Faculty of Science

B.Sc. Physics – Energy and Environmental Physics

Major Program Modification - Modifications to existing specialization

October 16, 2017

Prepared by: Dr. Joseph MacMillan

Motion: That CPRC recommend to Academic Council the approval of the modifications to the Energy and Environmental Physics specialization as outlined in the proposal.

Proposal Brief

1. SUMMARY OF PROPOSED CHANGE

We propose a number of changes to our Energy and Environmental Physics specialization within the Physics program to enhance student experience and improve recruitment. In general, the changes reflect both a move away from environmental physics and a desire to make the specialization more efficient and attractive to students.

These changes include:

- Change the name of the specialization to "Nanotechnology and Clean Energy." This name better reflects the content of the specialization and our research expertise in the physics group.
- Delete ENVS 3110U Economics and Politics of the Environment as a required course. The Physics group no longer has expertise to teach this course and our research has moved away from this topic.
- Delete ENVS 3020U Introductory Energy Science, PHY 4040U Solar Energy and Photovoltaics, PHY 4050U Emerging Energy Systems, and PHY 4080U Hydrogen-Based Energy Systems and Fuel Cells as required courses in favour of "Senior Nanotechnology and Clean Energy Electives," which will include these courses as options. Also included will be another elective choice, PHY 4510U Physics of Nanotechnology, offered depending on student need and faculty expertise.
- Decrease the number of specialized required from the current 6 to 4.
- Add a required course, PHY 3510U Biophysics, to winter of second year. This is a topic we have expertise in and is directly related to the energy and nanotechnology components of the specialization.

2. BACKGROUND

The name change to "Nanotechnology and Clean Energy" better reflects the research expertise of the Physics group, making it clear to students that this is a significant component of Physics at UOIT. Students in this specialization will have opportunity to conduct research in this field during both summer research and for their honours thesis project.

Removing specific upper-year specialized courses in favour of a more general "Senior Nanotechnology and Clean Energy Electives" allows us to be flexible with our offerings, ensuring that students always get the best experience depending on faculty expertise and the current needs of students. Decreasing the required "specialized courses" from 6 to 4 allows students to have the firm physics base they need to be successful as well allowing them some flexibility with elective choice. It also brings this program into better alignment with the comprehensive physics program and the Astrophysics specialization.

Adding a course in Biophysics to the specialization gives students experience in an exciting and growing field of nanotechnology dealing with biological systems. Furthermore, this course

could be to appealing to Biology and other non-physics majors, and we would design the course to fit those student as well as our physics ones.

In addition to the core course PHY 3510U Biophysics, we will also add one course as a Senior Elective, PHY 4510U Physics of Nanotechnology. This course will be offered when student demand and faculty expertise allow it, and will give an in-depth examination of nanotechnology to complement the other courses in the specialization which focus on applying aspects of nanotechnology to clean energy.

Process of consultation with other units if the change(s) involves students, staff, and/or faculty from other programs or courses.

This change only involves students and faculty from the Physics program. However, because of significant interest in both nanotechnology and clean energy, the Chemistry group, as well as members of the Faculty of Energy Systems and Nuclear Science (focusing on Clean Energy) have been consulted about these adjustments, and are in agreement with the changes.

3. DEGREE REQUIREMENTS

a) Program learning outcomes

The proposed changes are in line with the program's current learning outcomes, as listed below:

1) Describe and interpret the concepts, theories and principles of Physics and the related physical and biological sciences.
2) Analyze, evaluate and apply the scientific concepts, techniques or processes need in the study and application of Physics and the related physical and biological sciences, and investigate innovative solutions in line with the current state of knowledge in Physics to significant related scientific problems.
3) Describe and explain effectively experimental results, theoretical solutions, and general knowledge of Physics and the related physical and biological sciences to both technical experts and members of the general public, utilizing written, spoken and visual formats.
4) Foster a culture of science and interest in Physics within the greater community, and contribute as effective participants in multi-disciplinary and multicultural teams, in both membership and leadership roles.
5) Recognize and utilize contemporary laboratory and measurement techniques and procedures, and apply the appropriate safety protocols.
6) Plan and implement experiments and investigations, critically examine the results, draw valid conclusions, and evaluate the level of uncertainty in experimental results and theoretical predictions.
7) Apply relevant numerical skills including statistical analysis as necessary for physical sciences.
8) Use current information technology to access, store and retrieve information, to acquire and process data, and to analyze and solve problems.

b) Admission Requirements

Admission requirements are in line with existing Faculty of Science and UOIT practices.

Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and two of Biology (SBI4U), Calculus and Vectors (MCV4U), Chemistry (SCH4U) or Physics (SPH4U). In addition, a combined minimum of 70 per cent average in prerequisite math and science courses is required. It is recommended that all four of MCV4U, SBI4U, SCH4U and SPH4U be taken.

c) Program Structure

Physics – Nanotechnology and Clean Energy specialization

General information

The Bachelor of Science (Honours) in Physics provides a basic foundation in biology, chemistry, mathematics, computer science and a solid education in classical and modern physics.

The program meets the rapidly increasing demand for graduates with knowledge and skills in technology-oriented fields such as energy, materials science, microelectronics, health, photonics and communication technologies and astrophysics.

The Physics program offers specializations in Astrophysics, and Nanotechnology and Clean Energy, as well as a general Physics degree (Physics – Comprehensive).

The Faculty of Science offers separate Honours Bachelor of Science degrees in Applied and Industrial Mathematics and in Physics. Students with interest in both disciplines may wish to complete the academic requirements of both programs and be awarded a single degree, Bachelor of Science (Honours) in Applied and Industrial Mathematics and Physics. Eligibility requirements and academic information can be obtained from the academic advisor.

Nanotechnology and Clean Energy specialization

This specialization is designed to meet the urgent demand for graduates with the knowledge and skills to address global issues of escalating energy consumption and declining resources. It emphasizes alternative and conventional energy, with a particular focus on the application of nanotechnology to developing clean energy solutions. Students will learn the scientific principles underlying the field of nanotechnology along with the development of novel and economical means of generating and harvesting energy, while simultaneously minimizing the environmental impact.

In addition to the regular program, a co-op program is also available. Students in Nanotechnology and Clean Energy interested in the co-op program, should contact the Faculty of Science Co-op Coordinator as early as the fall of their second year.

Admission requirements

Admission is competitive. The specific average or standing required for admission varies from year to year. Students are selected by taking into consideration a wide range of criteria including school marks,

distribution of subjects taken, and performance in subjects relevant to the academic program. Possession of the minimum requirements does not guarantee acceptance. Preference will be given to applicants with the best qualifications.
Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and two of Biology (SBI4U), Calculus and Vectors (MCV4U), Chemistry (SCH4U), or Physics (SPH4U). In addition, a combined minimum 70 per cent average in math and science courses is required. It is recommended that all four MCV4U, SBI4U, SCH4U and SPH4U be taken. All other applicants should refer to admissions for the requirements for their specific category of admission.

Program details and degree requirements

Although reasonable efforts will be made to adhere to the following program map, course requirements and term offerings may change.

Year 1
Semester 1 (15 credit hours)

- CHEM 1010U – Chemistry I
- CSCI 1040U – Introduction to Programming for Scientists
  One of:
- BIOL 1010U – Biology I: Molecular and Cellular Systems [+] **or**
- BIOL 1011U – Introductory Cell and Molecular Biology
  One of:
- MATH 1000U – Introductory Calculus [++] **or**
- MATH 1010U – Calculus I [++]
  One of:
- PHY 1010U – Physics I [++] **or**
- PHY 1030U – Introductory Physics [++]

Semester 2 (15 credit hours)

- MATH 1020U – Calculus II
- MATH 2050U – Linear Algebra
- PHY 1020U – Physics II
- PHY 2060U – Modern Physics
  One of:
- BIOL 1020U – Biology II: Diversity of Life and Principles of Ecology [+] **or**
- BIOL 1021U – Introduction to Organismal Biology and Ecology **or**
- CHEM 1020U – Chemistry II

[+]Students who wish to take upper-year Biology courses must take BIOL 1010U and BIOL 1020U.

