# PHYS 102 Modern Physics (with CUREs) Syllabus

**Fall 2024** (Updated on 8/22/2024)

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# Instructor Information

Instructor Name: Pei-Chun Ho
Department: Physics
Email / Telephone: peiho@mail.fresnostate.edu / (559) 278-5990
Office: McLane 255 (Doorbell on McLane 254)
Student Support Hours: (days/times)
Tuesday & Thursday at McLane 162 or 255: 7:45 PM – 9 PM
Monday & Wednesday at McLane 255: 12:15 PM – 1:15 PM

# Course Information

Course Modality: in-person
Course ID: PHYS102–01-75800-2247
Units: 3
Class Meeting Location & Time: McLane 258 & M, W 11 AM – 12:15 PM
Canvas: fresnostate.instructure.com
Prerequisites:

***MATH 77 Calculus III*:** three-dimensional calculus, partial derivatives, multiple integrals, Green's Theorem, Stokes' Theorem.

***MATH 81 Applied Analysis (can be taken concurrently)*:** Introduction to ordinary linear differential equations and linear systems of differential equations; solutions by Laplace transforms. Solution of linear systems of equations; introduction to vector spaces; eigenvalues, and eigenvectors.

***PHYS 4C Light and Modern Physics*:** Geometrical optics; electromagnetic radiation; physical optics; introduction to special relativity; quantum physics; and the physics of atoms, nuclei, and the solid state.

Course description:

This three-unit upper division course explores the development of Modern Physics from the late 19th to early 20th centuries, highlighting the transition from Classical Physics to Quantum Mechanics and Special Relativity. Modern Physics has evolved from phenomena, unresolved experimental results, and technical challenges from the turn of the 20th century to the present. Therefore, representative experiments, their setups, results, and technical applications will be greatly emphasized. Key topics include the particle-wave duality of light and matter, wave functions and particle probabilities, atomic structure, energy level schemes, and black body radiation. The course also covers fundamental concepts in Statistical Physics, such as Fermions, Bosons, and Fermin energy of conduction electrons, Bose-Einstein Condensation, which are essential for understanding Condensed Matter Physics and modern technological devices.

- For the lecture component, it is generally expected that students will spend approximately 2 hours of study time outside of class for every one hour in class. Since this is a 3-unit class, you should plan to study an average of 6 hours outside of class each week.

- ❖ A new component Course-Based Undergraduate Research Experiences (CUREs), which incorporated project-based learning (PBL), has been implemented in this course. Students working in groups of three will undertake a project on Dye-Sensitized Solar Cells, applying the principles of Modern Physics to engage in research-style activities. At the end of the semester, each group will present their findings in a poster presentation at the Fresno State High Impact Practices (HIPs) Student Symposium.

## Required Course Materials

I. Textbook: Modern Physics for Scientists and Engineers, Publisher Brooks Cole, either 3rd, 4th, or 5th edition, by Stephen T. Thornton and Andrew Rex.

II. ***Immediate Access*** (***IA***) is set up for this course by using the ***Canvas*** System.

- All Immediate Access (IA) communication will be delivered to the student's Fresno State email account…It is the STUDENT'S RESPONSIBILITY to read all communication coming from the Kennel Bookstore. They should look for email headers such as "IMPORTANT INFORMATION" or "REMINDERS" and check the SPAM folder!
- IA contains an iClicker-Reef from **Canvas- iClicker Sync**:

➢ iClicker-Reef operated through APP (on laptops or Mobile device) is required for in-class quick quizzes. The iClicker-Reef Class is "**PHYS102Ho2024F**".

- All Immediate Access (IA) communication will be delivered to the student's Fresno State email account. It is the STUDENT'S RESPONSIBILITY to read all communication coming from the Kennel Bookstore. They should look for email headers such as "IMPORTANT INFORMATION" or "REMINDERS" and check the SPAM folder!
- ALL IA materials are accessible for the first few days of the start of the semester to all students enrolled. After the opt-out date of the term, students who did not OPT OUT of the materials will be charged on their Fresno State student account the cost of the materials. This information can be found in their welcome letter email from the Kennel Bookstore. If they did not receive an email, please contact ecarmona@mail.fresnostate.edu
- OPTING OUT means that students DO NOT want the digitally delivered materials we are offering. STUDENTS will then be responsible to get the materials on your own – usually at a higher cost. If students OPT OUT, their digital IA access will be revoked. **IMPORTANT!** If students OPT OUT of the program, they will also OPT OUT of the required ADAPTIVE materials associated with the IA eBook including their homework, quizzes, tests, etc.… This access will be turned off after the last date to opt-out for the semester.
- We ask students to **NOT purchase IA digital materials directly from the Publisher website or make any other outside purchase** that would require them to enter a credit card or pay out of pocket. This will result in a DOUBLE charge! If they are OPTED IN, the campus will bill their Fresno State student account after the opt out date.
- **DO NOT pay for your materials through Canvas!!!** If the link provided requires an "ACCESS CODE" it will be delivered to the student in their **IA**

**VitalSource** link or on any IA emails sent to their Fresno State email account from the Kennel Bookstore. ALL CHARGES will be billed to their Fresno State student account.

