DAWSON
COLLEGE

# PHYSICS
# Radiation Oncology Technology
## *203-BXB-05 Physics of Radiology*
## *Section 0003*
## Fall 2019


**Instructor:** Dr. M. Dikeakos

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**Instructor Accessibility:** office hours **TBA** ***(please see course outline addendum)***

## PRE-REQUISITE

Physical Science 436 or equivalent, Math 536 or equivalent

## CO-REQUISITE

None

## PONDERATION

3-2-3 (3 hours of lecture, 2 hours of labs, and 3 hours of work outside of class)

## REQUIRED TEXT AND MATERIALS

***College Physics*** by Serway and Vuille (11th ed)

- **Hardcopy:**
  Students may purchase a printed hardcopy of the textbook at the Dawson College bookstore.
- **eBook:**
  Students may elect to purchase an electronic version of the textbook (called an eBook) instead of a printed hardcopy.
- **Used book:**
  Students may acquire a second-hand copy of previous (older) editions of the textbook, however they will be responsible for cross referencing assigned readings and/or problems.
- **Library Copies:** Copies of the text should be available on reserve in the Dawson Library (as are other, similar, textbooks like ones by Serway & Jewett, or R. Knight)

## COURSE OBJECTIVES

This is a general physics course, covering topics in mechanics, electricity and modern physics, intended to provide a foundation for further studies in Radiation Oncology.

Since students may enter the radio-oncology program from high school with only a fourth year course in Physical Science as science background, or may be adult students, who last studied physics some years before enrolling in the program, the course presents the basic physics concepts and skills necessary for the successful completion of many of the program objectives, especially those concerning the generation of radiation and its interaction with matter.

## COURSE COMPETENCIES

**MELS:** code 005T

Specifically, by the end of the course, students will be able to achieve the following competencies:

| CAMRT Competency Profile Radiation Therapy 2014 Specific Objectives | | | | |
|---|---|---|---|---|
| **General Objectives** | **Specific Objectives (The student will learn...)** | | **CAMRT Competencies** | **Ref. in Curriculum** |
| 1.0 Basic Mathematics | 1.1 | Basic algebra manipulation involving simple, quadratic, and logarithmic equations; | | Chapter 1 & 3 |
| | 1.2 | Simple geometry, trigonometry; | | |
| | 1.3 | To analyze linear and non-linear graphs; | | |
| | 1.4 | The concepts of accuracy and precision of measured values, uncertainty in measured values and how to quote a calculated value and its uncertainty with proper significant figures; | | |
| | 1.5 | Basic standard units (SI and non-SI) and unit conversion, scientific notation and numeric prefixes; | | |
| | 1.6 | To manipulate scalar and vector quantities. | | |
| 2.0 Kinematics of Motion | 2.1 | To analyze numerically and graphically one-dimensional and two-dimensional motion of an object, including circular motion: position, displacement, distance, velocity, speed, acceleration; | | Chapter 2 & 7 |
| 3.0 Dynamics of Motion | 3.1 | The concept of force: contact forces vs field forces; | | Chapter 4 |
| | 3.2 | Newton's three laws of motion and to analyze the dynamics (cause) of the motion of an object; | | |
| 4.0 Energy & Momentum | 4.1 | The various forms of energy; | | Chapter 5 & 6 |
| | 4.2 | To apply the law of conservation of energy to analyze the motion of an object; | | |
| | 4.3 | The concept of energy transfer and transformation: to calculate the work done by a force and the power (rate of energy transfer) | | |
| | 4.4 | Einstein's mass-energy equivalence; | | |
| | 4.5 | To apply the law of conservation of momentum to collisions between objects; | | |
| 5.0 Basic Principles of Electricity | 5.1 | The two types of charges and the properties thereof; | | Chapter 15 & 16 |
| | 5.2 | The concept of electric field and to interpret electric field lines; | | |
| | 5.3 | The concept of electric force between charged objects; | | |
| | 5.4 | To calculate the electric field due to point charges; | | |
| | 5.5 | To calculate the electric force between stationary point charges using Coulomb's Law and the electric force on point charges in an electric field; | | |
| | 5.6 | To calculate the kinetic energy and acceleration of charged particles placed in a uniform electric field, To calculate the electric potential difference between points in an electric field. | | |