[++]All students who have completed Grade 12 Advanced Functions (MHF4U) and Calculus and Vectors (MCV4U) should take MATH 1010U and PHY 1010U. Students without one of these high school courses or equivalent are directed to take MATH 1000U and PHY 1030U.

Year 2
Semester 1 (15 credit hours)

- ~~Elective~~

- CSCI 2000U – Scientific Data Analysis
- MATH 2015U – Calculus III
- PHY 2030U – Mechanics I
- PHY 2050U – Thermodynamics and Heat Transfer
- ENVS 2010U – Introductory Environment Science

Semester 2 (15 credit hours)

- ~~ENVS 2010U – Introductory Environment Science~~
- PHY 3510U – Biophysics
- MATH 2060U – Differential Equations
- PHY 2010U – Electricity and Magnetism I
- PHY 2040U – Mechanics II
- STAT 2010U – Statistics and Probability for Physical Science

Year 3

Semester 1 (15 credit hours)

- Elective*
- PHY 3020U – Quantum Mechanics I
- PHY 3040U – Mathematical Physics
- PHY 3050U – Waves and Optics
- Senior Nanotechnology and Clean Energy Elective*

~~One of (offered in alternating years):~~

- ~~ENVS 3020U – Introductory Energy Science or~~
- ~~PHY 4040U – Solar Energy and Photovoltaics~~

Semester 2 (15 credit hours)

- Two Electives*
- ~~ENVS 3110U – Economics and Politics of the Environment~~
- PHY 3010U – Statistical Mechanics
- PHY 3030U – Electronics
- Senior Physics Elective*

~~One of (offered in alternating year):~~

- ~~PHY 4050U – Emerging Energy Systems or~~
- ~~PHY 4080U – Hydrogen-Based Energy Systems and Fuel Cells~~

Year 4

Semester 1 (15 credit hours)

- Elective*
- PHY 3080U – Electricity and Magnetism II
- PHY 4020U – Quantum Mechanics II
- Senior Nanotechnology and Clean Energy Elective*

~~One of (offered in alternating years):~~

- ~~ENVS 3020U – Introductory Energy Science or~~
- ~~PHY 4040U – Solar Energy and Photovoltaics~~

One of:

- PHY 4410U – Physics Thesis Project I ** **or**
- Senior Science elective**

Semester 2 (15 credit hours)

- Two electives*
- Senior Physics Elective*
- PHY 4010U – Condensed Matter

~~One of (offered in alternating years):~~

- ~~ENVS 3020U – Introductory Energy Science or~~
- ~~PHY 4040U – Solar Energy and Photovoltaics~~

One of:

- PHY 4420U – Physics Thesis Project II ** **or**
- Senior Science elective**

Notes:

No more than 42 credit hours may be taken at the first-year level.

***Electives and breadth requirements**

Students must complete 30 elective credit hours including 6 credit hours in senior physics electives and 6 credit hours in Senior Nanotechnology and Clean Energy electives. Students not accepted to take PHY 4410U and PHY 4420U must take an additional two Senior Science electives for a total of 36 elective credit hours. At least 18 elective credit hours must be in courses offered by the Faculty of Science including 6 credit hours in Senior Physics electives and 6 in Senior Nanotechnology and Clean Energy electives. The additional two Senior Science electives required for students who are not enrolled in thesis cannot be used to meet this requirement. In order to satisfy breadth requirements, no more than18 elective credit hours may be in Physics (PHY) courses; at least 12 elective credit hours must be in courses outside the Faculty of Science.