- **THE LAST DAY TO OPT OUT for Fall 2024 is September 6, 2024**. – – It is the STUDENT'S responsibility to OPT OUT. Once they click on the OPT OUT link in their Professor's Canvas page, they will receive a confirmation email within 24 hours. If they did not receive an email within 24 hours, please contact ecarmona@mail.fresnostate.edu
- Student accounts will be charged around **September 17, 2024**…Charges will be due around **September 25, 2024**. Students may pay on their Fresno State student account either online or at Joyal Administration.

**To make an on-line payment, go to https://my.fresnostate.edu, click on Student Self Service>Student Center>My Finances>View eBills/Make a Payment.
**To see your current balance, go to Student Self Service>Student Center>My Finances>Account Inquiry.

- If students are on financial aid, scholarship, or other benefit programs they are still obligated to pay on their account…They should put this money aside.
- If students enroll **after** the Opt-out date, they will have **24 hours** to review the materials and contact ecarmona@mail.fresnostate.edu if they choose to purchase elsewhere and OPT OUT of the program.
- Any questions about the IA program can be directed to ecarmona@mail.fresnostate.edu

I. Scientific Calculator (Graphing Calculator is "Not" allowed for this course).
II. A Fresno Stat email account. Instructor will not respond to the emails not sent through the Fresno State system.

Zoom (available to all Fresno State students)
https://fresnostate.edu/help/students/video_conferencing/

## Course Specifics

This course will include assigned readings in your textbook that should be completed outside of the class session. During the class sessions there will be lectures, demonstrations, quick quizzes, small group discussions, and class discussions. In order to facilitate your understanding of assigned readings, lectures may review portions of the readings, but they will not serve as a substitute for reading the materials. Important additional information will be presented during the lectures, which will be included in the exams.

To integrate an experimental research component, students **must** dedicate an additional three hours per week (by signing up 1 unit of PHYS 90 Direct Study) to a hands-on project focused on dye-sensitized solar cells. Each group of students will have to schedule with the instructor the lab time to access the facilities in her research laboratory at McLane 254 and McLane 216 to perform the experiments. The instructor will act as a guide to monitor and assist students' progress. In addition, there are some activities

1. Lecture on Solar Energy: Provide a series of lectures that convers the fundamentals of solar energy: black body radiation, which is traditionally covered in this course and the role of quantum mechanics in energy conversion processes.
2. Student-Led Experiments: Guide students through a hands-on experiment where they create their own DSSCs. This involves tasks like literature search, developing synthesis procedures, coating the conductive glass with titanium dioxide, applying natural dyes, and assembling the cell.
3. Measurements and Data Analysis Sessions: Teach students how to measure the efficiency of their solar cells and analyze the data. Discuss factors that affect the performance of DSSCs.
4. Group Discussions: Facilitate progress reports of the experimental data, discussions of the potential problems during the experiments, any change of the original plans.
5. Final Research Presentations: prepare students to do final presentations of their experimental results at the Fresno State HIPs Symposium.

**Course goals:**

Upon completion of this course, students are expected to analyze various properties of the quantum states using the free-electron model and understand and apply these concepts to modern technologies, such as X-ray diffractometer, Electron microscopes, PET scan, and development of dye-sensitized solar cells. With the CUREs component, students will be able to apply the principles of Modern Physics to engage in research-style activities.

**Student Learning Outcomes:**

Students will develop a strong foundation to identify, analyze, and solve problems within the core driplines described in the textbook of “Modern Physics For Scientists and Engineers,” by 4th edition, by Stephen T. Thornton and Andrew Rex, which is universally recognized as a standard in undergraduate physics education.

In addition, upon successful completion of the CUREs project (dye-sensitized solar cells) in PHYS 102, students will be able to:

1. Understand the fundamental principles of photovoltaic technology and articulate the operational mechanisms of dye-sensitized solar cells.
2. Apply theoretical knowledge to practical situations by constructing and testing a functional dye-sensitized solar cell.
3. Analyze and interpret data collected from experimental procedures to evaluate the efficiency and performance of the solar cells.
4. Demonstrate problem-solving skills by identifying and troubleshooting potential issues in the design and execution of the solar cell project.
5. Communicate scientific concepts effectively through written Power Point Slides, delivering oral presentations, and detailing the process and results of the project.
6. Reflect on the broader implications of renewable energy technologies in the context of modern physics and sustainability.

