Course Syllabus

Physics 344: Modern Physics

Spring Semester, 2025

Instructor:	Dr. Steven Sahyun
Office:	Upham Hall 157
Phone:	Ext. 5113
E-mail:	sahyuns@uww.edu
Class Home page:	http://sahyun.net/courses/physcs344/index.html
Canvas:	**The Canvas site is linked from the UW-W and class Web sites (www.uww.edu) and select Canvas.**
Class Meetings:	Class: M, W 11:00 a.m. – 12:15 p.m. Lab: M 8:00 a.m. - 10:50 a.m.
Office Hours:	M - R 1:00 pm – 1:50 p.m.; T 3:00 – 4:00 pm or by appointment.
Webex Office:	https://uww.webex.com/meet/sahyuns
Required Text:	Krane: ***Modern Physics*, 4th ed.** (ebook available at the UWW bookstore)
Supplemental text:	**Openstax University Physics, Vol. 3 (free download)** https://openstax.org/details/books/university-physics-volume-3
Pre-requisite:	Physics 181 or Physics 141, and Math 254.
Course modality:	**Face-to-Face**. This course will be offered face-to-face. Laboratory is Face-to-Face.

Other required materials:
LabArchives https://www.labarchives.com account for laboratories. This will be discussed in class.
You are also expected to have a **bound laboratory notebook** (not a spiral), these are available at the bookstore. Also bring paper, a scientific calculator (one with trigonometric and logarithmic functions, scientific notation, etc. These are available for **less than** $20), and a USB data storage device. Although there are computers in the classroom to access Web based applets we will use in class, if you have one, you may bring a laptop to class as well.

Recommended Items:
The use of MATLAB or Python will be required for certain assignments and laboratories. There is access to these on the Physics department computers, however, it is extremely useful to have access on your personal computing device to at least one of these methods for coursework completion.

- MATLAB Student edition (~$100), Octave or Python
    - MATLAB is available on Physics Department computers and via remote access. Alternative #1: OCTAVE (https://www.gnu.org/software/octave/ **free**) may substitute for most MATLAB project items.
    - Alternative #2: Python (free!) Python programming language may be used as an alternative for any MATLAB items. I will attempt to convert MATLAB items to Python programs but there may be some unforeseen challenges. You may complete Homework, Class activities, and Laboratory data analysis and reports using Python whenever MATLAB is mentioned or used.

Course Description: Topics covered include relativity, selected topics of 20th century physics, atomic and molecular structure, elementary quantum physics and its applications in modern technology, elementary nuclear physics and fundamental particles. Laboratory experiments complement material presented in lectures.

Course Learning Outcomes: Learning outcomes: Students successfully completing this course will demonstrate knowledge of fundamental concepts in modern physics including special relativity and quantum mechanics and will be able to apply this knowledge to solve problems. Students will also demonstrate a working knowledge of physics-related technical and laboratory skills including data analysis.
Course learning objectives: By successfully completing this course a student should be able to:

General

- Identify the major 20th and 21st century developments in Physics.
- Apply Special Relativity to the solution of problems involving time dilation, length contraction, simultaneity, relativistic momentum, and relativistic energy.
- Define the experimental basis of the Quantum Theory of Matter.
- Apply quantum methods in the solution of problems such as involving atomic spectra, blackbody radiation, the photoelectric effect, X-ray emission, the structure of the atom, and one-dimensional potentials.
- Communicate scientific ideas and physical concepts in writing clearly and effectively.

Experimental Procedures and Analysis of Experimental Data

- Organize & assemble modern physics laboratory experiments.
- Explain in own words how specific modern physics experiments work.
- Perform data acquisition using assembled experiment.
- Work with a team of researchers
- Maintain a laboratory notebook with detailed entries on everything performed in the lab.
- Distinguish between theoretical predications & experiment measurements.
- Provide computational analysis and presentation of acquired data by constructing graphs based on acquired data.
- Analyze, interpret, and draw conclusions from data and corresponding uncertainties presented in graphs.
- Perform curve fitting to graphical data exhibiting various relationships and interpret the physical meaning of fitting parameters.
- Explain the difference between values predicted by a theory and values measured in an experiment in light of the experimental uncertainties.