| CAMRT Competency Profile Radiation Therapy 2014 Specific Objectives | | | | |
|---|---|---|---|---|
| **General Objectives** | **Specific Objectives (The student will learn...)** | | **CAMRT Competencies** | **Ref. in Curriculum** |
| 6.0 Circuits | 6.1 | The definition of electric current, potential difference (voltage), resistance R, Ohm's Law, electric power and energy; | | Chapter 17 & 18 |
| | 6.2 | To analyze basic DC circuits: calculate equivalent resistance of resistors connected in series and parallel, the current through and voltage across resistors; | | |
| | 6.3 | To analyze more complex DC circuits using Kirchhoff's rules; | | |
| | 6.4 | The properties of a capacitor and how to calculate the energy, voltage and charge of a capacitor. | | |
| | 6.5 | To define the properties of a conductor, semiconductor, and insulator; | | |
| 7.0 Basic Principles of Magnetism | 7.1 | The two types of magnetic poles; The concept of magnetic domains and permanent magnets, Curie temperature; | | Chapter 19 & 20 |
| | 7.2 | The differences between ferromagnetic, paramagnetic and diamagnetic material; | | |
| | 7.3 | The concept of a magnetic field and how to interpret magnetic field lines; | | |
| | 7.4 | To analyze and determine the magnetic field of a straight and circular current-carrying wire as well as of a current-carrying solenoid; | | |
| | 7.5 | Determine the force of a magnetic field on a moving charge and on a current-carrying wire; Use the right-hand-rule to determine the direction of the magnetic force; | | |
| | 7.6 | To use Faraday's Law and Lenz's law to determine the emf (voltage) and current induced in a secondary coil; | | |
| | 7.7 | To identify step-up and step-down transformers, and to use transformer equations to calculate current and voltage. | | |
| **INTRODUCTION TO RADIATION PHYSICS** | | | | |
| 8.0 Electromagnetic (EM) Radiation (Wave-Particle Duality) | 8.1 | The concept of a wave and to differentiate between mechanical waves (including sound waves) and electromagnetic waves; | **E4.1.3** Apply knowledge of radiation physics | Chapter 21 |
| | 8.2 | To characterize a wave in terms of its wavelength, frequency, period, amplitude, intensity; | | |
| | 8.3 | The wave equation and the inverse-square-law for intensity; | | |
| | 8.4 | The electromagnetic spectrum and should be able to identify the different ranges especially the x-ray and $\gamma$-ray ranges; | | |
| | 8.5 | The wave-particle duality of EM radiation; | | |
| | 8.6 | The properties of reflection and refraction of light as it travels from one medium to another: law of reflection, specular vs diffuse reflection, Snell's law of refraction, dispersion of light, absorption/transmission of light; | | |
| | 8.7 | To examine the equivalence of energy and mass through Einstein's equation; examine the wave-particle duality for particles, calculate the DeBroglie wavelength of electrons. | | |

