DEPARTMENT OF PHYSICS & ASTRONOMY
TRENT UNIVERSITY

PHYS 2620H: ATOMIC, MOLECULAR, AND NUCLEAR PHYSICS 2017 WI

Peterborough

Instructor: Patrick Clancy	**Trent Email:** jamespatrickclancy@trentu.ca	**Telephone:** (705) 748-1011, ext. 7155
Campus: Peterborough	**Office Location:** SC 322	**Office Hours:** To be determined by mutual agreement

Academic Administrative Assistant: Gina Collins	**Email:** gcollins@trentu.ca
Office Location: SC 327	**Telephone:** (705) 748-1011, ext. 7715

Lab Demonstrator: David Marshall	**Email:** dmarshall@trentu.ca
Office Location: SC 319	**Telephone:** 705-748-1011, ext. 7461

Teaching Assistant: Donovan Allum	**Email:** donovanallum@trentu.ca

Course Description: This course will provide an introduction to the field of atomic, molecular, and nuclear physics. Topics to be covered include: quantum mechanics of one-electron atoms, magnetic dipole moments and spin, transitions and selection rules, identical particles, excited states of atoms, molecules, nuclear and particle physics.

Course Pre-requisites: PHYS 2610H (Introductory Quantum Physics), PHYS–MATH 2150H (Ordinary Differential Equations) and MATH 2110H (Calculus III: Calculus of Several Variables).

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

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	12:00-1:50 pm	SC 317
Lecture	Thursday	10:00-10:50 am	SC 317
Seminar	Thursday	11:00-11:50 am	SC 317
Laboratory (W01)	Monday	9:00-11:50 am	SC 127
Laboratory (W02)	Tuesday	9:00-11:50 am	SC 127

Notes:

The weekly seminar timeslot will primarily be used for review and problem solving sessions.

The laboratory portion of this course involves a series of experiments designed to illustrate the principles of atomic spectroscopy, nuclear spectroscopy, and radioactive decay. Details of the lab and experiment schedule will be discussed during the first meeting of the term. All labs will be coordinated by David Marshall.

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. Apply the principles of quantum mechanics to describe simple one-electron atoms, such as hydrogen.
2. Understand the mechanisms responsible for atomic energy levels, selection rules, and transition rates.
3. Analyze the bonding, rotational, and vibrational properties of simple diatomic molecules.
4. Explain the liquid drop and shell models of the nucleus, and solve quantitative problems involving nuclear binding and radioactive decay.
5. Describe and discuss the fundamental forces and particles of the Standard Model.

Course Evaluation:

Type of Assignment	Weighting	Due Date
Quizzes	5%	~weekly
Assignments (x4)	20%	Jan. 30, Feb. 16, Mar. 13, Mar. 27
Lab Reports (x3)	15%	~monthly
Midterm	15%	March 6th
Group Presentation	10%	April 3rd to 6th
Final Exam	35%	April Exam Period

Quizzes (5%): There will be a series of eight to ten "mini-quizzes" held at the beginning of the two hour Monday lecture period. These quizzes will be approximately fifteen 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.

Assignments (20%): There will be four 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 weighting.

Lab Reports (15%): There will be three 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 two hour long midterm examination held on Monday, March 6th, during the normal class timeslot (12:00-1:50 pm).

Group Presentation (10%): There will be a series of 20 to 25 minute long group presentations held during the week of April 3rd to 6th. Students will be divided into groups of 3 to 4, and will present on a topic of their choice from the field of nuclear and particle physics (e.g. nuclear magnetic resonance, nuclear fission/fusion reactors, nuclear astrophysics, the Higgs Boson, the Large Hadron Collider, SNO, neutrino oscillations, etc.). Topics must be selected by March 9th, and must be approved by the instructor.

Final Exam (35%): There will a three hour long final examination for this course, which will be held during the April 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 primarily cover material from Chapters 7, 8, 10, 11, and 12 in *Modern Physics* by Harris. A schedule of topics is listed below:

- Quantum mechanics in three dimensions (Ch. 7)
- The Schrodinger equation with central forces (Ch. 7)
- One electron atoms: the hydrogen atom (Ch. 7)
- Transitions and selection rules (Ch. 7)
- Quantization of angular momentum, magnetic dipole moments and spin (Ch. 8)
- Identical particles and the exclusion principle (Ch. 8)
- Multielectron atoms and excited states (Ch. 8)
- Molecular bonding (Ch. 10)
- Rotation and vibration (Ch. 10)
- Nuclear structure and binding (Ch. 11)
- Models of the nucleus (Ch. 11)
- Radioactivity (Ch. 11)
- Fundamental forces and particles (Ch. 12)

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 (excluding 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.