UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS & ASTRONOMY
COURSE OUTLINE

1. **Course:** PHYS 325, Modern Physics -- Winter 2018

   Lecture 01: (MWF, 09:00-09:50 in ES443)

Instructor Name	Email	Phone	Office	Hours
Michael Wieser	mwieser@ucalgary.ca	403 220 3641	SB 131	TBA

   Course Site:

   D2L: PHYS 325 L01-(Winter 2018)-Modern Physics

   Department of Physics & Astronomy: Science B 605, 403 220-5385, office@phas.ucalgary.ca

   Students must use their U of C account for all course correspondence.

2. **Prerequisites:**

   See section 3.5.C in the Faculty of Science section of the online Calendar.

   > Physics 211 or 221 or 227; and 223 or 255 or 259 or 355; and Mathematics 211 or 213; and Mathematics 249 or 251 or 265 or 275 or Applied Mathematics 217.
   > Credit for Physics 325 and 209 will not be allowed.

3. **Grading:**

   The University policy on grading and related matters is described in F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Component(s)	Weighting %
Laboratory Reports (9)	25
Poster Presentation (last week of classes)	5
Tutorials (8)	25
Quizzes (3)	25
Final Examination (2h Scheduled by Registrar)	20

   Each of the above components will be given a letter grade using the official university grading system. The final grade will be calculated using the grade point equivalents weighted by the percentages given above and then converted to a final letter grade using the official university grade point equivalents.

4. **Missed Components of Term Work:**

   The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in Section 3.6. It is the student's responsibility to familiarize himself/herself with these regulations. See also Section E.3 of the University Calendar

5. **Scheduled out-of-class activities:**

   There are no out-of-class activities scheduled for this course.

REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY. If you have a conflict with the out-of-class-time-activity, please contact your course coordinator/instructor no later than **14 days prior** to the date of the out-of-class activity so that alternative arrangements may be made.

6. **Course Materials:**

   "Modern Physicsâ€, by Kenneth Krane, John Wiley & Sons, 3rd Edition, 2012

   Online Course Components: Assignments, and supporting lecture material will be posted on the course D2L website. Laboratory information will be posted at the Physics Junior Laboratory website http://www.pjl.ucalgary.ca/

7. **Examination Policy:**

   For all quizzes, tests, and examinations a calculator is allowed. Otherwise, no additional aids are permitted.

   Students should also read the Calendar, Section G, on Examinations.

8. **Approved Mandatory and Optional Course Supplemental Fees:**

   There are no mandatory or optional course supplemental fees for this course

9. **Writing across the Curriculum Statement:**

   For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of those reports. See also Section E.2 of the University Calendar.

10. **Human studies statement:**

    Students will not participate as subjects or researchers in human studies.

11. **Reappraisal of Grades:**

    A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See Section I.3 of the University Calendar.

    1. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **15 days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall immediately submit the Reappraisal of Graded Term work form to the department in which the course is offered. The department will arrange for a re-assessment of the work if, and only if, the student has sufficient academic grounds. See sections I.1 and I.2 of the University Calendar
    2. **Final Exam:**The student shall submit the request to Enrolment Services. See Section I.3 of the University Calendar.

12. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

    a. **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties. Examples of academic misconduct may include: submitting or presenting work as if it were the student's own work when it is not; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; collaborating in whole or in part without prior agreement of the instructor; borrowing experimental values from others without the instructor's approval; falsification/ fabrication of experimental values in a report. **These are only examples**.

    b. **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on assembly points.

    c. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at procedure-for-accomodations-for-students-with-disabilities_0.pdf.

       Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics & Astronomy, Dr. David Feder by email dfeder@ucalgary.ca or phone 403-220-3638. Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question: http://www.ucalgary.ca/pubs/calendar/current/e-4.html

    d. **Safewalk:** Campus Security will escort individuals day or night (www.ucalgary.ca/security/safewalk/) . Call

403-220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

e. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see also www.ucalgary.ca/legalservices/foip.

f. **Student Union Information:** VP Academic, Phone: 403-220-3911 Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: 403-220-3913 Email: sciencerep@su.ucalgary.ca. Student Ombudsman, Email: suvpaca@ucalgary.ca.

g. **Internet and Electronic Device Information:** Unless instructed otherwise, cell phones should be turned off during class. All communication with other individuals via laptop, tablet, smart phone or other device is prohibited during class unless specifically permitted by the instructor. Students that violate this policy may be asked to leave the classroom. Repeated violations may result in a charge of misconduct.

h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction (USRI) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

i. **SU Wellness Center:** The Students Union Wellness Centre provides health and wellness support for students including information and counselling on physical health, mental health and nutrition. For more information, see www.ucalgary.ca/wellnesscentre or call 403-210-9355.

Course Description

Origins of quantum mechanics, a historical perspective. Concepts of wave mechanics and applications. Nuclear physics and radioactivity. The aim of the course is to survey some of the significant challenges to classical physics encountered in the 20th century and to show how the solutions to these phenomena shaped our understanding of the natural world. Quantitative problem solving will be emphasized as a means of gaining deeper understanding of the concepts. The laboratory is considered a very essential component of the course where you will get a â€œhands-onâ€ sense of some of the phenomena studied.

Tutorials

There are eight tutorial periods throughout the term that will take place during the assigned lectures on Fridays (09:00 to 09:50) in ENG 230. The objective of the tutorial is to give you an opportunity to work in a supported environment to solve problems related to the course material. A set of problems will be posted on Monday prior to the tutorial. At the end of the tutorial session, you will hand in one or two problems (indicated on the question sheet) to be graded. These will count towards the Tutorial component in the course.

Quizzes

There are three quizzes throughout the course scheduled for Friday January 26, Friday February 16, and Friday March 16 from 09:00 to 09:50 in ENG 230. The first 20 minutes of the quiz are to be done independently. This will be followed by 15 minutes when you can work collectively in pre-assigned groups on a related problem. Eighty percent of the grade for the quiz will come from your independent work and twenty percent from the group work. Your score will not be lower than the work you did independently. Quizzes are closed-book and you may only use a non-programmable calculator and the equation sheet provided for the exam (a copy of which is posted on the D2L website for the course).

Laboratory Reports

The laboratory component of Phys325 is an essential opportunity for you to experience some of the exciting phenomena encountered in this course. A laboratory manual is available online at www.pjl.ucalgary.ca. Each laboratory exercise is accompanied by â€œPre-lab Questionsâ€. You must read over the laboratory exercise and complete these questions prior to entering the laboratory and working on the experiment. Your TA will check that these questions are complete at the start of the session.

The laboratory exercises begin the week of January 22nd and take place in ST029.

The first four lab reports must be completed during the laboratory period and handed in to the TA before the end of your laboratory session. After the Reading Break (February 19th to February 23rd), you and your group can select to do five experiments from a list of seven. Two of the experiments must be chosen from Compton Scattering, Rutherford Scattering, and Nuclear Decay. Your laboratory TA will work with you to make the selection

and coordinate when you perform an experiment. Note that experiments including Nuclear Decay and Rutherford Scattering require several days to complete and a limited amount of time outside of your scheduled laboratory section may be needed to complete each experiment. Your group will submit one laboratory report for the five experiments completed after the Reading Break and the same grade will be applied to all members of the group. The grading criteria and format for the laboratory reports will be discussed in the lectures.

Poster Presentation

You and your group will select one experiment to present in the form of a poster during a*Symposium on Experiments in Modern Physics* that will be held during from 09:00 to 11:00 on Friday, April 13. The poster presentation will last approximately two hours during which time you and your group members will discuss your results and conclusions with your peers and other members of the department. Laboratory TAs and the course instructor will grade your work and your responses to questions. Strategies for designing an effective poster as well as the criteria for grading will be discussed in the lectures. The same grade will be applied to all group members.

Below is the tentative lecture schedule, including dates for the tutorials and quizzes.