| CAMRT Competency Profile Radiation Therapy 2014 Specific Objectives | | | | |
|---|---|---|---|---|
| **General Objectives** | **Specific Objectives (The student will learn...)** | | **CAMRT Competencies** | **Ref. in Curriculum** |
| 9.0 Atomic Physics | 9.1 | To describe the features of the simplified atomic model (Rutherford-Bohr model); | **E4.1.3** Apply knowledge of radiation physics | Chapter 28 |
| | 9.2 | To use the simplified atomic model to explain and calculate the absorption and emission of photons due to electron energy-level transitions, the binding energy of atomic electrons and the ionization energy required to ionize an atom; | | |
| | 9.3 | To determine the possible characteristic photons of an element. | | |
| 10.0 Quantum and Nuclear Physics | 10.1 | The basics of radioactivity: factors affecting nuclear stability; | **E4.1.3** Apply knowledge of radiation physics | Chapter 27 & 29 |
| | 10.2 | To identify the common radioactive decay processes: alpha, beta, and gamma, including electron capture; | | |
| | 10.3 | To compare particulate and electromagnetic radiation; | | |
| | 10.4 | To identify and compare types of ionizing radiation: compare x-ray radiation to alpha-particle, beta and gamma radiation - compare ionization ability and penetration depth; | | |
| | 10.5 | To analyze a decay curve of a sample of radioactive atoms: decay constant, half-life; | | |
| | 10.6 | To calculate the activity of a radioactive sample, the number of radioactive nuclei present and the time for the activity or number of nuclei to decrease by a given factor. | | |
| | 10.7 | To calculate the energy equivalence of the nuclear mass deficit: nuclear binding energy. | | |
| 11.0 X-ray and Electron Production | 11.1 | The interactions with matter: coherent scattering, Compton scattering, photoelectric effect (including stopping potential), nuclear pair production & triplet production, photodisintegration; Auger effect; | **E4.1.3** Apply knowledge of radiation physics | Class Notes |
| | 11.2 | To examine x-ray emission spectrum: characteristic vs Bremsstrahlung radiation; | | |
| | 11.3 | The factors affecting x-ray quality: exponential attenuation and half-value layer, attenuation coefficient; | | |
| | 11.4 | Precautionary safety measures: radiation shielding | | |

The study of physics also contributes to building analytical problem solving skills, critical thinking, and mathematical skills needed in the other components of the program.

## COURSE CONTENT & SCHEDULE

The material to be covered is contained in the following chapters and sections of the text.

| | TOPIC | CHAPTER | WEEK # *(TENTATIVE)* |
|---|---|---|---|
| Mechanics | Mathematical Review | 1 | 1 |
| | Kinematics and Vectors | 2 and 3 | 1-2 |
| | Dynamics | 4 | 3 |
| | Work, Energy and Power | 5 | 4 |
| | Momentum and Collisions | 6 | 4-5 |
| | Circular Motion and Gravity | 7 | 2-3 |
| E&M | Coulomb's Law, E-Field, Potential | 15 and 16 | 6-7 |
| | Current and Resistance | 17 | 7-8 |
| | Direct Current Circuits | 18 | 8-9 |
| | Magnetism and Electromagnetism | 19 and 20 | 9-10 |
| | Alternating Current and Electromagnetic Waves | 21 | 10-11 |
| Modern Physics | Relativity | 26 | 11-12 |
| | Quantum Physics | 27 | 12 |
| | Atomic Physics | 28 | 13 |
| | Radioactivity and Nuclear Physics | 29 | 14 |

## TEACHING METHODS

The material will be presented using a mix of active learning activities, lectures, in-class problem solving, laboratory experiments and demonstrations. Laboratory periods will be used for experiments/activities as well as quizzes/class tests and lectures.

## ATTENDANCE AND COURSE PARTICIPATION REQUIREMENTS

Although class attendance is not compulsory, students should make every effort to attend *all* classes. In the event that a class is missed, the student is responsible for all material covered or assigned during that class. Students are required to participate in the class by asking questions, discussing the topics and working with other students during problem-solving sessions.

**Attendance at laboratory experiments and tests is compulsory.**

*As indicated above*, students must be present to write the tests and perform the lab experiments at the scheduled times except for unforeseen emergencies confirmed by proper documents.

For additional information students should refer to the Institutional Student Evaluation Policy (ISEP section III-C) regarding attendance.

## SUBMISSION OF MATERIAL FOR EVALUATION

Students must show a basic understanding of material covered in the lectures and laboratory sessions in order to pass the course. This is achieved by attaining at least an average grade of 60%, calculated according to the evaluation scheme below.

## EVALUATION SCHEME AND SCHEDULE

The **Institutional Student Evaluation Policy (ISEP)** is designed to promote equitable and effective evaluation of student learning and is therefore a crucial policy to read and understand. The policy describes the rights and obligations of students, faculty, departments, programs, and the College administration with regard to evaluation in all your courses, including grade reviews and resolution of academic grievance. ISEP is available on the Dawson website.