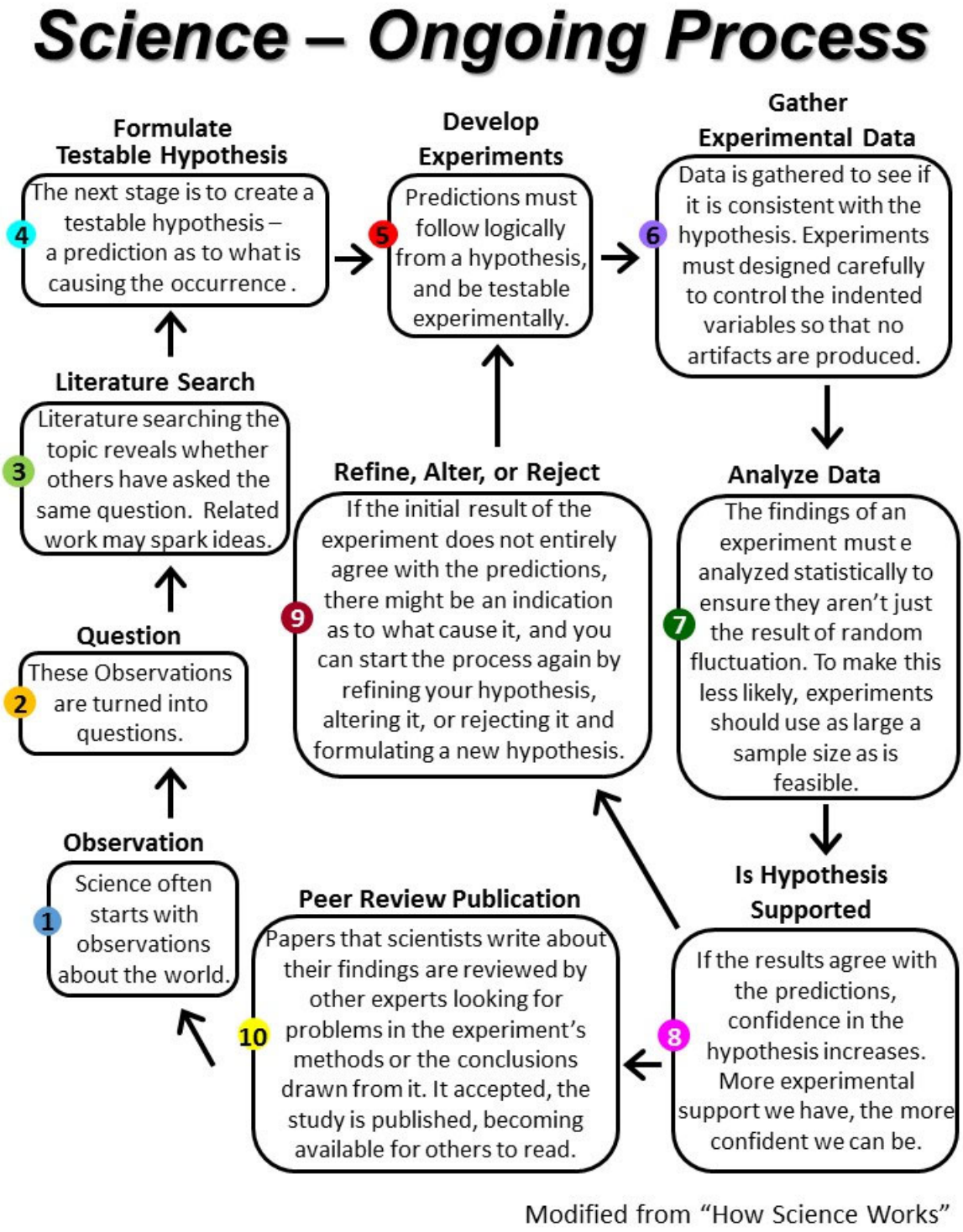


**Figure 1** In order to achieve sensible science goal, iterations of science process usually take place.

**Course Requirements/Assignments**:

I. Quick Quizzes: In order to encourage students to preview the textbook contents before class, focus learning in the virtual class room, and engages in interactive learning, 1-10 questions will be randomly given as quick quizzes in most of the class meeting time. Total of the quick-quiz score which will be counted as 12% of the weighted grade. ***Full participant points (i.e., attendance) will only be given when students complete all quick-quiz questions.***
II. Homework will be assigned through Canvas. Detail procedures need to be provided. One combined PDF file of each homework with proper page order is required to be uploaded to Canvas. Homework passes the deadline will be counted as zero. (15% of weighted grade)
III. Two midterms will be offered and each weighs 17%.
IV. Final exam will be given according to the University Final Exam (24% of weighted grade).
V. CUREs project: Dye-Sensitized Solar Cells will

**Instructions for significant assignments:** If your course has a project, a paper, or other significant assignment, please give detailed requirements and instructions on how to complete them, such as length, fonts and/or number of references that must be used for the project/paper.

