**TENTATIVE COURSE OUTLINE UNTIL APPROVED**

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

1. **Course:** Physics 325, Modern Physics Winter 2017

   **Instructor:** Dr. Michael Wieser | SB 131 | 403.220.3641 | mwieser@ucalgary.ca | Office Hours: TBA

   **Lecture Sections:** L01: MWF | 09:00-09:50 | ST 132

   **Course Website**: d2l.ucalgary.ca

   **Departmental Office**: SB605 | 403.220.5385 | phasugrd@ucalgary.ca

2. **Prerequisites:** 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 Applied Mathematics 217.
   http://www.ucalgary.ca/pubs/calendar/current/physics.html#6035

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

| | |
|---|---|
| Laboratory reports | 25 % |
| Poster presentation | 5 % |
| In-class activities | 5 % |
| Assignments (5) | 25 % |
| Midterm examinations (2) | 20 % (February 15 and March 29) |
| Final Examination | 20 % (2 h scheduled by the Registrar) |

   All class work will be graded numerically which can directly be converted to percent. The final course mark will be calculated as a percent then converted to a grade.

   Percentage to letter grade conversion scale:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| > = 95% | A + | > = 75 % | B + | > = 60 % | C + | > = 45 % | D + |
| > = 85 % | A | > = 70 % | B | > = 55 % | C | > = 40 % | D |
| > = 80 % | A - | > = 65 % | B - | > = 50 % | C - | < 40 % | F |

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.6 of the University Calendar

5. **Scheduled out-of-class activities:** none

6. **Course Materials:** *"Modern Physics"*, 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. In some cases the quiz, test or examination will also be open book or a formula sheet (prepared by the student) will be allowed: if so, the instructor will notify students in advance. Students should also read the Calendar, Section G, on Examinations.

8. **Course fees**: none

9. **Writing across the curriculum statement:** In this course, the quality of the student's writing in quizzes, tests and examinations will be a factor in their evaluation. See also Section E.2 of the University Calendar.

10. **Human studies statement**: Students in this course are not expected to participate as subjects or researchers. See also Section E.5 of the University Calendar.

11. OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) **Academic 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.

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

(c) **Student Accommodations:** 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 http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-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 and Astronomy, Dr. David Feder, by email (dfeder@ucalgary.ca) or by phone (403.220.3638).

(d) **Safewalk:** Campus Security will escort individuals day or night (http://www.ucalgary.ca/security/safewalk/). Call 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). As one consequence, 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 http://www.ucalgary.ca/secretariat/privacy.

(f) **Student Union Information:** VP Academic Phone: 220-3911 Email: suvpaca@ucagary.ca.
SU Faculty Rep: Phone: 220-3913
Email: science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca
Student Ombuds Office: 403 220-6420 Email: ombuds@ucalgary.ca; http://ucalgary.ca/provost/students/ombuds

(g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

(h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and

teaching, and selecting courses (www.ucalgary.ca/usri). Your responses make a difference - please participate in USRI Surveys.

## 12. OTHER COURSE RELATED INFORMATION:

### (a) Course Description

Origins of quantum mechanics, a historical perspective. Concepts of wave mechanics and applications. Nuclear physics and radioactivity. Topics include: Special Theory of Relativity, Electromagnetic waves, Blackbody radiation, Photoelectric Effect, X-rays and Bragg Diffraction, Compton Scattering, Atomic Structure, The Bohr Model, Atomic Spectra, Applications of the Schrödinger Wave Equation, Radioactivity, Nuclear Stability, Nucleosynthesis, Structure of the Nucleus, Elementary Particles.

### (b) Course Learning Outcomes

At the end of this course, students should be able to:

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

### (c) 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

### (d) Syllabus

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 “hands-on” sense of some of the phenomena studied.