**Formative Evaluation:**

Professional Conduct progression: Pass or Fail; the critical competencies must be met. See Annex A.

**Summative Evaluation:**

There are *two grading schemes*. **Your final grade will be the higher of the two schemes.**

| | Scheme 1 | *OR* | Scheme 2 |
|---|---|---|---|
| **Quizzes/Class Tests** | 50 % | | 30 % |
| **Laboratory Activities/Experiments** | 20% | | 20% |
| **Final Examination [cumulative]** | 30% | | 50% |

***†Your teacher will provide a course outline addendum during the first week of class in which will be found a detailed breakdown of these components along with a tentative test and lab schedule.***

Course work not submitted by the due date may be ***penalized*** at the teacher's discretion.

In the *rare* event that a student for a *valid* reason (e.g. due to an intensive course, illness, etc.) is or anticipates to be absent during a laboratory experiment or a class test, the student must, where possible, inform the teacher and provide the necessary documents before the absence or, at the latest, on the day of their return. ***If*** the absence is excused, students will have the opportunity to complete the assessment.

All other assessments (readings, quizzes, lab activities, etc.) missed due to absence are:

- assigned a grade of zero where the absence is *not* excused;
- given zero weight in the calculation of the final grade where the absence *is* excused.

****IMPORTANT:***

***"EACH of the three individual components (Quizzes/Class Tests, Laboratory Activities/Experiments, and Final Examination [cumulative]) must be successfully completed with a minimum of 60% in order to pass the course. A maximum grade of 55% will be given if one component is unsuccessfully completed."***

## LITERACY STANDARDS

It is expected that students will be able to comprehend the course material and express themselves appropriately as a normal part of their academic performance in the course. Marks may be deducted for inadequate communication skills.

Accommodations for students in ESL courses will be made wherever possible.

Homework and tests will contain questions requiring short written answers as well as numerical questions. Lab reports will require clear and logical written explanations and conclusions.

## LABORATORY SAFETY REGULATIONS

Experimentation is an essential part of science. Students will be expected to perform experiments and report on their results. Your teacher will provide you with instructions for lab experiments and activities (there is no manual to purchase). Additional information about lab reports is available in the Science Student Handbook which is posted on ***Omnivox-Lea***. **Students must be present during the entire lab activity to receive credit.** Lab work not submitted as prescribed by the due date will be penalized at the teacher's discretion. Proper lab etiquette and safety regulations must be observed at all times.

## STUDENT OBLIGATIONS

Everyone has the right to a safe and non-violent environment. Students are obliged to conduct themselves as stated in the Student Code of Conduct and in the ISEP section on the roles and responsibilities of students (ISEP section II-D). ***Disruptions or excessive noise will not be tolerated.*** *Students who do not comply with these rules will be asked to leave the class and may be referred to Student's Services for disciplinary action.* **Mutual respect is the key to a harmonious learning environment.**

## ACADEMIC INTEGRITY

**Cheating, copying, or any other form of academic dishonesty will not be tolerated.**
Students should acquaint themselves with the policy of the College on plagiarism and cheating. ***According to ISEP, the teacher is required to report to the Sector Dean all cases of cheating and plagiarism affecting a student's grade.*** (see ISEP section IV-C.) The usual penalty for the first instance of cheating will be a ***grade of zero*** for the piece of work in question to all parties involved (under certain circumstances, even a first offence may be penalized by ***a failure of the course***). A second offence may result in the ***failure of the course***. Students should note that using someone else's laboratory data without authorization from the student and the teacher is cheating.