[These outcomes are an edited version from:
https://www.uab.edu/cas/physics/images/Documents/PH351_syllabus_Catledge.pdf]

Use of Artificial Intelligence (AI) in coursework

While the use of AI (Artificial Intelligence) for text generation may be helpful as a starting point to overcome writer's block as well as for checking spelling, grammar and structure, the purpose of the coursework is **for you to reflect on your learning** of the material and to put **your own** thoughts into words. The use of AI as an AID in improving writing and analysis is permissible, **however, any assignment that *appears*, according to the grader's judgement, *overly reliant* on use of AI for submitted assignment will be given between no credit up to, at maximum, half-credit.**

Course Policies and Expectations:

Assigned reading: You are expected to read the assigned pages before coming to class in order to make the best use of the day's activities. **You will be expected to submit a paragraph summary at the beginning of the class on each of the assigned readings.**

Homework: There are two categories of homework. **Assigned Homework** will be assigned one week prior to the due date. In general, assigned homework will not be accepted late. If the schedule is modified, I will post the changed schedule on the course Web site. The answers to homework and in class problems will be posted on the course D2L site. Sometimes the assigned homework will be gone over and discussed during the class period when it is due. **Late** homework will generally **not be accepted** for credit.

The second category of homework is additional recommended problems. Recommended problems are for you to work on specific concepts. These problems are found at the end of the chapter. You are encouraged to work on as many problems as you are able. These problems will generally not be gone over in class unless there are specific question, solutions to the problems will be posted on D2L. Questions similar to the recommended problems may show up on the exams.

Classroom activities: There will usually be some sort of activity during the class. You are expected to fully participate and complete these activities. Activities are to be worked on in small groups, but you are expected to maintain your own notes for the activity. Activity participation will be checked for completeness the day of the activity. If you miss a class, you are expected to make-up the missed activity (complete and submit). **Activities are a graded item.**

MATLAB/Python activities: There will be three MATLAB/Python assignments to be completed. These will have written reports showing your solutions to several assigned projects.

Exams: There will be two mid-term exams as well as a comprehensive final. See the attached schedule (current schedule posted at: http://sahyun.net/courses/physcs344/schedule.pdf) for dates.

Laboratory: There will be 10 laboratory experiments, each will have regular (weekly) written reports. The laboratory reports will be typed and follow a grading rubric style. **Typed** laboratory reports are due one week after the lab completion. **Typed reports are to be submitted as single .pdf files on LabArchives**. Reports will be reduced by 2 pts. for each day they are late. **You MUST complete 9 of the 10 regular laboratory experiments** (assuming there are no technical problems with the experiments and that there are 10 experiments offered**) to pass the course.** If you complete fewer than 9 regular laboratory experiments (assumption as noted above) your grade will be impacted accordingly. A bound lab notebook is to be kept for recording your experiments and data, and will be evaluated (for part of the lab grade) in lab for good record keeping. Your lab notes will be scanned in and submitted to LabArchives and will be part of your lab grade.

Physics 344: Modern Physics Laboratory Report Tentative Guidelines

(2 pts.) Lab Book: Your laboratory procedure is clearly outlined and easy to follow. There is an accurate index at the start of the lab book. Each page is numbered and dated. The laboratory experiment and objective are clearly stated. It is clear what you did and why you did it. There are drawings, diagrams, and notations for each experiment. Filenames and locations of data files are recorded. The data and results are clearly At the end of each day, there is a short, clear preliminary analysis and commentary of the results obtained for the day.

The purpose of the report is to create a clear communication of your laboratory experience and contains information so that others can reproduce what you have accomplished. Your report must have your name and the experiment title. In addition, your report will have:

(2 pts.) I. Objective/Introduction (future tense) – A couple paragraphs that provide an explanation about the purpose of the experiment and why it is of interest.
(4 pts.) II. Theory – This section details the physics behind the experiment. Any equations that you will use will be *explained* in the theory section.
(2 pt) III. Set-up (Past tense) – This section describes what equipment was used and *diagrams* of any apparatus. This section is NOT a restatement of laboratory instruction handouts.
(4 pts) IV. Data Results (Past tense) – This section shows the data from your experiment. Data may be presented in tables, charts, or graphs and is referred to in the analysis section.
(4 pts.) V. Analysis and Interpretation (Past tense) – Manipulation of the data and interpretation of what it means. This section shows your theoretical modeling and correlation to data results.
(2 pt.) VI. Conclusion (Past tense) – Final statement of what you found and any experimental uncertainties. For example, for part of your conclusion you will state: We determined the electron's mass to be xxxxx with an uncertainty of yyyy. This result differs from the accepted value of aaaaa by zzz%.

