

# 1. Introduction

## 1.1. Overview of the Program(s)

### *Program Under Review*

The Bachelor of Science, Major in Physics for Modern Technology (PMT) is an undergraduate program offered by the Department of Physics, Astronomy and Engineering at Kwantlen Polytechnic University (KPU). Most industrial achievements are based on science, and although physicists play an important role in technology development, there is a dearth of programs in North America designed to prepare physics graduates for work in industry. The major goal of the PMT program is that graduates will find employment in local high-tech industry upon graduation. It is specifically designed to address the long-standing issue with many traditional science degrees in which graduates are not prepared to apply their knowledge and skills in the workplace after graduation. PMT is the first physics degree in Canada with this explicit goal.

In 2010, the Department initiated the idea of a program to specifically tackle this issue. This was followed by a visit to similar successful applied physics programs offered in Ireland at Galway-Mayo Institute of Technology, Cork Institute of Technology, & Waterford Institute of Technology in 2011. At the same time, consultation with local high-tech companies revealed the demand for an applied physics program. In 2012, KPU approved the PMT program, followed by approval from the BC Ministry of Advanced Education in 2013.

The PMT program underwent a “soft launch” in 2014 when a selection of new courses were offered for the first time. The Program Advisory Committee (PAC) was established within the same year. In 2015, the PMT program fully launched, which resulted in the first students graduating in 2018. PMT graduates have proven to be successful in securing technical, scientific, and management roles in the local tech sector.

### *Admission Requirements*

Admission to the PMT program is classified as open-intake – there is no set limit to the number of students admitted. For students intending to pursue the PMT program directly from high-school or without any post-secondary experience, admission into the program is a two-step process. First, these students must be admitted to the Faculty of Science & Horticulture (FSH), which requires meeting KPU’s undergraduate English proficiency requirement. These students are classified as undeclared-FSH students with a Physics intention. In order to complete the required first-year courses in the PMT program, students must meet the following prerequisites:

- Math 12 (C+)
- Physics 12 (P)
- Chemistry 12 (C+)
- English 12 (B)

Students missing any of the above prerequisites can upgrade at KPU.

The second step to enter the PMT program is program declaration. At the time of declaration, the student must satisfy all of the following requirements:

- In good academic standing with the University
- Completion of a minimum of 24 credits of undergraduate coursework, including the following:
- 3 credits of ENGL at the 1100 level or higher

- PHYS 1102 or PHYS 1220, with a minimum grade of “C”
- MATH 1220 or MATH 1230, with a minimum grade of “C”

All KPU students intending to graduate with a bachelor’s degree from the Faculty of Science and Horticulture degree must declare their major by the time they complete 60 credits of undergraduate coursework.

*Other Pathways into the Program:*

Students with post-secondary experience at KPU or any other post-secondary institution can declare directly into the PMT program if all the declaration requirements are met. In particular, students who have successfully completed KPU’s Certificate in Engineering meet the PMT declaration requirements and may transfer directly into the second year of the PMT program. Note, Engineering Certificate graduates would still need to complete BIOL 1110 as a graduation requirement. Students transferring from other KPU programs or post-secondary institutions will be required to complete PHYS 1600 Introduction to Modern Technology as a prerequisite for some second-year PMT courses.

*Credential & Curricular Requirements*

Currently, students must meet the following minimum requirements to graduate with a Bachelor of Science from the Faculty of Science and Horticulture:

- 120 credits from courses at the 1100 level or higher.
- 45 credits from a minimum of 15 courses at the 3000 level or higher, including 9 credits at the 4000 level.
- 18 credits of breadth electives (see Electives below) including:
  - at least 12 credits from courses that are offered outside the Faculty of Science & Horticulture; and
  - up to 6 credits from fields of science not prescribed in the Major requirements; and
  - 3 credits from a course at the 3000 level or higher.
- Cumulative GPA of 2.0 or higher
- At least 50% of all courses for the BSc, and at least 66% of upper-level courses for the BSc, must be completed at KPU (See the Laddering and Transferability for more details).

See Appendix A for a full list of the course requirements for the PMT program (including course numbers and titles).

*Transferability*

As mentioned above, the program aims to attract students who have completed (fully or partially) their first year at another post-secondary institution. KPU is a member of the BC Council on Admission and Transfer (BCCAT) which manages articulation agreements between post-secondary institutions across BC. As such, most of the PMT program’s first-year courses have existing course articulation agreements with many post-secondary institutions across BC (see Figure 1). The only first-year course that does not articulate is PHYS 1600 Introduction to Modern Technology, which was specifically designed for the PMT program. Students from other institutions are also able to transfer a limited number of second year Physics and Math courses for credit toward the PMT degree. The relatively small number of institutions with transferrable second year courses is because many smaller institutions do not offer second year Physics courses, and many of the second-year courses were uniquely designed for the PMT program.