Recommended Senior Nanotechnology and Clean Energy electives that students may choose to take include:

- PHY 4040U Solar Energy and Photovoltaics
- PHY 4050U Emerging Energy Systems
- PHY 4080U Hydrogen-based Energy Systems and Fuel Cells
- ENVS 3020U Introductory Energy Science
- PHY 4510U Physics of Nanotechnology

****Thesis Project or Senior Science electives**

Students in clear academic standing who have completed 90 credit hours of their program and six third-year required PHY courses may optionally apply to take a two-course sequence consisting of PHY 4410U – Physics Thesis Project I and P PHY 4420U – Physics Thesis Project II. Students not accepted to take the thesis courses must complete two additional Senior Science electives instead. A Senior Science elective is defined as any 3000- or 4000-level science course not specified in the program map, excluding SCIE and ENVS courses. A student meeting the above requirements who does not take PHY 4410U and PHY 4420U may optionally apply to take PHY 4430U – Directed Studies in Physics as one of the required Senior Science electives. Opportunities for the Thesis Project and Directed Studies options are limited; students must apply through Science Advising by March 30 following completion of the first three years of the program.

Recommended Senior Science electives that students in Physics – Nanotechnology and Clean Energy program may choose to take include:

- CSCI 3010U – Simulation and Modelling
- CSCI 3070U – Analysis and Design of Algorithms
- CSCI 3090U – Computer Graphics and Visualization
- MATH 3040U – Optimization
- MATH 3050U – Mathematical Modelling
- MATH 3060U – Complex Analysis
- MATH 3070U – Algebraic Structures
- MATH 4050U – Partial Differential Equations
- PHY 3060U – Fluid Dynamics
- PHY 4030U – Topics in Contemporary Physics
- STAT 3010U – Biostatistics

d) Program Content

Two new courses are included in this proposal (templates attached):

- An additional elective to be including in the selection of Senior Nanotechnology and Clean Energy course options: PHY 4510U Physics of Nanotechnology
- An additional core course: PHY 3510U Biophysics

4. RESOURCE REQUIREMENT

a) Faculty members

There are no changes to the list of core faculty associated with this program. The changes to this specialization are in part to bring the specialization's focus more closely aligned with the research areas and disciplines of the existing faculty members.

b) Additional academic and non-academic human resources

There are no changes to the administrative requirements for this program.

c) Physical resource requirements

There are no changes to the physical resource requirements for this program.

5. BUSINESS PLAN

a) Statement of funding requirements:

Analysis of financial and enrolment implications

There is both a positive financial and enrolment implication.

With the reduction of 6 required courses to 4, we will be effectively teaching one less course in the specialization per year, resulting in a net financial savings. Note that the upper-year courses are offered to both 3rd and 4th year students on a two-year cycle.

We expect, particularly with the change of name, to see positive enrolment gains in the specialization. The specialization in this form is supportable long-term and will be heavily advertised for recruiting purposes.

The new core course PHY 3510U Biophysics would be open to any science student and would be designed to accommodate a variety of backgrounds; we expect the enrolment to be about 30 students per year.

b) Statements of resource availability
As this a change to an existing specialization, no new resources are required.

6. TIMELINE OF IMPLEMENTATION & TRANSITION PLAN (Include semester of implementation)

Proposed Implementation Date (state term, e.g. Fall 2017):
Fall 2018.

Transition Plan (include a plan for all current students in the program, by year level)

Students currently in 2nd, 3rd and 4th year level will not be affected; they will continue with their respective program maps until leaving the program.

Students currently in 1st year (entering into 2nd year in Fall 2018) will be given a choice of program map to follow; there is no issue with students choosing to follow this new program map, as any changes only take place at the second year level and beyond. Students will be contacted about the new program map and which courses they will have to take if they so choose.

Students entering into the program in Fall 2018 will follow the new program map outlined here.