A good report has the following items: Your project shows a very good analysis and conclusions. It is a well-written paper with a clear summary of your laboratory experiments.

- The introduction shows why this experiment is of interest and the experimental objective is clearly stated.
- The experimental set-up clearly described and any necessary figures included.
- There is a coherent THEORY section that clearly shows how the theory relates to the experiment. Application of the equations are clearly shown.
- The method of how the data was acquired and results are clearly noted. Graphs of acquired data or other presentation of your work are shown.
- There is a clear and correct analysis and interpretation of what your data indicates and commentary of the results,
- There is a **useful** summary and conclusions of the experiment (including your final results). Your final results are clearly stated as well as a discussion of the implications of your experiment or activity.
- The paper has good grammar, complete sentences and paragraphs, and a logical structure.

Notes:
There will be up to a 2 pt. deduction for a poorly written (grammar/spelling) report.
There is a late fee of 1 pt. per day.

Grading:

Course grades will be determined by the percentage of total points assigned for the course.

93% = A,	80% = B-,	67% = D+,
90% = A-,	77% = C+,	63% = D,
87% = B+,	73% = C,	60% = D-,
83% = B,	70% = C-,	< 60% = F.

The **approximate** assignment of points will be as follows:

Item	Score	~%
Exam 1: See schedule	50	9%
Exam 2: See schedule	50	9%
Final: See schedule	100	18%
Reading Summaries (21 @ 1 each)	21	4%
Class activities (21 @ 1 each)	21	4%
Homework (78 @ 1 pt. each.)	78	14%
MATLAB/Python projects.	15	3%
Laboratory reports (11 @ 20 pts.)	230	41%
Total	500	100

I reserve the right to adjust grades slightly based on class participation. There may be occasional opportunities for extra credit.

Inclusive Learning Environment Statement: The University of Wisconsin-Whitewater is dedicated to a safe, supportive, and non-discriminatory learning environment. It is the responsibility of all students to familiarize themselves with UWW policies regarding: Special Accommodations, Academic Misconduct, Religious Beliefs Accommodation, Absence for University Sponsored Events, the "Rights and Responsibilities" section of the Undergraduate Catalog or the “Academic Requirements and Policies” section of the Graduate Catalog, the "Student Academic Disciplinary Procedures” (UWS Chapter 14), and the "Student Non-academic Disciplinary Procedures" (UWS Chapter 17).

Mandatory Reporting Statement: Federal law requires all university employees to report information obtained during the course of their duties regarding sexual misconduct, including domestic and dating violence, unless otherwise exempt by state law. For more information, including on how to report an incident, see http://www.uww.edu/sexual-misconduct-information.