**Attendance:** (**attendance and participation is required**)

Full participant points (i.e., attendance) will only be given when students complete all quick-quiz questions.

**Grading policy:** List how grades are distributed and weighted by assignments to make 100% of the course grade. Your grading policy should include a description of how you calculate grades, if applicable (such as using a grading scale).

Explain exactly how you will calculate the course grades. What will be the point values and weightings for assignments, activities, and examinations? What will be the cut-off points on percent for each grade (e.g., 80 to 89% is B, etc.)? An optional "Assignment and Examination Schedule" with point values may be an efficient way to transmit some of this information (this is only an example for your reference):

A grade of C or better is required to pass this class.

**Grade will "Not" be curved, completely based on performance.**

***Table 1*** *Assignment and Point Distribution*

| **Assignment** | **Points/Percent** |
|---|---|
| Lecture Component (85%) | |
| Quick Quizzes (In Class) | 12% |
| Homework | 15% |
| Two Midterms | 34% (17% each) |

| Assignment | Points/Percent |
|---|---|
| Final Exam on 12/16/2024 | 24% |
| CUREs Component (15%) | |
| Overall laboratory performance and documentation in the notebook | 4% |
| Oral presentation of the proposal in PPTx (9/18/2024) | 3.5% |
| Oral midterm progress report on preliminary findings (PPTx, 10/30) | 3.5% |
| Final oral presentation: Conclusion (PPTx,11/25) | 2% |
| Final poster presentation at HIPs Student Symposium (PPTx,12/13) | 2% |

The CURE component will account for 15% of the student's final grades for the semester. The breakdown of the CURE component's grade distribution is as follows:

1. Overall laboratory performance and documentation in the notebook will be assessed with **4%** of the final grade.
2. The oral presentation of the proposal in Power-Point format will account for **3.5%**. This includes 12 minute presentation followed by 3 minutes for questions. Students must submit their

presentation file beforehand and are responsible for bringing the require adapter for projector.

3. An oral midterm progress report, also in Power-Point format, will make up another **3.5%**. It follows the same format as the proposal presentation, with 12 minute presentation and 3 minutes for questions, and requires prior submission of the presentation file.
4. The final oral presentation on December 2 will contribute 2% and the final poster presentation at Fresno State's HIPs Student Symposium on December 13th will also contribute 2%. The poster must be submitted one week before the HIPs symposium for printing. As this poster presentation is at the University level, students will be expected to articulate their project clearly, and the grade will also reflect the evaluation of faculty members present at the event.

*Table 2 Rubrics for Evaluation of PPTx Presentations*

| **Group # _____**<br>**Presentation Trait** | **5**<br>Strongly Agree | **4** | **3** | **2** | **1**<br>Strongly Disagree |
|---|---|---|---|---|---|
| I. Quality of Information: Main points are clear, well-developed, and well supported with evidence; appropriate use of terminology | | | | | |

| | |
|---|---|
| II Quality of Organization: Information and ideas are presented in a logical order; presentation flows well; presentation of information promotes audience understanding. | |
| III Quality of Communication: Speaker(s) demonstrate an engaging and inviting presence; their voice is confident, steady, clear, and effectively conveys the message. | |
| IV Visual Tools: Visual aids (e.g., graphs, diagrams, pictures, etc.) are clear, easy to read, and significant enhance the presentation's effectiveness; all images are directly relevant to the main ideas. | |
| V Overall Impact: Information is clearly linked to the presentation topic and demonstrates the broad impact and significance of the work. | |
| Total Score | Points |
| Scale to 100% | % |

*Table 3 Distribution of Letter Grade to Percent and Points*

| Letter Grade | Percent | Points |
|---|---|---|
| A | 87 | 100 |
| B | 74 | 86.999 |
| C | 60 | 73.999 |
| D | 50 | 59.999 |
| F | 0 | 49.999 |

# Course Policies & Safety Issues

**Classroom Behavior**

(University Policy on Disruptive Classroom Behavior)