## INTENSIVE COURSE CONFLICTS STATEMENT

If a student is attending an intensive course, ***the student must inform the teacher, within the first two weeks of class,*** of the specific dates of any anticipated absences. **A form for this purpose is available on Lea and at the end of this document.**

## POLICY ON RELIGIOUS OBSERVANCE

**Students who intend to observe religious holidays must inform their teachers, in writing, within the first two weeks of the semester as prescribed in the ISEP Policy on Religious Observances. This applies both to the semester or term, as well as to any final examination period. (ISEP, Section IV D).**

Please refer to the academic calendar for the exact dates.

**A form for this purpose is available on Lea and at the end of this document.**

Your teacher will inform you of any modifications to planned course activities resulting from the teacher's own religious commitments.

## IF YOU HAVE QUESTIONS OUTSIDE OF CLASS

1. All teachers will be available in their respective offices to their students during posted **office hours**. Your teacher will tell you the schedule of his/her weekly office hours and it will be ***posted outside their office***.
   A schedule of the office hours may also be posted on ***Omnivox-Lea***.
2. Room ***7A.1*** is a **physics study room**. At scheduled times a teacher or peer tutor will be on duty there to answer your questions. The schedule of teachers and peer tutors will be posted outside of 7A.1 in the 2nd or 3rd week of term.
3. Many teachers in the Science Program – including the Physics Department – will communicate with their students by computer using ***Omnivox-Lea***. Lea is accessible via the student's home page on the Dawson website.

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## RELIGIOUS OBSERVANCE/ INTENSIVE COURSES FORM

Students who intend to observe religious holidays or who take intensive courses must inform their teachers in writing as prescribed in the ISEP Policy on Religious Observance (ISEP Section IV-D).
***The following form must be submitted by the end of week 1 of classes.***

Student Name: _____

Student Number: _____

Course # and Name: _____

Section: _____

Teacher: _____

| **Date of Absence** | **Conflicts with Test / Quiz / Lab / Lecture** | **Reason for Absence (name of holiday, intensive course, etc.)** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**Student signature:** _____

**Date signed:** _____

**Course:** _____ **Student Name:** _____ **Student #:** _____

**E [ 1 ]** = The student demonstrates outstanding performance or behaviours; **R [ 0.75 ]** = The student meets reasonable expectations; **I [ 0.5 ]** = Improvement in behaviour is required;
**F [ 0 ]** = The student does not meet reasonable expectations; **[N/A]** = Not applicable or unable to assess the behaviour.

| **ANNEX A - PROFESSIONAL CONDUCT ASSESSMENT (CAMRT 2014)** | | **Comments** | **F** | **I** | **R** | **E** | **Points** |
|---|---|---|---|---|---|---|---|
| **Part A: Personal Skills**<br>**RESPONSIBILITY:** Fairness, Accountability and Integrity | | | | | | | |
| **1** | ***Organizes efforts to achieve objectives*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **2** | ***Demonstrates effort and success at self-improvement*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **3** | ***Demonstrates dependability when called upon to do something (be accountable for actions)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **MORAL ATTITUDE:** Respect and dignity; Fairness, Accountability and Integrity | | | | | | | |
| ***4*** | ***is respectful of the rights of others*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| ***5*** | ***is respectful of property, including the College's resources and facilities*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| *Dishonest conduct, failure to maintain standards of academic integrity e.g.: Cheating | | ***Automatic failing grade for the course** | | | **-** | | **/0** |
| *Acting without disclosure when in conflict of interest. | | | | | **-** | | **/0** |
| *Violating Dawson College's and/or the Program's Professional Code of Conduct, Hospital Rules and Regulations<br>e.g., sexual harassment; violating patient confidentiality, carelessness (risk management) | | | | | **-** | | **/0** |
| **Part B: Interpersonal Skills**<br>**COMMUNICATION:** Patient respect and dignity; Patient centered care and safety | | | | | | | |
| **9** | ***Demonstrates effective listening skills (including class participation)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **10** | ***Speaks and acts in a respectful manner*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **11** | ***Shows discretion and maintain confidentiality and privacy*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **INTERACTION WITH OTHERS:** Modules A & B | | | | | | | |
| **12** | ***Conducts him/herself in a professional manner (A3)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **13** | ***Interacts well with others (A3.2-5)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **14** | ***Interacts well with instructors(Respect (1); A3.1)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **15** | ***Interacts well with patients (A3, B2.2-4) (hospital)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **16** | ***Interacts well with other health professionals(A3.1-5) (hospital)*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| Displaying disruptive behavior and/or lack of respect, e.g., arguing over any program activities | | *A professional conduct form must be filled by the RO Program Coordinator and sent to the Dean depending on severity.* | | | **-** | | **/0** |
| Displaying lack of respect,<br>e.g., using an aggressive tone of voice, profanity, rude language and/or vulgar gestures | | | | | **-** | | **/0** |
| **Part C: Punctuality & Attendance** Accountability | | | | | | | |
| **17** | Starts the designated activity on time | | **0** | **0.5** | **0.75** | **1** | **/1** |
| **18** | Attends classes regularly; ***attends all labs / clinical activities*** | | **0** | **0.5** | **0.75** | **1** | **/1** |
| Not attending a Laboratory, Clinical activity or Exam | | *As per course's outline / Program Policies* | | | **-** | | **/0** |
| **Less than 70%: Appointment with Program Coordinator.**<br>*** Maximum grade of 55%** | | **TOTAL:** | | | | | **/15** |
| | | **GRADE:** _____ **%** **PASS** ☐ **FAIL** ☐ | | | | | |
| **Date:** | **Evaluator Name:** | **Evaluator (Signature):** | | | | | |

