do not "click in" during the class do to tardiness or any other reason will not necessarily have their attendance recorded. As safety instruction will be delivered at the start of the lab session, entrance to the lab will be denied 15 minutes after the lab starts.

CONDUCT & DISRUPTIONS:
It is expected that you are aware of and follow the guidelines for conduct as described in the COD Catalog: *Student Rights and Responsibilities*. In particular, *Student Code of*

Conduct (Board Policy 20-35). Individuals that exhibit disruptive behaviors that interfere with the lectures and/or laboratory sessions will be removed from the class so that those individuals who wish to learn physics can do so. Those individuals removed must then conference with either the Dean or an Associate Dean in Natural & Applies Sciences Division. Those individuals may then rejoin the class pending the outcome of the conference.

Anyone caught cheating or plagiarizing will receive an automatic failure for the course. You will not be allowed to drop the class if you are found in violation of this section. It is expected that you are aware of and follow the guidelines for conduct as described in the COD Catalog, pp. 163-164: *Students Code of Academic Conduct (Board Policy 20-41)* and that you are aware of the definitions of the terms described therein. Also, the college will not tolerate discrimination or harassment. It is also expected that you are aware of and follow the guidelines for conduct as described in the COD Catalog, page 167: *Prohibition of Discrimination, Harassment and Sexual Harassment (Board Policies 15-10 and 15-11)*. The policies described in this section can be accessed at

https://catalog.cod.edu/student-services-general-student-information/

RELIGIOUS OBSERVANCE:
The College will reasonably accommodate the religious observances of individual students with respect to class attendance, and the scheduling of examinations and class requirements. The student should notify the instructor well in advance of any anticipated absence or a pending conflict between a scheduled class and the religious observance.

Physics 2115 TENTATIVE SCHEDULE for Spring 2024 Semester

Week	Dates	Chapter	Topic(s)
1	Jan. 22-25	13	Fluid Statics (Pascal's & Archimedes' Principles)
2	Jan. 9-Feb. 1	13	Fluid Dynamics (Bernoulli's Principle)
		17	Temperature
3	Feb. 5-8	17	Ideal Gasses & Kinetic Theory
		20	Thermal Properties & Processes
4	Feb. 12-15	20	Heat Transfer Mechanisms
		18	Heat, Work & the 1st Law of Thermodynamics
5	Feb. 19-22	18	Adiabatic Processes
			Equipartition Theorem
6	Feb. 26-29	19	Irreversible Processes & Heat Engines
			Entropy & 2nd Law of Thermodynamics
7	Mar. 4-7	Exam I	Chapters 13, 17-20
		R	Einstein's Postulates & Special Relativity
8	Mar. 11-14	39	Relativistic Energy & Momentum
9	Mar. 18-21	34	Quantum Physics: Photons & Probability Waves
10	Mar. 25-29	NO CLASSES	SPRING BREAK
11	Apr. 1-4	35	Schrödinger Equation & Wave Functions
12	Apr. 8-11	35	Potential Wells & Barriers
		36	Hydrogen Atom & Multi-electron Atoms
13	Apr. 15-18	Exam II	Chapters R, 39, 34-36
		37	Molecules & Bonding
14	Apr. 22-25	38	Electrical Conductivity in Solids
		40	Nuclear Properties & Radioactivity
15	Apr. 29-May 2	40	Nuclear Fission & Fusion
16	May 6-9	41	Elementary Particles & Cosmology
17*	May 14	Final Exam	All material: Chapters 13, 17-20, R, 34-41

* Shortened week due to final exams.

There are NO CLASSES on the following dates:
Monday-Friday, March 25th-29th due to Spring Break

NOTE: Not every topic in each assigned chapter may be discussed in class. However, you are responsible for every topic in each assigned chapter unless otherwise stated. If you are having trouble with a topic that is not discussed in class, it is your responsibility to seek out the instructor and/or other resources to ensure understanding of that topic.

PHYSICS 2115 TENTATIVE LABORATORY SCHEDULE for Spring 2024

Week	Date*	Investigation	Topic(s)
1	January 22nd	1	Archimedes' Principle
2	January 29th	2	Temperature vs. Heat
3	February 5th	3	Specific Heat Capacity & Latent Heat
4	February 12th	4	Thermal Processes
5	February 19th	5	Heat Engines
6	February 26th	6	Entropy: A Statistical Interpretation
7	March 4th	7	Exam 1 & Intro. to Relativity Pt. 1
8	March 11th	8	Introduction to Relativity Pt. 2
9	March 18th	9	Introduction to Quantum Phenomena
10	March 25th	NO LAB	SPRING BREAK
11	April 1st	10	Observation of the Photoelectric Effect
12	April 8th	11	Quantum Tutorials
13	April 15th	12	Exam 2 & Optical Spectroscopy
14	April 22nd	13	Radioactive Half-Life
15	April 29th	14*	Field Trip to the Advanced Photon Source at Argonne National Laboratory
16	May 6th	15	Electromagnetic Interactions in Matter

*Pending approval from Argonne National Laboratory.