Both the instructor and the students are to adhere to high standards of professionalism, common courtesy, and respect for others. Please refrain from the following behaviors, bearing in mind that if your behavior interrupts the class you may be asked to leave the class for the rest of the period:

- Coming to class late, please use the back doors for entrance. If you must leave early, please sit near a door.
- During lecture sessions, mute all cell phones, laptops and other electronic devices. You only need one electronic device to run iClicker-Cloud (formerly iClicker-Reef).
- Do not speak or write to anyone in a rude or aggressive fashion, or speak of others in a disrespectful fashion
- The University Policy on Disruptive Classroom Behavior (APM 419) is well worth reading and can be found in the Class Schedule and the Academic Policy Manual.

If you are absent from class, it is your responsibility to check on announcements made while you were away.

**Late work and make-up work policy:** Either delayed or make-up exams for midterms and final exam will not be allowed by the instructor. If a midterm is missed for a *"compelling reason"* (e.g. illness documented by a physician's note, official evidence of which has to be provided), the part of the grade that midterm would have counted will be voided, and the rest of the grade will be counted as 100%. If the final exam is missed for a "*compelling reason"* (e.g. illness documented by a physician's note, the student will receive a grade of **"I"** (incomplete) for the semester. It will also be the student's responsibility to contact the university administration in a timely manner and make the necessary arrangements to remove the **"I"** grade. Please check "the California State University Fresno General Catalog" for regulation regarding the **"I"** grade. Only students who can document very compelling reasons to miss final exams, e.g. with a physician's note, will be eligible for incompletes; other students missing the final exam will receive 0% for the grade of final exam.

***The following sections regarding COVID are subject to change given changing circumstances on-campus and in the community. Please check the COVID website for the most up-to-date information***

**Vaccination:** The California State University system strongly recommends the COVID-19 vaccination and booster for all students, faculty, and staff. As a reminder, you are eligible for a booster five (5) months after receiving a final dose of the Pfizer or Moderna vaccine; or two (2) months after receiving a Johnson & Johnson vaccine.

**Face Coverings:** Fresno State no longer requires masks to be worn indoors, but based on updated guidance from public health experts, the University highly recommends that all students, faculty, and staff, regardless of vaccination status, wear a surgical grade or KN95 mask indoors. ***Faculty will continue to have the discretion to require face coverings for their in-person classes as they evaluate the health and safety needs of their individual classroom environments***.

**Testing:** The campus was fortunate to receive the Higher Education Emergency Relief (HEERF) Funds during the pandemic and through June 2023 but funds are no longer available. Students will still be able to obtain free kits from the Student Health and Counseling Center. Additionally, free COVID-19 test options are offered by the Fresno County Department of Public Health.

**Intellectual Property**: All course materials, including but not limited to the syllabus, readings, quiz questions, exam questions, and assignments prepared by the instructor are property of the instructor and University. Students are prohibited from posting course materials online (e.g., Course Hero) and from selling course materials to or being paid for providing materials to any person or commercial firm without the express written permission of the professor teaching this course. Doing so will constitute both an

academic integrity violation and a copyright violation. Audio and video recordings of class lectures as well as images of chat or messages shared during course sessions are prohibited unless the instructor gives you explicit permission in advance. Students with an official letter from the Services for Students with Disabilities office may record the class if SSD has approved that service. Otherwise, recordings of lectures are included in the intellectual property notice described above. These provisions exist regardless of the modality of the course. That is they apply to in-person, hybrid and online courses.

**Student Ratings of Instruction:** In the final weeks of the semester, you will be asked to complete a short survey to provide feedback about this class. The primary goal of student ratings is to help your instructor improve the class. Feedback will also be reviewed by the department chair and the college dean. You will be given 15 minutes of class time to complete student ratings. Please offer feedback honestly and thoughtfully. Your participation is appreciated. You can access your student rating surveys and get more information at Fresno State Student Ratings for Instruction (SRI)

# University Policies

**Students with Disabilities:** Upon identifying themselves to the instructor and the university, students with disabilities will receive reasonable accommodation for learning and evaluation. For more information, contact Services to Students with Disabilities in the University Library, Room 1202 (278-2811).

**Financial Aid Satisfactory Academic Progress Standards and Appeals Process:** https://studentaffairs.fresnostate.edu/financialaid/policies/sap/index.html

**The following University policies can be found on the web at:**

- Adding and Dropping Classes
- Cheating and Plagiarism
- Computers
- Copyright Policy
- Disruptive Classroom Behavior
- Honor Code
- Title IX

Fresno State is committed to fostering a safe, productive learning environment for all students. Title IX and CSU policy prohibit discrimination on the basis of sex, which includes sexual harassment, domestic and dating violence, sexual assault, sexual exploitation, and stalking. We understand that sexual violence can impact a students' ability to be successful in the learning environment. We encourage students who have experienced sexual misconduct to seek information on where to report from any member of our faculty or staff in order to ensure that the university can provide students with the necessary resources and supportive measures.

