This is a sample syllabus only. The instructor may make changes to the syllabus in future courses.

# PH 351-2B & PH 351L-8M: Modern Physics I
## Fall Semester 2015

**Time and location:**
PH 351-2G (Lecture): Tuesdays & Thursdays 9:30 – 10:45 AM (CH 394)
PH 351L-8M (Lab): Mondays 5:45 – 8:35 PM (CH 470)

**Instructor and office hours:**
Dr. Aaron Catledge, catledge@uab.edu
(205) 934-8143 or (205) 934-3693

Tues/Thurs 8:30-9:30 AM in CH 353
Friday 9:30-10:30 AM in CBSE G89
(Other times by appointment)

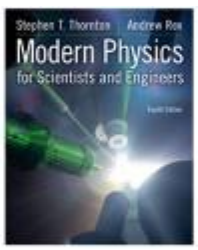
**Teaching Assistants and office hours:**
Zack Lindsey, zack@uab.edu
CH 460 (email 1st)

Office Hours: Wednesdays 11:00AM-12:00PM
(Other times by appointment)

Matt Rhoades, mrhoades@uab.edu
CH 362

Office Hours: Wednesdays 11:00AM-12:00PM
(Other times by appointment)

Required Textbook:




Modern Physics for Scientists and Engineers
Thornton & Rex, 4th Ed., 2013
Publisher: Brooks/Cole, Cengage Learning
ISBN10: 1-133-10372-3
ISBN13: 978-1-133-10372-1

Other Useful Books and Resources Suggested:

| | | |
|---|---|---|
| **Special Relativity**<br>*A. P. French*<br>*M.I.T. Physics Series* | **Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles** (2nd Edition)<br>*J. Eisberg & R. Resnick*<br>*Wiley* | **Modern Physics**<br>(3rd Edition)<br>*K. S. Krane*<br>*Wiley* |

**Catalog Description:** Special relativity, atomic physics, and quantum mechanics. Theoretical and experimental studies to understand observable properties of matter in terms of microscopic constituents. Emphasis on the use of quantitative reasoning to solve modern physics problems. Writing and scientific ethics assignments based on laboratory experiences. Lecture and laboratory.

**Prerequisite: PH 222**

Last Day to Add/Drop: August 31

Last Day to Withdraw: October 23

This is a sample syllabus only. The instructor may make changes to the syllabus in future courses.

**Course Activities:** This course will comprise lectures, classroom discussions, homework problem sets, and weekly laboratory activities.

**Related UAB core 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**

(1) Define the major 20$^{th}$ century developments in Physics.
(2) Compare and contrast Modern Physics with Classical Physics.
(3) State the fundamental tenets of the Theory of Special Relativity.
(4) Apply Special Relativity to the solution of problems involving time dilation, length contraction, simultaneity, relativistic momentum, and relativistic energy.
(5) Define the experimental basis of the Quantum Theory of Matter.
(6) Command elementary and intermediate quantum methods.
(7) Apply quantum methods in the solution of problems involving atomic spectra, blackbody radiation, the photoelectric effect, X-ray emission, the structure of the atom, and one-dimensional potentials.
(8) Quantitatively defend the assertions of Modern Physics theories.
(9) Perform experimental work with atomic and subatomic particles and photons.
(10) Communicate scientific ideas and physical concepts in writing clearly and effectively.
(11) Define and explain at least 5 areas of cutting edge 21$^{st}$ century Physics and its relation to Modern Physics theories developed in the 20$^{th}$ century.

**Experimental**

(12) Organize & assemble modern physics laboratory experiments.
(13) Explain in own words how specific modern physics experiments work.
(14) Perform data acquisition using assembled experiment.
(15) Engage in experimental troubleshooting with teaching assistants.
(16) Maintain a laboratory notebook with detailed entries on everything performed in the lab.

**Analysis of Experimental Data**

(17) Distinguish between theoretical predications & experiment measurements.
(18) Identify sources of error and fluctuations in data obtained in laboratory activities.
(19) Organize the data obtained in the laboratory activities in the form of tables.
(20) Construct graphs using graph paper and pencil based on data presented in tables.
(21) Construct graphs using computers based on data presented in tables.
(22) Distinguish between trends and fluctuations in data presented in graphs.
(23) Distinguish between random errors and systematic errors in an experiment.
(24) Identify the elements of theory of errors and statistical treatment of data that are essential for interpretation of modern physics experiments.