**PROFESSIONAL COMPORTMENT AND CLASS PARTICIPATION**

| | EXPECTED | LESS THAN EXPECTED | PROBLEMATIC | SERIOUS PROBLEMATIC |
|---|---|---|---|---|
| **Attendance Promptness** | Student is always prompt and regularly attends class. | Student is absent but ensures that the teacher is notified in advance. Email, phone or verbally | Student is absent & does not advise the teacher. Student exhibits habit of lateness. Student misses 4-6 classes | Student is late to class and/or leaves early more than 4 times. Student misses more than 6 classes. |
| **Level of engagement in Class** | Student contributes to class by offering ideas & asking questions once per class. More than once in small group discussions. | Student contributes less than once per class. | Student rarely contributes to class by offering ideas or conversely dominates the discussions. | Student never contributes to class discussions or small group discussions. |
| **Listening Skills** | Student listens when others are speaking. Student incorporates or builds on ideas of others. | Student listens when others speak (in class or in groups) | Student does not listen, sometimes interrupts, and disregards others' comments and contributions. | Student does not listen, interrupts, disregards others and engages in side chatter while others are speaking. (including the teacher) |
| **Behavior** | Student displays a positive team player and professional attitude. | | Student displays a negative and self centered behavior; competitive, judgmental and critic attitude toward the others. Definitely not a Team player. | Student displays behavior causing **disruption*** to the educational process or constitutes a safety hazard. |
| **Respect of due date & completion of assignments** | Student completes & submits all assignments on due date. | On one occasion student contacts teacher to request extension for valid reasons. | Student requests extensions more than once or submits work late without having contacted the teacher to explain. | Student work consistently late; does not contact the teacher; does not complete or submit 1 assignment or more |
| **Ethical behavior, academic integrity and plagiarism** | Student always submit his/her own work. All references are cited correctly using APA** format. | Student submits only their own original work. References are cited without formal structure. | | Student commits plagiarism as defined in ISEP and in the course outline. |

Contribution of Shirley Watkins Social service

*Disruption: Coming late/leaving early; cell phone used or left on text messaging; inappropriate laptop use; overt inattentiveness; sleeping in class; lying on desk; reading; writing or working on unrelated material; passing notes; chatting, whispering/monopolizing class discussion; failing to respect the rights of others; creating a distraction by verbal or non-verbal expressions; inappropriate interruptions of the teacher; intoxication; use of profanity; violent or threatening act; noisy eating.
To answer their cell phone, students must leave the classroom and will not be permitted to re-enter until the end of the class.

**General format of APA citation, the most commonly used style in the sciences.