As an instructor, I have a mandatory reporting responsibility as a part of my role. It is my goal that you feel comfortable sharing information related to your life experiences in

classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep the information you share private to the extent possible. However, I am required to report any information I receive regarding sexual misconduct or information about a crime that may have occurred during your time at Fresno State.

**Students can report incidents of alleged sexual misconduct to either or both of the following resources:**

Office of Compliance and Civil Rights | occr.fresnostate.edu | 559.278.5003
Fresno State Police Department | fresnostate.edu/police | 559.278.8400

**Students can also report other incidents of discrimination or harassment to:**

Office of Compliance and Civil Rights | occr.fresnostate.edu | 559.278.5003

**Students can access *confidential support* from two separate resources on campus:**

Counseling Services | studentaffairs.fresnostate.edu/health/counseling | 559.278.2734 Survivor Advocacy Services | fresnostate.edu/survivoradvocate | 559.278.6796

**Pregnancy or Related Conditions:**

Pregnant Students or those with related conditions should contact the Title IX Coordinator in the Office of Compliance and Civil Rights for assistance. The Title IX Coordinator can coordinate specific actions to prevent sex discrimination and ensure the student's equal access to educational programs or activities.

Office of Compliance and Civil Rights | occr.fresnostate.edu | 559.278.5003

Parent scholars provides information on priority registration and other support for parenting students.

Services for Students with Disabilities can also provide assistance with accommodations.

**If you have concerns and you are unsure who to contact, please visit the Concern & Action Guide.**

**Emergency Information:** In the event of an emergency, everyone in the campus community becomes a partner in the response. To ensure you are prepared and remain calm you must make yourself familiar with campus protocols. To contact the Fresno State Police Department call 559.278.8400 from your cell phone or 911 from a campus phone. Prior to an emergency, assess your environment for options depending on the emergency. Identify all possible exit routes, in an emergency always use the closest most safe exit. Once you exit the building go to the predetermined evacuation assembly point, if that is unavailable then go to an open safe space away from the emergency. Identify where and how you can secure yourself inside if you need to shelter in place or hide from a threat. Be prepared to help guide those around you and assist individuals

who may be in need. Additional information can be found at www.fresnostate.edu/emergency

## University Services

The following University services can be found on the web at:

- Associated Students, Inc.
- Students with Disabilities
- Dream Success Center
- Library
- Learning Center Information
- Student Health and Counseling Center
- Academic Success Coaching
- Survivor Advocacy
- Writing Center

## Subject to Change Statement

THIS SYLLABUS AND SCHEDULE ARE SUBJECT TO CHANGE IN THE EVENT OF EXTENUATING CIRCUMSTANCES.

## Course Calendar

All deadlines of prelecture activities and homework can be found on the Canvas.

*Table 4* ***Examination Schedule***

| Date | Exam | Points |
|---|---|---|
| Monday, 10/2/2023<br>(Time: To Be Announced) | 1st Midterm<br>Bulldog Testing Center<br>(Bring Blue Book) | 100 |
| Monday, 11/13/2023<br>(Time: To Be Announced) | 2nd Midterm<br>Bulldog Testing Center<br>(Bring Blue Book) | 100 |
| Monday, 12/16/2024<br>11 AM – 1 PM<br>(Following the University Final Exam Schedule) | Final Exam<br>Bulldog Testing Center<br>(Bring Blue Book) | 100 |

