DEPARTMENT OF PHYSICS & ASTRONOMY
TRENT UNIVERSITY

PHYS 2610H: INTRODUCTORY QUANTUM PHYSICS 2016 FA

Peterborough

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Course Description: This course will provide an introduction to the major discoveries and fundamental theories of modern 20th (and 21st) century physics. Topics to be covered include: special relativity, particle-like aspects of radiation, atomic structure, wave-like properties of matter, Schrodinger equation and applications to one-dimensional systems.

Course Prerequisites: 60% or higher in PHYS 1002H/1000Y (Introductory Physics II) and MATH 1120H/1100Y/1101Y (Calculus II: Integrals and Series), or the permission of the department. Pre- or co-requisite: PHYS-MATH 2150H (Ordinary Differential Equations).

Required Texts: Randy Harris, *Modern Physics*, 2nd Edition, Pearson, 2007.

Supplementary Texts (Optional):

Randall D. Knight, *Physics for Scientists & Engineers: A Strategic Approach*, 3rd Edition, Pearson, 2012. [A good introductory reference book]

Thomas Moore, *A Traveler's Guide to Spacetime: An Introduction to the Special Theory of Relativity*, McGraw-Hill Science/Engineering/Math, 1995. [For students interested in further reading on the subject of special relativity]

David J. Griffiths, *Introduction to Quantum Mechanics*, 2nd Edition, Pearson, 2004. [For students interested in further reading on the subject of quantum physics]

learningSystem/Blackboard: The course website is available on Blackboard and can be accessed through the myTrent portal. Announcements, lecture notes, assignments, solutions, and other supplemental course material will be posted on this website throughout the term. As such, it is recommended that you log on to check the learningSystem/Blackboard regularly.

Course Format:

Type	**Day**	**Time**	**Location**
Lecture	Monday	12:00-12:50 pm	SC 317
Lecture	Wednesday	1:00-2:50 pm	SC 317
Laboratory (F01)	Monday	1:00-3:50 pm	SC 312
Laboratory (F02)	Tuesday	2:00-4:50 pm	SC 312

Note: The laboratory portion of this course involves completing four classic experiments from the dawn of modern physics. The labs for this course are coordinated by David Marshall. Details of the lab and experiment schedule will be discussed during the first meeting of the term.

Learning Outcomes/Objectives/Goals/Expectations: This course has been developed to address several learning outcomes. By the end of the course a successful student should be able to:

1. Understand the fundamental postulates of special relativity and quantum physics
2. Discuss key pieces of experimental evidence which support each of these two theories
3. Apply the principles of special relativity to resolve apparent paradoxes and to solve quantitative problems involving simultaneity, time dilation, length contraction, relativistic energy and momentum
4. Apply the principles of quantum physics to explain phenomena such as blackbody radiation, the photoelectric effect, the double slit experiment, wave-particle duality, the uncertainty principle, and the atomic structure of hydrogen
5. Solve classic problems in quantum mechanics using the one-dimensional Schrodinger equation (e.g. the particle in a box, the simple harmonic oscillator, the potential step, the potential barrier, and tunneling)

Course Evaluation:

Type of Assignment	**Weighting**	**Due Date**
Quizzes	5%	~weekly
Assignments (x5)	25%	~biweekly
Lab Reports (x4)	20%	~triweekly
Midterm	15%	October 17th
Final Exam	35%	December Exam Period

Quizzes (5%): There will be a series of eight to ten "mini-quizzes" held at the start of the two hour Wednesday lecture period. These quizzes will be approximately ten minutes long, and will consist of short questions based on class discussion or pre-class readings. Missed quizzes cannot be made up, but the two lowest quiz marks of the term will be dropped. All quizzes will be announced at least one class in advance.

Assignments (25%): There will be five assignments due throughout the term, consisting of problems similar to those discussed in class or provided in the textbook. Assignments will be due at ~2 to 3 week intervals, and each assignment will be given equal weight.

Lab Reports (20%): There will be four lab reports due throughout the term. Details of the lab schedule and grading scheme will be discussed during the first meeting of the semester.

Midterm (15%): There will be a 50 minute long midterm examination held on Monday, October 17^{th}, during the normal class timeslot (12:00-12:50 pm).

Final Exam (35%): There will a three hour long final examination for this course, which will be held during the December exam period. This exam will be cumulative, and may encompass any material covered from the beginning of the course.

Week-by-Week Schedule:

This course will cover material taken from Chapters 1 to 6 in Harris. The schedule of topics is listed below:

- Physics at the dawn of the 20^{th} century: troubling questions and surprising results (Ch. 1)
- Introduction to the theory of special relativity (Ch. 2)
- The Lorentz transformation and consequences of special relativity: simultaneity, time dilation, length contraction, and more (Ch. 2)
- Relativistic momentum and energy (Ch. 2)
- Introduction to quantum mechanics: wave-particle duality (Ch. 3 and 4)
- Electromagnetic radiation behaving as particles: blackbody radiation, the photoelectric effect, the Compton effect, and the double-slit experiment (Ch. 3)
- Matter behaving as waves: the double-slit experiment, diffraction of matter waves (Ch. 4)
- Basic principles of quantum mechanics: probabilistic interpretation of the wavefunction, the Schrodinger Equation, and the uncertainty principle (Ch. 4)
- The Bohr model of the atom (Ch. 4)
- Solving the one-dimensional Schrodinger equation (Ch. 5 and 6)
- Bound state problems: the particle in a box, infinite well, finite well, and the simple harmonic oscillator (Ch. 5)
- Unbound state problems: potential steps, potential barriers, and quantum tunneling (Ch. 6)

Although specific dates are not listed, I will follow the order of topics as given and will regularly communicate in class and on the learningSystem/ Blackboard about the pacing of the lectures. For this reason, it is important for you to attend class and log on to the learningSystem/ Blackboard regularly.

Department and/or Course Policies:

Midterms and Exams: Regardless of the final grade calculated using the marking scheme above, a weighted average of at least 40% must be obtained on the midterm and the final exam in order to pass this course. If this condition is not met, a final grade not exceeding 45% (F) will be assigned.

Late Policy: Marks will be deducted for late assignments and lab reports at a rate of 10% per day (including weekends). Assignments will normally be accepted up to one week beyond the due date, after which a mark of zero will be assigned.

University Policies

Academic Integrity:

Academic dishonesty, which includes plagiarism and cheating, is an extremely serious academic offence and carries penalties varying from failure on an assignment to expulsion from the University. Definitions, penalties, and procedures for dealing with plagiarism and cheating are set out in Trent University's *Academic Integrity Policy*. You have a responsibility to educate yourself – unfamiliarity with the policy is not an excuse. You are strongly encouraged to visit Trent's Academic Integrity website to learn more: www.trentu.ca/academicintegrity.

Access to Instruction:

It is Trent University's intent to create an inclusive learning environment. If a student has a disability and documentation from a regulated health care practitioner and feels that he/she may need accommodations to succeed in a course, the student should contact the Student Accessibility Services Office (SAS) at the respective campus as soon as possible.