Lec #	Date	Content	Text Section
1	Jan 08	Galilean and Lorentzian Transformations	2.1, 2.2, 2.5
2	Jan 10	Einsteinâ€™s Postulates, Length Contraction, Time Dilation	2.3, 2.4, 2.5
3	Jan 12	Tutorial #1	
4	Jan 15	Relativistic Energy and Momentum Equations	2.7
5	Jan 17	Relativistic Energy and Momentum Conservation	2.8
6	Jan 19	Tutorial #2	
7	Jan 22	Planckâ€™s Blackbody Radiation	3.3
8	Jan 24	Einstein and the Photoelectric Effect	3.2
9	Jan 26	Quiz #1	
10	Jan 29	Bragg Diffraction, Compton Scattering	3.1, 3.4
11	Jan 31	Rutherford Scattering	6.1 - 6.3
12	Feb 02	Tutorial #3 (Compton Scattering equation)	
13	Feb 05	Bohrâ€™s Postulate and the Bohr Model	6.4-6.8
14	Feb 07	deBroglie Matter Waves	4.1-4.3
15	Feb 09	Tutorial #4	
16	Feb 12	The Born Postulate, Probability Densities, Wave Packets	4.5 - 4.6
17	Feb 14	Expectation Values	
18	Feb 16	Quiz #2	
	Feb 19	Reading Break	
	Feb 21	Reading Break	
	Feb 23	Reading Break	
19	Feb 26	Position, Momentum, and Energy Operators	
20	Feb 28	Heisenberg Uncertainty Principle	4.4
21	Mar 02	Tutorial #5 (Uncertainty in Observables)	
22	Mar 05	The SchrÃ¶dinger Wave Equation	5.1 - 5.3
23	Mar 07	One dimensional infinite potential well, Eigen function, Eigen value, Normalization, Expectation Values, SWE in 2 Dimensions	5.4
24	Mar 09	Tutorial #6	
25	Mar 12	Harmonic Oscillator, Potential Barriers and Unbound States	5.5, 5.6
26	Mar 14	Tunneling	
27	Mar 16	Quiz #3	
28	Mar 19	SWE for the H atom and Orbital Angular Momentum	7.1 - 7.3
29	Mar 21	Radial Probability Density	7.4 - 7.5
30	Mar 23	Tutorial #7	
31	Mar 26	Zeeman Effect, Stern-Gerlach, Spin Angular Momentum	7.6 - 7.9
32	Mar 28	Radioactivity and Nuclear Decay	12.1 - 12.6
	Mar 30	Good Friday	
33	Apr 06	Tutorial #8	
34	Apr 09	Alpha, Beta and Gamma Decay	12.7 - 12.9
35	Apr 11	Natural Decay Chain, Fission, Nuclear Reactors	12.10, 13.1 - 13.4
36	Apr 13	Poster Presentations	

Course Learning Incomes

Coming into this course, students should be able to:

- Explain how interactions between systems affect motion.

- Calculate the behavior of systems using the energy principle.

- Make mathematical predications about collisions using the momentum principle.

- Solve basic problems using the concepts of electric and magnetic field, the associated forces, and the electric potential.

- Apply mathematical techniques including vectors, algebra, full and partial derivatives, and first and second order ordinary differential equations to physical problems.

Department Approval: Electronically Approved **Date:** 2018-01-04 19:16

Course Outcomes

1. Recognize the equivalence of matter and energy
2. Justify the role of photons and failure of classical physics to explain blackbody radiation, the photoelectric effect and Compton scattering
3. Recognize that simple microscopic systems must be described by probability densities using one-dimensional, time independent SchrÃ¶dinger wave equations
4. Calculate physical observables for simple interactions and relate them to experimental outcomes
5. Collaborate in a group to execute laboratory experiments
6. Demonstrate proper laboratory techniques including data acquisition, analysis of data and uncertainty, and safe operation of equipment
7. Clearly and accurately communicate concepts and arguments in writing