Sahyun			Physics 344 Modern Physics Tentative Schec	Spring 2025 Updated 1/17/2025				
Texts: Krane, Modern Physics, 4th ed., OpenStax University Physics Vol. 3								
Week	**Class**		**Date**	**Topic/Lab**	**Book Sections**	**Assigned Reading Pages**	**Assignment**	**Laboratory (8:00 am - 10:50 am)**
1	1	Mon	27-Jan	Course Introduction; MATLAB, Python, LabArchives and LaTeX				No lab 1/27!
	2	Wed	29-Jan	1. Classical Physics I	1.1 - 1.4	1 - 20		
		Fri	31-Jan					
2	3	Mon	3-Feb	2. Relativity I	2.1 - 2.5	25 - 45	H01: Q1.7 P1.1, 1.6, 1.13	**Lab 1: Speed of Light**
	4	Wed	5-Feb	2. Relativity II	2.6 - 2.9	46 - 65	H02: Q2.1 P2.3, 2.7, 2.17	
		Fri	7-Feb					
3	5	Mon	10-Feb	3. EM Waves	3.1 - 3.4	72 - 92	H03: Q2.6 P2.25, 2.43	**Lab 2: Relativity**
	6	Wed	12-Feb	3. Compton effect	3.4 - 3.6	93 - 99	H04: Q3.2 P3.3, 3.9, 3.17	
		Fri	14-Feb					
4	7	Mon	17-Feb	MATLAB/Python Project 1: Blackbody curve				**Lab 3: Photoelectric Effect**
	8	Wed	19-Feb	4. Wave Properties	4.1 - 4.3	106 - 117	H05: Q3.15 P3.25, 3.31	
		Fri	21-Feb					
5	9	Mon	24-Feb	4. Heisenburg	4.4 - 4.7	118 - 133	H06: Q4.3 P4.3, 4.8, 4.13	**Lab 4: Blackbody**
	10	Wed	26-Feb	5. Schrodinger Equation	5.1 - 5.3	140 - 149	H07: Q4.13 P4.20, 4.29	
		Fri	28-Feb					
6	11	Mon	3-Mar	**Exam 1 (1-4)**				Exam 1 review time
	12	Wed	5-Mar	5. Schrodinger Applications	5.4 - 5.6	150 - 173	H08: Q5.5 P5.5, 5.9, 5.15	
		Fri	7-Mar					
7	13	Mon	10-Mar	6. Atoms	6.1 - 6.4	178 - 190	H09: Q5.12 P5.21, 5.27	**Lab 5: Compton Scattering**
	14	Wed	12-Mar	6. Frank-Hertz	6.5 - 6.8	191 - 203	H10: Q6.3 P6.1, 6.5, 6.15	
		Fri	14-Mar					
8	15	Mon	17-Mar	7. H Atom	7.1 - 7.4	208 - 219	H11: Q6.15 P6.23,6.31	**Lab 6: e/m and SEM**
	16	Wed	19-Mar	7. H Atom II	7.5 - 7.9	220 - 232	H12: Q7.9 P7.3, 7.7, 7.15	
		Fri	21-Mar					
9				Spring Break (3/22 - 3/30)				
10	17	Mon	31-Mar	8. Pauli Exclusion	8.1 - 8.4	238 - 247	H13: Q7.16 P7.25, 7.27	**Lab 7: Atomic Spectra**
	18	Wed	2-Apr	8. Elements	8.4 - 8.7	248 - 265	H14: Q8.3 P8.1, 8.7, 8.9	
		Fri	4-Apr					
11	19	Mon	7-Apr	MATLAB/Python Project 2: Atom Shell Models				**Lab 8: Franck Hertz**
	20	Wed	9-Apr	12. Nuclar Structure	12.1 - 12.5	390 - 402	H15: Q8.13 P8.13, 8.15	
		Fri	11-Apr					
12	21	Mon	14-Apr	**Exam 2 (chapter 4-8)**				Exam 2 review time
	22	Wed	16-Apr	12 Radioactive Decay	12.6 - 12.10	403 - 421	H16: Q12.1 P12.3, 12.5, 12.15	
		Fri	18-Apr					
13	23	Mon	21-Apr	13 Nuclear Reactions	13.1 - 13.4	428 - 442	H17: Q12.21 P12.30, 12.35	**Lab 9: Zeeman**
	24	Wed	23-Apr	13 Fusion	13.5 - 13.7	443 - 459	H18: Q13.9 P13.3,13.11,13.19	
		Fri	25-Apr					
14	25	Mon	28-Apr	14 Elementary Particles	14.1 - 14.4	464 - 480	H19: Q13.20 P13.22, 13.31	**Lab 10: EFNMR/NMR**
	26	Wed	30-Apr	14 Standard Model	14.5 - 14.8	481 - 499	H20: Q14.1 P14.1, 14.7, 14.19	
		Fri	2-May	**Lab Assessment Activity**				
15	27	Mon	5-May	15 Cosmology	15.1 - 15.5	504 - 522	H21: Q14.21 P14.23, 14.27	**Lab 11: Radioactivity**
	28	Wed	7-May	15 General Relativity	15.6 - 15.10	423 - 541	H22: Q15.4 P15.1, 15.3, 15.5	
		Fri	9-May				MATLAB/Python Project 3: General Relativity (due)	
16	29	Wed	14-May	**Final 10:00 am - 12:00 noon**				

FINAL EXAM SCHEDULE

All instructional staff of on- and off-campus classes are expected to meet during their scheduled final exam times. All comprehensive final exams shall be administered at the prescribed time during the final exam times. For those classes where there is no final exam, the time prescribed during the final exam times shall be used as a regular class meeting. Exception to meeting classes during the exam times requires specific written approval in advance from the college dean.

The general schedule will be available via PDF around the beginning of the given term. Due to the amount of department requested changes, the specific final exam schedule in WINS will not be available to view until after the tenth day of classes for the term.

For classes that have set meeting times, the final exam shall be administered at the prescribed time during finals week. For classes with set meeting times that do not have a final exam, the time prescribed during finals week shall be used as a regular class meeting.