***Table 5*** *Timeline of CUREs project*

***CUREs Project: Dye-Sensitized Solar Cells (DSCCs)***
***2024 Fall***

| Activity Description | Due Date | Week | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Aug. 26 - Aug. 30 | Sept. 2 - Sept. 6 | Sept. 9 - Sept. 13 | Sept. 16 - Sept. 20 | Sept. 23 - Sept. 27 | Sept. 30 - Oct. 4 | Oct. 7 - Oct. 11 | Oct. 14 - Oct. 18 | Oct. 21 - Oct. 25 | Oct. 28 - Nov. 1 | Nov. 4 - Nov. 8 | Nov. 11 - Nov. 15 | Nov. 18 - Nov. 22 | Nov. 25 - Nov. 29 | Dec. 2 - Dec. 6 | Dec. 9 - Dec. 13 |
| Conduct a literature review to identify the necessary materials, methods, and equipment to create DSCCs | | | Phase 1 | | | | | | | | | | | | | | | |
| * Proposal-style oral presentations to demonstrate the feasibility of their projects and experimental setup | W 9/18 | | | | | | | | | | | | | | | | | |
| Actively engage in the experimental process, synthesizing DSSCs, collecting and analyzing data | | | | | | | Phase 2 | | | | | | | | | | | |
| * Progress report on preliminary findings, challenges, revise plan | W 10/30 | | | | | | | | | | | | | | | | | |
| Completing data analysis, delivering a conclusive oral presentation, and preparing for the Fresno State HIPs Student Symposium | | | | | | | | | | | | | | Phase 3 | | | | |
| * Conclusive oral presentation (PPTx) in class meeting time | M 12/2 | | | | | | | | | | | | | | | | | |
| * PPTx poster making according to feedbacks from instructors and peers | | | | | | | | | | | | | | | | | | |
| * PPTx poster submitted for printing to EES office | F 12/6 | | | | | | | | | | | | | | | | | |
| csmposters@csufresno.edu | | | | | | | | | | | | | | | | | | |
| * Poster presentation at Fresno State's HIPs Student Symposium | F 12/13 | | | | | | | | | | | | | | | | | |

# Tentative Course Schedule

***The course schedule is subject to change in the event of extenuating circumstances.***

*If you are absent from class, it is your responsibility to check on announcements made verbally in class while you were absent.*

*Table 6 Fall 2024 Tentative Course Schedule: Monday, Wednesday Courses*

| Day | Date | Topic | Reading Assignment |
|---|---|---|---|
| 1 | Wed., Aug 21 | Course Syllabus<br>& General Rules<br>Introduction to the new component CUREs and<br>Modern Physics, unresolved Questions of 1895<br>Review of Classical Statistics | Ch1 The birth of modern physics<br>Ch9 Statistical physics<br>9.1 Historic Overview<br>Entropy –Degeneracy |
| 2 | Mon., Aug 26 | Maxwell Boltzmann Statistics | Ch9 Statistical physics<br>9.2 Maxwell Velocity Distributions & Phase Space |
| 3 | Wed., Aug 28 | Maxwell Boltzmann Statistics | Ch9 Statistical physics<br>9.2 Maxwell Speed Distributions & Average Thermal Energy of an ideal-gas particle |
| N/A | Mon., Sep 2 | Holiday, Labor Day | |
| 4 | Wed., Sep 4 | Quantum Statistics<br>Two classes of particles:<br>Fermions<br>Bosons | Ch9 Statistical physics<br>9.3 Equipartition Theorem<br>9.4 Maxwell Speed Distribution |
| 5 | Mon., Sep 9 | Quantum Statistics<br>Two classes of particles:<br>Fermions<br>Bosons | Ch9 Statistical physics<br>9.5 Classical and Quantum Statistics<br>9.6 Fermi-Dirac Statistics |
| 6 | Wed., Sep 11 | Quantum Statistics<br>Two classes of particles:<br>Fermions<br>Bosons | Ch9 Statistical physics<br>9.6 Fermi-Dirac Statistics |
| 7 | Mon., Sep 16 | Quantum Statistics:<br>Fermi-Dirac Statistics | Ch9 Statistical physics<br>9.6 Fermi-Dirac Statistics |
| 8 | Wed., Sep 18 | CUREs: Proposal-style oral presentations to demonstrate the feasibility of their projects and experimental setup (PPTx) | |
| 9 | Mon., Sep 23 | Quantum Statistics:<br>Bose-Einstein Statistics | Ch9 Statistical physics<br>9.7 Bose-Einstein Statistics |