(25) Apply principles of theory of errors and statistical treatment of data to analyze experimental uncertainties.
(26) Analyze, interpret, and draw conclusions from data and corresponding uncertainties presented in graphs.
(27) Perform curve fitting to graphical data exhibiting various relationships and interpret the physical meaning of fitting parameters.
(28) Explain the difference between values predicted by a theory and values measured in an experiment in light of the experimental uncertainties.
(29) Evaluate the possible reasons for disagreement between predicted and measured values.

**Written Scientific Communication**

(30) Analyze and apply rubrics to written scientific documents prepared by others.
(31) Write laboratory reports with organized and logical flow of ideas containing: Title, Introduction, Objective of Experiments, Method Used, Results and Discussion, Conclusions, and Cited References.
(32) Write laboratory reports that define unfamiliar terms and concepts used, establish the importance of the activity reported, provide sufficient information to enable activity to be reproduced by others, and make critical analysis of the results.
(33) Write laboratory reports that integrate mathematical, tabular, and graphical representation of data, including statistical analysis of acquired data.
(34) Write laboratory reports that compare and contrast theoretical predictions and experimental measurements and draw conclusions and inferences from agreements and/or disagreements observed.

**Ethical Performance of Experiments and Scientific Communication**

(35) Define the various modes of plagiarism.
(36) Write laboratory reports without resorting to plagiarism.
(37) Write laboratory reports in own words without cutting and pasting from other electronic sources or copying from other written sources.
(38) Write laboratory reports with ethical acknowledgement of used sources.
(39) Discuss contemporary issues such as the role of science in society, the contribution of Physics to the development of clean energy sources, the principles and safety issues related to nuclear power, nuclear weapons, nanotechnology, etc
(40) Develop a sense of the broad cultural and gender diversity of the practitioners of science, including the basic cultural background of key scientists in Modern Physics.
(41) Work effectively as part of a group or team of students with diverse cultural, racial, intellectual, and educational backgrounds

**Measurement of learning outcomes.** Documented completion of laboratory activities, laboratory reports, problem sets, in-class tests, and a final exam will be used to measure attainment of learning objectives.

This is a sample syllabus only. The instructor may make changes to the syllabus in future courses.

**Course Grade:**

| | |
|---|---|
| Laboratory Notebook | 5% |
| Laboratory Participation | 5% |
| Laboratory Reports | 20% |
| Problem Sets | 20% |
| Average of In-Class Tests | 30% |
| Final Exam | 20% |

• **Laboratory Notebook**. Every student will maintain an ***individual*** laboratory notebook. This notebook will be reviewed periodically by the teaching assistants and graded at the end of the semester according to the lab notebook rubric.

• **Laboratory Participation**. In every lab session students will be asked to complete certain activities. The laboratory notebook and activity sheets will document a student's engagement and participation in the laboratory. In every lab session the teaching assistants will review student records on laboratory notebooks and/or completed activity sheets to confirm student participation. A student's score in this participation component will scale linearly with the number of activities he or she completed (from zero for no activities completed to 5% for all activities completed).

• **Laboratory Reports**. Following several experiments students will create a written scientific document reporting their findings. These laboratory reports will be prepared according to guidelines and standards provided by the instructor and the teaching assistants. Guidelines will vary from one report to another, including whether they are ***group*** or ***individual*** exercises. The final value of this grade component will correspond to the average score of the reports. Reports will be graded according to a written scientific communications rubric.

• **Problem Sets**. Problem sets featuring a variety of activities to foster learning will be regularly assigned by instructor. Activities must be completed and turned in by the due date.

Policy regarding late Problem Set without proper justification:

- ½ credit while solutions have not yet been posted
- 0 credit after solutions have been posted

• **Three In-Class Tests**. Non-cumulative closed book tests during regular lab periods.

• **Final Exam**. Open book comprehensive exam (2½ hours).

**Student collaboration policy**. Guidelines regarding student collaboration will be provided for each Assigned Activity and Problem Set:

• Open Exchange of Ideas: In general, students are encouraged to discuss concepts, assigned problems, and engage in lively exchange of ideas.

• Independent Work: Specific problems and activities will be assigned for students to complete independently. The purpose is that each student can be confident that he or she has acquired the desired knowledge in specific topics.