Attachments

New course template – PHY 3510 Biophysics
New course template—PHY 4510 Physics of Nanotechnology

APPROVAL DATES

Curriculum Committee Approval	October 18th, 2017
Faculty Council Approval	November 1st, 2017
CPRC or GSC Approval	17 November 2017
Academic Council Approval	
Report to Board of Governors	

TEMPLATE 8-A

NEW COURSE TEMPLATE

For changes to existing courses see Course Change Template

Faculty: Science			
Full Course Title: Biophysics			
Short Form Course Title (max 30 characters): Biophysics			
Subject Code and Course number: PHY 3510U	**Cross-listings:**	☒ **Core** ☒ **Elective**	**Credit weight: 3 cr. hrs.**
Contact hours (please indicate number of total hours for each component): ☒ Lecture __3hrs___ ☐ Lab _____ ☐ Tutorial _____ ☐ Other _____			

PROGRAM(S) IMPACTED [For a core course, please list all impacted programs including any applicable fields or specializations here and include this form with a program adjustment/proposal; for an elective course being inserted anywhere other than the Course Description section of the Academic Calendar, please list all impacted programs including any applicable fields or specializations and place the Calendar copy for each here (e.g. in a list of electives tied to a specific program).]

This course will be a core course for the Physics – Nanotechnology and Clean Energy program, and will be an elective course open to other Physics majors as well as Science students in other programs, such as Biological Science and Forensic Science.

Elective - Associated Calendar Copies:

Physics – Comprehensive

"Recommended Senior Science electives that students may choose to take include:"

- CSCI 3010U – Simulation and Modelling
- CSCI 3070U – Analysis and Design of Algorithms
- CSCI 3090U – Computer Graphics and Visualization
- MATH 3040U – Optimization
- MATH 3050U – Mathematical Modelling
- MATH 3060U – Complex Analysis
- MATH 3070U – Algebraic Structures
- MATH 4050U – Partial Differential Equations
- PHY 3060U – Fluid Dynamics
- PHY 3510U – Biophysics
- PHY 4030U – Topics in Contemporary Physics
- PHY 4040U – Solar Energy and Photovoltaics
- PHY 4050U – Emerging Energy Systems
- PHY 4080U – Hydrogen-Based Energy Systems and Fuel Cells
- PHY 4510U – Physics of Nanotechnology
- STAT 3010U – Biostatistics

Physics – Astrophysics specialization

Recommended Senior Science electives that students may choose to take include:"

- CSCI 3010U – Simulation and Modelling
- CSCI 3070U – Analysis and Design of Algorithms

- CSCI 3090U – Computer Graphics and Visualization
- MATH 3040U – Optimization
- MATH 3050U – Mathematical Modelling
- PHY 3060U – Fluid Dynamics
- PHY 3510U – Biophysics
- PHY 4030U – Topics in Contemporary Physics
- PHY 4040U – Solar Energy and Photovoltaics
- PHY 4050U – Emerging Energy Systems
- PHY 4080U – Hydrogen-Based Energy Systems and Fuel Cells
- PHY 4510U – Physics of Nanotechnology
- STAT 3010U – Biostatistics

Forensic Science – Physics specialization
"Recommended Physics electives:"

- PHY 2040U – Mechanics II
- PHY 2050U – Thermodynamics and Heat Transfer
- PHY 2060U – Modern Physics
- PHY 2900U – Astronomy I
- PHY 3010U – Statistical Mechanics
- PHY 3050U – Waves and Optics
- PHY 3060U – Fluid Dynamics
- PHY 3080U – Electricity and Magnetism II
- PHY 3510U – Biophysics
- PHY 4010U – Condensed Matter
- PHY 4030U – Topics in Contemporary Physics
- PHY 4100U – Medical Imaging
- PHY 4510U – Physics of Nanotechnology
- FSCI 4040U – Fire Investigation
- MATH 2050U – Linear Algebra

CALENDAR DESCRIPTION

This course serves as an introduction to the field of biophysics, which is broadly defined as applying physical laws and methodologies to biological systems. Incorporating data and results from nano-science experimental techniques, computer simulations, and analytic techniques, several biophysics research areas will be covered. Emerging nanotechnologies related to each system will be discussed. Possible topics include: the importance of diffusion in biological processes (stochastic dynamics); structure, function, and dynamics of biomolecules such as DNA, RNA, proteins; transport across biological membranes; self-assembly of biological material; organization and dynamics within the cell; and active matter such as bacterial colonies.