COURSE EXPECTATIONS

Physics 2115

What Dr. Fazzini Expects from You:

- You will have read the syllabus.
- You will be punctual to class.
- You do not make or receive telephone calls or text messages during class or lab sessions.
- You demonstrate respect for what I and your fellow students have to say.
- You will come to class prepared (pencils, calculator, iClicker, etc.)
- You will come to class ready to ask and answer questions of substance on the day's topic(s).
- You will concentrate exclusively on this course during the class hours of this course.
- You will notify me prior to class if you have to leave early.
- You will "check your entitlement at the door" and take responsibility for your own learning.

What You Can Expect from Dr. Fazzini:

- I will be punctual to class.
- I will give each of you a fair share of my attention.
- I will work to make the class interesting and relevant.
- I will make myself available as a helpful resource outside of class.
- I will work to help you learn the material and perform at your best.
- I will be the sole arbiter of partial credit.
- I will grade the QUALITY of your work rather than the amount of time and effort you spent on it. (In other words, you will be assessed on your demonstrated performance rather than on anecdotal testimony.)

Disclaimer:

To the best of the instructor's knowledge, the information in this syllabus was correct and complete at the start of the semester. However, the instructor reserves the right, acting within the policies and procedures of the College of DuPage, to make changes in the course content, instructional techniques or grading policy during the term. (Any changes would always be in favor of the student.) It is assumed that you have read this course syllabus. Your continued enrollment in this course means that you accept the terms and conditions outlined in this syllabus.

Detailed Topical Outline

Fluids

- Definition of density and pressure
- Relationship between depth and pressure for a static fluid
- Buoyant force and Archimedes' principle
- Pascal's principle
- Bernoulli's equation and the relationship among depth, pressure, and velocity for a fluid in motion

Temperature and heat

- Definition of temperature and different temperature scales
- Definition and units of heat
- Distinction among temperature, heat, and internal energy
- Mass specific heat capacity
- Thermal expansion
- Mechanisms of heat transfer (conduction, convection, and radiation)

Kinetic theory of gases

- The first law of thermodynamics
- The ideal gas law
- Work done by a gas
- Molar specific heat capacity
- P-V diagrams
- The equipartition of energy

Entropy and the 2nd law of thermodynamics

- Cycles, heat engines, and refrigerators
- Efficiency of a heat engine
- Carnot engines and Carnot cycle efficiency
- The second law of thermodynamics
- Conceptual and statistical definitions of entropy

Relativity

- Basis of special relativity
- Length contraction and time dilation
- Relativity of simultaneity
- Lorentz transformation
- Relativistic Doppler effect
- Relativistic velocity addition
- Invariance of space-time and space-time 4-vectors

Invariance of momentum-energy and momentum-energy 4-vectors

Wave-particle duality

Experimental foundations for quantum mechanics including photoelectric effect and Bragg scattering of electrons
Momentum and energy from wave properties of mattes
Schrodinger wave equation
Heisenberg uncertainty principle
Quantum mechanical tunneling

Applications of the Schrodinger wave equation

One-dimensional infinite square well
Quantized energy levels of trapped particle
One-dimensional finite square well
Two- and three-dimensional infinite square well
Quantized atomic structure
Bohr model of the atom
Quantized electromagnetic spectrum of hydrogen
Electron spin
Total angular momentum
Magnetic resonance
Pauli exclusion principle and the periodic table
Lasers

Solid state physics

Band theory and energy levels
Insulators and metals
Semiconductors p-n junctions
Diodes and light-emitting diodes
Transistors

Nuclear physics

Components of the nucleus
Properties of the nucleus
Alpha, beta, and gamma decay
Measuring radiation dosage
Calculating material activity and half-lives
Energy from the nucleus
Basic process of nuclear fission
Nuclear reactors
Nuclear fuel production and disposal
Basic process thermonuclear fusion

- Fusion in nature and as a possible power source
- Processes involved in nuclear weapons
- Effects of nuclear weapons

Particle physics and cosmology

- The Standard Model
- Hadrons from quarks
- Conservation laws
- Exchange model view of forces
- Vector bosons
- Cosmological models
- Interaction between particle physics and cosmology