Copying and verbatim rendering of solutions from other students are not appropriate. These practices constitute violation of the University honor code and may result in academic disciplinary action including dismissal from the degree program. Collaboration among students ***is not allowed*** during tests and exams.

This is a sample syllabus only. The instructor may make changes to the syllabus in future courses.

**Lab. Attendance**: Teaching assistants will maintain written records of student attendance. Laboratory reports for a specific lab activity will only be accepted from students who actually completed the activity. Knowledge of experiments and topics covered in the laboratory is essential to the Modern Physics course and will be demanded on Problem Sets, Tests and Final Exam.

Letter grades will be evaluated according to the following table, subject to revision based on overall class performance:
(All calculated grades will be rounded up to the nearest 0.1%.)

| | |
|---|---|
| 90.0% to 100% inclusive | A |
| 80.0% to 89.9% inclusive | B |
| 70.0% to 79.9% inclusive | C |
| 60.0% to 69.9% inclusive | D |
| 0.0% to 59.9% inclusive | F |

Turning in all assigned work is a necessary condition for an **A** grade

**Comments:**
(i) Discuss difficulties with course material, course style and schedules early.
(ii) Make use of office hours, telephone & email (in that order).
(iii) Read material *before* the class.

**Test & Exam Dates (subject to change)**:

- **Test 1:** **Monday, September 28; 5:45 – 8:35 PM**
- **Test 2:** **Monday, October 26; 5:45 – 8:35 PM**
- **Test 3:** **Monday, November 30; 5:45 – 8:35 PM**
- **Final Exam:** **Thursday, December 10; 8:00 – 10:30 AM**

**Policy regarding reasonable accommodations:**
If you are registered with Disability Support Services (DSS), please make an appointment with me to discuss accommodations that may be necessary. If you need to contact DSS, please call 934-4205 or visit DSS at 516 Hill University Center. Students with disabilities must be registered with DSS and provide an accommodation request letter before receiving accommodations for class.

**Web learning resources**: Lectures, assignments, class information and grades will be available through the Canvas online system. http://www.uab.edu/online/canvas

**Early Alert System (EAS):** The early alert system is a notification used during the months of February/March. If your performance is at the "D" or below level, you will be alerted via email by this system. EAS is designed to help students be more successful academically at UAB. If you receive an email with EAS in the title, please open it, read it, and take advantage of the support that UAB offers to all students. UAB is committed to ensuring that students receive academic support and are aware of the resources available that will help assist them in successfully completing their degree program.

This is a sample syllabus only. The instructor may make changes to the syllabus in future courses.

## Topical Outline

1. The Special Theory of Relativity
    a. Newtonian Relativity and the Galilean Transformation
    b. The Michelson-Morley Experiment
    c. The Lorentz Transformation
    d. Space-time; Time dilation; Length contraction; Simultaneity
    e. Relativistic Momentum & Energy

2. The Experimental Basis of Quantum Mechanics
    a. The Discovery of X-rays
    b. The Electron and Charge Quantization
    c. Blackbody Radiation
    d. The Photoelectric Effect
    e. X-ray Production
    f. The Compton Effect
    g. Pair Production and Annihilation

3. The Structure of the Atom and the Old Quantum Theory
    a. The Thomson and Rutherford Models
    b. The Bohr Model
    c. Successes and Failures of the Old Theory
    d. Critical Review of the Old Theory

4. Quantum Mechanics I – Wave Properties of Matter
    a. X-ray and Electron Scattering
    b. The de Broglie Postulate
    c. Wave-Particle Duality
    d. The Uncertainty Principle
    e. Wave Functions and Probability Densities

5. Quantum Mechanics II – Schrödinger's Theory
    a. Schrödinger's Wave Equation
    b. Expectation Values
    c. Solution for Infinite Square-Well Potential
    d. Solution for Finite Square-Well Potential
    e. Solution for 3D Infinite Potential Well
    f. Solution for the Harmonic Oscillator Potential
    g. Barriers and Tunneling

## Laboratory Experiments (subject to change)

1. Measurement of the Speed of Light (Foucault and Time-Of-Flight Methods)
2. Statistical Treatment of Data (Part I and II)
2. Measurement of the Electron Charge-to-Mass Ratio
3. The Photoelectric Effect and Compton Effect (Demo)
5. Hydrogen Spectrum
6. The Millikan Experiment of Charge Quantization