Prerequisites	PHY1020U or PHY 1040U, MATH 1015U or MATH 1020U, BIO 1010U or BIO 1011U
Co-requisites	
Credit restrictions	
Equivalency courses	
Grading scheme	☒ **letter grade** ☐ **pass/fail**

LEARNING OUTCOMES (this section is required)

At the end of this course, successful students will

i) Recognize the physical principles that govern the nature and behaviour of biological systems.

ii) Explain the fundamental phenomenon that underlie biological systems such as the structure, function, and dynamics of biomolecules and biological membranes.

iii) Identify and describe the established and emerging nanoscience techniques and technologies that are used to study and alter biological systems at the nanoscale.

iv) Investigate in depth a particular area of current biophysics research and identify the multidisciplinary nature of the field.

COURSE INSTRUCTIONAL METHOD

(check all that may apply) ☒ **CLS (in-class)** ☒ **HYB (in-class and online)**
☐ **IND (individual studies)** ☐ **OFF (off-site)**
☐ **WB1 (synchronous online delivery)**
☐ **WEB (asynchronous online delivery)**

TEACHING AND ASSESSMENT METHODS

Teaching will consist of lectures in which a topic is presented, results derived and/or presented, and discussion of the topic as a class. Students will also have the opportunity to present in class for their particular research project.

Assessment may consist of regular assignments, a midterm, and final exam. A research project on a current biophysical topic will be a significant part of the marking scheme.

CONSULTATION AND FINANCIAL IMPLICATIONS, WHERE APPROPRIATE

This course is part of a series of changes to the Physics program and Nanotechnology and Clean Energy specialization, and will replace a core second year course from the specialization (ENVS 3020U). The removal of ENVS 3020U as a core course means that it is no longer be required to be offered. As such, the financial implications of running PHY 3510U should be offset by the removal of this existing core course.

EFFECTIVE SEMESTER (Specify First Active Term e.g. Fall 2017)

Fall 2018

APPROVAL DATES

Curriculum Committee approval	***October 18, 2017***
Faculty Council approval	***November 1st, 2017***
Submission to CPRC/GSC	17 November 2017

TEMPLATE 8-A

NEW COURSE TEMPLATE

For changes to existing courses see Course Change Template

Faculty: Science			
Full Course Title: Physics of Nanotechnology			
Short Form Course Title (max 30 characters): Physics of Nanotechnology			
Subject Code and Course number: PHY 4510U	**Cross-listings:**	☐ **Core** ☒ **Elective**	**Credit weight: 3 cr. hrs.**
Contact hours (please indicate number of total hours for each component): ☒ Lecture __3 hrs___ ☐ Lab _____ ☐ Tutorial _____ ☐ Other _____			

PROGRAM(S) IMPACTED [For a core course, please list all impacted programs including any applicable fields or specializations here and include this form with a program adjustment/proposal; for an elective course being inserted anywhere other than the Course Description section of the Academic Calendar, please list all impacted programs including any applicable fields or specializations and place the Calendar copy for each here (e.g. in a list of electives tied to a specific program).]

This is will be an approved specialized elective for the Physics - Nanotechnology and Clean Energy program (see major program change document), as well as an elective course open to other Physics majors and Science students in other programs (i.e. Forensic Science).