Department also runs introductory Astronomy courses for non-science majors, which have been particularly popular with Arts students. The Department has recently started offering an astrophysics course for science students. At the Langley campus, the Physics department runs two courses annually, *Energy, Environment, Physics (PHYS 1400)*, and *Environmental Physics Lab (PHYS 1401)*, for students in the Environmental Protection Technology program. The first year of the PMT program is run at both the Richmond and Surrey campuses. All second, third- and fourth-year Physics courses are delivered at the Richmond campus only.

There are nine full-time faculty, five full-time lab instructors and two full-time technicians. The faculty and lab instructor contingents are augmented by part-time personnel as needed. Roughly half of the Department is based in Richmond and half in Surrey; however, the lab instructors and faculty are routinely called upon to teach on both campuses based on expertise or timetabling logistics. In addition, there is a full-time instrumentation specialist on the Richmond campus to support the needs of the PMT program.

### 1.3. Program Purpose

The purpose of the program is to provide an applied and hands-on education that prepares students for careers in the tech sector.

#### *Changes Since Program Launch*

Since program launch, the program has been adapting to meet the needs of its stakeholders. These changes have not altered the program significantly. While some changes have been procedural, others have been curricular, requiring Senate approval. Some of the revisions are outlined below:

#### **CHANGES THAT REQUIRED SENATE APPROVAL:**

<b><i>Issue to be addressed</i></b>	<b><i>Resulting program change(s)</i></b>
The senior project was originally completed in one semester. However, discussions within our department and with our Program Advisory Committee led us to the conclusion that a two-semester project would be more beneficial for our students as it gives them more time to plan their project, would allow them to work on a more substantial project, and would increase the likelihood of achieving the desired outcomes.	The senior project was lengthened from one semester to two semesters in duration. PHYS 4199 (semester 1) largely involves project proposal, planning, and management, while PHYS 4299 (semester 2) involves the actual project work.
PHYS 4010 was originally intended to cover both quantum mechanics and solid state physics. However, it became apparent that it would be very difficult to fit both topics into one course. We realized that it makes more sense to give students a firmer foundation in quantum mechanics and to offer a separate course in solid state physics.	PHYS 4010 is now dedicated to quantum mechanics and PHYS 4700 was changed from “Spectroscopic Instrumentation” to “Solid State Physics: Theory and Practice”.

<b><i>Issue to be addressed</i></b>	<b><i>Resulting program change(s)</i></b>
The list of recommended business electives on the PMT calendar page contained some courses that had been discontinued.	Discontinued courses were removed from the list.
After the initial offerings of some of the second-year courses it was realized that some course names and prerequisites should be changed to better reflect their content and requirements as well as to provide more flexibility to students.	MATH 2721 is no longer a co-requisite of PHYS 2010.  PHYS 2600 and PHYS 2610 are no longer co-requisites.  Name of PHYS 2600 changed from “Electronics with Microcontrollers” to “Electronics”.

***OTHER CHANGES:***

<b><i>Issue to be addressed</i></b>	<b><i>Resulting program change(s)</i></b>
Students must work full-time for at least 14 weeks in a relevant department-approved position in order to satisfy the mandatory work experience requirement. This is intended to take place at the end of a student’s third year in the program. In order to accommodate work terms longer 14 weeks, the three 3 <sup>rd</sup> -year Spring semester courses are accelerated. Originally the accelerated courses finished at the end of February, so that students could have up to six months (March to August) for their work term. However, feedback from faculty and students indicated that the semester was too demanding in this format.	The accelerated courses now run until mid-March, which decreases the time-pressure, while still allowing for longer work terms of up to five months.  PHYS 3710 (Applied Optics & Optoelectronics) was moved from the Spring to the Fall semester as it was deemed to be too demanding to run in accelerated mode. It was replaced in the Spring semester with PHYS 4900 (Special Topics).
Lower enrollment in 3 <sup>rd</sup> and 4 <sup>th</sup> year courses.	We have been running the third- and fourth-year courses in alternate years. This has ensured healthier enrolment in those courses, with third- and fourth-year students taking them together.

***External Accreditation***

There is no external accreditation for physics degrees in Canada. This issue was discussed several years ago by physics department chairs from across Canada at the annual Canadian Association of Physicists Congress. As far as the authors of this review are aware, the conversation has not progressed any further, but it is something we will keep track of and ensure our involvement in.

Although there is no external accreditation of physics degrees in Canada, the Canadian Association of Physicists does have a Professional Physicist (P.Phys.) designation that our graduates can apply for after three years of physics-related work experience.

## 1.4. Issues for Program Review

As Physics for Modern Technology is a relatively new program, this is its first program review. However, since the launch of the program, there have been various issues identified by students, faculty, and the program advisory committee (PAC) that the Department hopes the program review will shed further light on. It is hoped that the following four goals and related issues will be addressed by this program review.

1. Determine whether or not the program is meeting its primary purpose of preparing students for employment in the technology sector.