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Below is a tentative lecture schedule for Winter 2017:

| Date | # Lectures | Topics | Textbook Section |
|---|---|---|---|
| Jan 9 – Jan 18 | 5 | Special Theory of Relativity: Einstein's postulates and consequences, Time Dilation, Length Contraction, Simultaneity, Lorentz Transformations, Conservation of Relativistic Momentum and Energy | 2.1 – 2.9 |
| Jan 20 – Jan30 | 5 | Subatomic particles, Electromagnetic Radiation, Blackbody radiation, Photoelectric Effect, X-rays and Compton Scattering | 3.1 – 3.6 |
| Feb 01 – Feb 06 | 3 | Atomic Structure, Rutherford Scattering Experiment, The Bohr Model, Atomic Spectra | 6.1 – 6.8 |
| Feb 8 – Feb 17 | 3 | DeBroglie's Matter Waves, Bragg Diffraction, Heisenberg Uncertainty Principle, Probability Density | 4.1 – 4.7 |
| Feb 15 | | MIDTERM #1 | |
| Feb 20 – Feb 24 | | READING WEEK – No Lectures | |
| Feb 27 – Mar 10 | 6 | The Schrödinger Wave Equation, Operators, Expectation Values, Applications of the Schrödinger Wave Equation: Rigid Box/Potential Wells/2D Potential Wells, Degeneracy, Harmonic Oscillator, Tunneling Phenomena | 5.1 – 5.6 |
| Mar 13 – Mar 27 | 7 | The Hydrogen Atom, Energy Levels and Radial Probability Density, Quantization of Angular Momentum, Electron Spin, Zeeman Line Splitting | 7.1 – 7.9 |
| Mar 29 | | MIDTERM #2 | |
| Mar 31 – Apr 12 | 6 | Radioactivity, Nuclear Stability and Nuclear Decay, Alpha, Beta, and Gamma Decay, Natural Decay Chain, Fission and Nuclear Reactors, Nucleosynthesis, Geochronology | 12.1-12.10; 13.1-13.7 |
| Week of April 03 | | Poster Presentation: Time and Date to be determined | |

### Assignments

There will be five assignments throughout the term. The assignments will be distributed via the course D2L website. Your solutions must be submitted by 4:00 pm on the due date.

### In-class activities

There will be several opportunities throughout the semester to participate in independent and group activities, which will include problem solving using the Top Hat Monocle classroom response system as well as short oral presentations. You are encouraged to bring a laptop, smartphone, or tablet to class to enable you to connect with the Top Hat Monocle system. If this is not possible, please contact me as soon as the course starts so an alternate method of participation can be explored.

### 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. Two of the laboratory reports will be submitted as group project and in a format, like that required for a Physics journal. The details of the format will be discussed in the lectures. In the case of the group report, the same grade will be applied to all members of the group.

Each laboratory exercise is accompanied by "Pre-lab Questions". 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 first five lab reports must be completed during the laboratory period and handed in to the TA before the end of your laboratory session. In the final half of the course, you will complete five experiments selected from a list of seven. Your laboratory TA will work with you to make the selection and coordinate when you perform an experiment. 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.

### 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 the week of April 4. The exact date and time will be decided during the term. 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 response 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.

## (e) Laboratory schedule

The laboratory schedule is posted on line at http://pjl.ucalgary.ca.

## (f) Additional books that might be of interest

Modern Physics for Scientists and Engineers, 2nd edition
John Taylor, Chris Zafiratos, and Michael Dubson
Pearson / Addison Wesley
ISBN-10:0-13-805715-X
(This was a previous text for the course and used copies are probably available)

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Modern Physics 2nd Edition (or now 3rd Edition)
Raymond Serway, Clement Moses, and Curt Moyer
Harcourt College Publishers
ISBN-10: 0-03-001547-2

Quantum Theory: A Very Short Introduction
John Polkinghome
Oxford University Press
ISBN-10: 0-19-280252-6

Quantum Theory: A graphic Guide to Science's Most Puzzling Discovery
J. P. McEnvoy
Totem Books
ISBN-13: 978-1840468502

Department Approval_____Date_____