Elective - Associated Calendar Copies:

Physics – Comprehensive

"Recommended Senior Science electives that students may choose to take include:"

- CSCI 3010U – Simulation and Modelling
- CSCI 3070U – Analysis and Design of Algorithms
- CSCI 3090U – Computer Graphics and Visualization
- MATH 3040U – Optimization
- MATH 3050U – Mathematical Modelling
- MATH 3060U – Complex Analysis
- MATH 3070U – Algebraic Structures
- MATH 4050U – Partial Differential Equations
- PHY 3060U – Fluid Dynamics
- PHY 3510U – Biophysics
- PHY 4030U – Topics in Contemporary Physics
- PHY 4040U – Solar Energy and Photovoltaics
- PHY 4050U – Emerging Energy Systems
- PHY 4080U – Hydrogen-Based Energy Systems and Fuel Cells
- PHY 4510U – Physics of Nanotechnology
- STAT 3010U – Biostatistics

Physics – Astrophysics specialization

Recommended Senior Science electives that students may choose to take include:"

- CSCI 3010U – Simulation and Modelling
- CSCI 3070U – Analysis and Design of Algorithms

- CSCI 3090U – Computer Graphics and Visualization
- MATH 3040U – Optimization
- MATH 3050U – Mathematical Modelling
- PHY 3060U – Fluid Dynamics
- PHY 3510U – Biophysics
- PHY 4030U – Topics in Contemporary Physics
- PHY 4040U – Solar Energy and Photovoltaics
- PHY 4050U – Emerging Energy Systems
- PHY 4080U – Hydrogen-Based Energy Systems and Fuel Cells
- PHY 4510U – Physics of Nanotechnology
- STAT 3010U – Biostatistics

Forensic Science – Physics specialization
"Recommended Physics electives:"

- PHY 2040U – Mechanics II
- PHY 2050U – Thermodynamics and Heat Transfer
- PHY 2060U – Modern Physics
- PHY 2900U – Astronomy I
- PHY 3010U – Statistical Mechanics
- PHY 3050U – Waves and Optics
- PHY 3060U – Fluid Dynamics
- PHY 3080U – Electricity and Magnetism II
- PHY 3510U – Biophysics
- PHY 4010U – Condensed Matter
- PHY 4030U – Topics in Contemporary Physics
- PHY 4100U – Medical Imaging
- PHY 4510U – Physics of Nanotechnology
- FSCI 4040U – Fire Investigation
- MATH 2050U – Linear Algebra

CALENDAR DESCRIPTION

This course examines the physics of nanotechnology. Topics covered depend on student need and demand as well as instructor availability, and may include surface science, materials science and photovoltaics, semiconductors, nanofabrication, nanofluidic devices, nanoparticles, and bionanotechnology.

Prerequisites	**PHY 2010U (Electricity and Magnetism I), PHY 2060U (Modern Physics)**
Co-requisites	
Credit restrictions	
Equivalency courses	
Grading scheme	☒ **letter grade** ☐ **pass/fail**

LEARNING OUTCOMES (this section is required)

1. Apply knowledge of appropriate physics theory to problems at the nanoscale.
2. Identify and demonstrate an understanding of the theory behind various examples of nanotechnology
3. Describe how nanotechnology is used in applications.

COURSE INSTRUCTIONAL METHOD

(check all that <u>may</u> apply)	☒ **CLS (in-class)**	☐ **HYB (in-class and online)**
	☐ **IND (individual studies)**	☐ **OFF (off-site)**
	☐ **WB1 (synchronous online delivery)**	
	☐ **WEB (asynchronous online delivery)**	

TEACHING AND ASSESSMENT METHODS

Teaching will consist of lectures in which a topic is presented, results derived and/or presented, and discussion of the topic as a class.

Assessment may consist of regular assignments, projects, a midterm, and final exam.

CONSULTATION AND FINANCIAL IMPLICATIONS, WHERE APPROPRIATE

This is an elective course, which is part of a group of "specialized electives" within the Nanotechnology and Clean Energy program. It will be offered on a rotating basis with the other courses in that grouping, dependent on student need and faculty availability. As such, there is no new or additional financial implications.

EFFECTIVE SEMESTER (Specify First Active Term e.g. Fall 2017)

Fall 2018

APPROVAL DATES

Curriculum Committee approval	***October 18th, 2017***
Faculty Council approval	***November 1st, 2017***
Submission to CPRC/GSC	17 November 2017