| Day | Date | Topic | Reading Assignment |
|---|---|---|---|
| 10 | Wed., Sep 25 | New discoveries in the end of 19th century<br>Black Body Radiation | Ch3 The experimental basis of quantum theory<br>3.1 Discovery of X-ray and Electrons, line spectra, and helium<br>3.2 Determination of Electron Charge |
| 11 | Mon., Sep 30 | Black Body Radiation<br>Transition from Classical interpretation to Quantum Explanation in Statistics | Ch3 The experimental basis of quantum theory<br>3.3 Line Spectra<br>3.4 Quantization<br>3.5 Blackbody Radiation |
| 12 | Wed., Oct 2 | Particle property of Light – Photon | Ch3 The experimental basis of quantum theory<br>3.6 Photoelectric Effect<br>3.7 X-ray Production |
| 13 | Mon., Oct 7 | Particle property of Light – Photon | Ch3 The experimental basis of quantum theory<br>3.8 Compton Effect<br>3.9 Pair Production and Annihilation |
| 14 | Wed., Oct 9 | Atomic Model and Rutherford Scattering | Ch4 Structure of the Atom<br>4.1 The Atomic Model of Thompson and Rutherford<br>4.2 Rutherford Scattering |
| 15 | Mon., Oct 14 | Classical Atomic Model and Bohr's Model for Hydrogen Atom | Ch4 Structure of the Atom<br>4.2 Rutherford Scattering<br>4.3 The Classical Atomic Model |
| 16 | Wed., Oct 16 | Characteristic X-ray and spectroscopy | Ch4 Structure of the Atom<br>4.4 The Bohr Model of the Hydrogen Model<br>4.5 Success and Failure of the Bohr Model |
| 17 | Mon., Oct 21 | X-ray Scattering and Crystallography | Ch4 Structure of the Atom<br>4.6 Characteristic X-ray Spectra and Atomic Number<br>4.7 Atomic Excitation by Electrons |
| 18 | Wed., Oct 23 | Wave nature of Particles | Ch5 Wave properties of matter and quantum mechanics I<br>5.1 X-ray Scattering<br>5.2 De Broglie Waves |
| 19 | Mon., Oct 28 | Wave-Particle Duality<br>Concept of Probability and Wave Function of a Particle | Ch5 Wave properties of matter and quantum mechanics Wave-Particle Duality<br>5.3 Electron Scattering<br>5.4 Wave Motion<br>5.5 Wave or Particles? |
| 20 | Wed., Oct 30 | CUREs: Progress report on preliminary findings, challenges, any revise plan (oral presentation in PPTx) | |

| Day | Date | Topic | Reading Assignment |
|---|---|---|---|
| 21 | Mon., Nov 4 | Uncertainty Principle<br>Particle in a Box | Ch5 Wave properties of matter and quantum mechanics Wave-Particle Duality<br>5.6 Uncertainty Principle<br>5.7 Probability, Wave Functions, and the Copenhagen Interpretation<br>5.8 Particle in a Box |
| 22 | Wed., Nov 6 | Application of the Schrödinger Equation to Solve for a Wave Function | Ch6 Quantum Mechanics II<br>6.1 The Schrodinger Wave Equation<br>6.2 Expectation Values<br>6.3 Infinite Square-Well Potential |
| N/A | Mon., Nov 11 | Holiday, Veteran's Day | |
| 23 | Wed., Nov 13 | Application of the Schrödinger Equation to Solve for a Wave Function | Ch6 Quantum Mechanics II<br>6.3 Infinite Square-Well Potential<br>6.4 Finite Square-Well Potential |
| 24 | Mon., Nov 18 | Application of the Schrödinger Equation to Solve for a Wave Function | Ch6 Quantum Mechanics II<br>6.5 Three-Dimensional Infinite Potential Well<br>6.6 Simple Harmonic Oscillator |
| 25 | Wed., Nov 20 | Analysis and Application of Wave Functions | Ch6 Quantum Mechanics II<br>6.7 Barrier and Tunneling |
| N/A | Mon., Nov 25 | Thanksgiving Break | |
| N/A | Wed., Nov 27 | Thanksgiving Break | |
| 26 | Mon., Dec 2 | CUREs: Final oral presentation plan in PPTx | |
| 27 | Wed., Dec 4 | Wave Function and Electron Clouds for a Hydrogen Atom | Ch7 The hydrogen atom<br>7.1 Application of the Schrodinger Equation to the Hydrogen Atoms |
| 28 | Mon., Dec 9 | Energies and Quantum States for Hydrogen-Like Atoms | Ch7 The hydrogen atom<br>7.1 Application of the Schrodinger Equation to the Hydrogen Atoms<br>7.2 Solution of the Schrodinger Equation for Hydrogen |
| 29 | Wed., Dec 11 Last Day of Instruction | Splitting of the Energy Levels in Magnetic Field | Ch7 The hydrogen atom<br>7.3 Quantum numbers<br>7.4 Magnetic Effects on Atomic Spectra – The Normal Zeeman Effect |
| | Fri., Dec 13 | CUREs: Poster presentation at Frenso State's HIPs Student Symposium | |

*Table 2 Finals Week Schedule*

| Finals week | Days | Dates |
|---|---|---|
| Final Exam Preparation & Faculty Consultation Days: | Thursday and Friday | Dec 12 and 13 |
| Final Semester Examinations | Monday – Thursday | Dec 16 to 19 |
| Final Exam in this course | Monday | Dec 16<br>11 AM -1 PM |