For classes without set meeting times (ie. online classes), the timing of the final exam or final assignment is at the discretion of the instructor within finals week.

No undergraduate student shall be required to take more than two comprehensive final exams on the same day. Any student with more than two comprehensive final exams scheduled for the same day may elect to reschedule the additional examination(s). These alternative arrangements are available only when the exams are comprehensive.

- Final exams for web-based and arranged classes are to be held during final exam week at the discretion of the instructor.
- Final exams for off-campus classes are to be held at the regular class meeting time that falls during the final exam week.
- Classes offered at times not listed below do not have designated final exam times. Instructors are to make arrangements by the end of week 11 to administer these exams during the standard final exam times*.
- Instructors needing an alternative time or location, different than the one assigned, must work with their department associate to request an alternative.
- 0.5 - 1 unit courses will not be assigned a final exam time. However, if instructors would like to host a final exam, please contact the Registrar's Office by the tenth day of classes to ensure proper time and room assignments occur.

Monday

7:45-9:45 am	MW, MWR, MWF, MTWR, MF or WF classes beginning between 7:00-8:50 am
10:00-12 Noon	MW, MWR, MWF, MTWR, MF or WF classes beginning between 10:00-10:50 am
12:15-2:15 pm	MW, MWR, MWF, MTWR, MF or WF classes beginning between 12:00-12:50 pm
2:30-4:30 pm	MW, MWR, MWF, MTWR, MF or WF classes beginning between 2:00-2:50 pm
4:45-6:45 pm	M, MW, MWR, MWF, MTWR or MF classes beginning between 4:00-6:25 pm
7:00-9:00 pm	M, MW, MWR, MWF, MTWR or MF classes beginning 6:30 pm or later

Tuesday

7:45-9:45 am	TR, MTR, MTWRF or TWR classes beginning between 7:00-8:50 am
10:00-12 Noon	TR, MTR, MTWRF or TWR classes beginning between 10:00-10:50 am
12:15-2:15 pm	TR, MTR, MTWRF or TWR classes beginning between 12:00-12:50 pm
2:30-4:30 pm	TR, MTR, MTWRF or TWR classes beginning between 2:00-2:50 pm
4:45-6:45 pm	T, TR, MTR or MTWRF classes beginning between 4:00-6:25 pm
7:00-9:00 pm	T, TR, MTR or MTWRF classes beginning 6:30 pm or later and Common Exam 1

Wednesday

7:45-9:45 am	MW, MWR, MWF, MTWR, MF or WF classes beginning between 9:00-9:50 am
10:00-12 Noon	MW, MWR, MWF, MTWR, MF or WF classes beginning between 11:00-11:50 am
12:15-2:15 pm	MW, MWR, MWF, MTWR, MF or WF classes beginning between 1:00-1:50 pm
2:30-4:30 pm	MW, MWR, MWF, MTWR, MF or WF classes beginning between 3:00-3:50 pm
4:45-6:45 pm	W or WF classes beginning between 4:00-6:25 pm
7:00-9:00 pm	W or WF classes beginning 6:30 pm or later

Thursday

7:45-9:45 am	TR, MTR, MTWRF or TWR classes beginning between 9:00-9:50 am
10:00-12 Noon	TR, MTR, MTWRF or TWR classes beginning between 11:00-11:50 am
12:15-2:15 pm	TR, MTR, MTWRF or TWR classes beginning between 1:00-1:50 pm
2:30-4:30 pm	TR, MTR, MTWRF or TWR classes beginning between 3:00-3:50 pm
4:45-6:45 pm	R or TWR classes beginning between 4:00-6:25 pm
7:00-9:00 pm	R or TWR classes beginning 6:30 pm or later and Common Exam 2

Friday*

7:45-9:45 am	F only classes beginning between 7:00-9:55 am
10:00-12 Noon	F only classes beginning between 10:00-11:55 am
12:15-2:15 pm	F only classes beginning between 12:00-1:55 pm
2:30-4:30 pm	F only classes beginning between 2:00-3:55 pm
4:45-6:45 pm	F only classes beginning between 4:00 pm or later

*Friday will also include courses offered at a non-standard start time and special makeup exams for on-campus students if authorized by the instructor.

Saturday

Saturday classes should hold exams during the meeting time that falls during exam week.

Sunday

Sunday classes should hold exams during the meeting time that falls during exam week.