The following are specific employment-related issues/questions that have been identified:

- Career progression: Are students progressing in their careers? Are there things related to the program that are holding our graduates back from advancing in their careers? What kinds of upgrades to their education have they been seeking to further advance their careers?
- Work Experience: Feedback from the PAC has generally been that longer (eight months) work terms are preferred by many companies (though four-month positions are very common). In addition, about 50% of students who have completed their work terms have indicated that longer and/or more work terms would be beneficial (at least as an option, if not mandatory). From time to time, there is also discussion on whether or not a co-op model should be used, instead of coordinating everything from within the Department, which is the current practice.
- Communication Skills: One career-related topic that is often discussed among faculty and at PAC meetings is the development of students' communication skills. The importance of communication skills is also mentioned often by students in their work experience reports. Although this has been incorporated throughout the program, faculty experience has been that our students need even more opportunity to develop these skills. To that end, the spring 2021 offering of our Special Topics course (PHYS 4900, which students take in their 3rd or 4th year) was on the topic of communication. However, by its nature, the topic of that course changes from year to year. This program review can help determine whether and/or how students' communication skills should be increased in the program.

2. Determine how best to adjust the program curriculum to serve the PMT students' needs.

Students, faculty, and the PAC have expressed a desire for additional topics to be added to the PMT program. However, any additional topics will require the removal of others. The hope is that this program review will provide quantitative data to support the addition/removal of content from the PMT program. The following are specific curricular issues that we would like to investigate:

- Computer Programming: Since computer programming is an essential skill for most academic and industrial physicists and technologists, it has always been clear that it must be a skill that students develop during the PMT program. So far, feedback from faculty, students, and the PAC has been that more explicit emphasis on programming is needed, with the likely development of at least one new dedicated programming course focused on programming fundamentals and best practice for scientists and engineers. It is also hoped to incorporate a data science course into the program, and its requirements would help inform the content of any additional programming courses that develop. Although departmental discussions on this topic have already begun and are ongoing, this program review will help identify the best way forward.

- Mathematics: MATH 2721 and MATH 2821 were designed specifically for the PMT program in consultation with the math department. When developing the program, the alternative option was for our students to take at least four existing math courses (in addition to MATH 1120 and 1220). The decision to instead develop and offer MATH 2721 and 2821 was made so that students' math education would be focused on what they need for their 2nd, 3rd, and 4th year physics courses. Recent feedback from the math department has been that it is difficult to cover the content of MATH 2721 in one semester. This program review will be used to determine if changes need to be made to the math content of the program.
- Chemistry: Based on consultations that occurred while designing the program, it was decided to include a total of four chemistry courses in the program. It is important to ascertain whether or not these courses are valued by our graduates and by current members of our PAC (i.e. whether the content is useful in the types of jobs PMT graduates have been securing).
- Breadth: Currently the PMT program requires students to complete 6 elective/breadth courses (18 credits). Two of those courses must be business courses and were included in the program on the basis of feedback from local industry – it was deemed important for graduates to have some business knowledge when entering the workforce. The 18-credit requirement comes from KPU's BSc framework (see Appendix B). It is understood that the BSc framework is due to be revised by the Faculty of Science and Horticulture, partly in light of the new policy AC14 (KPU Credential Framework). The program review will help determine if we can or should change the breadth requirement of the program. Such investigations could in turn help inform the revision of the BSc framework.

### 3. Identify ways to promote the program and increase enrolment.

Most of the second, third and fourth year PMT courses have a maximum class size of 20. This is because most of these courses take place in a lab, and lab capacity is more limited than a regular classroom. However, since the PMT program launch, class sizes have been significantly smaller than the maximum. This program review will examine data on class sizes, how they have changed over the years, and how they vary across years one to four. This data will hopefully help identify ways to attract more students.

- Promotion: Faculty have recently been discussing the need for increased promotion of the program. Earlier, the Department engaged quite regularly in promotional activities, but the level of activity has fallen off. Also, at that time, questions about the kinds of careers that graduates of the program could pursue could only be answered hypothetically. Now that PMT graduates have been securing positions in the technology sector, more concrete material can be included to promote the program and attract students. The Department hopes to identify ways to achieve this goal, internally and in liaison with other groups at KPU (e.g. Dean's office, Future Students Office, Marketing).
- Transferability: As discussed above, there are gaps in the ease with which students can transfer into the PMT program. An investigation of ways to increase and facilitate transferability from local institutions (and perhaps into our third year) may help to increase enrolment.

### 4. Identify ways to allow students to pursue other post-degree educational opportunities (i.e. graduate studies).

As previously mentioned, preparing students for graduate studies is not a primary goal of the program. However, there are several current students who are interested in pursuing graduate studies. It is hoped that this program review will give a better handle on the extent of that interest among our student body. This review should also help decide whether and how to further facilitate such opportunities (e.g. through modification of the program and/or the creation of more agreements with other universities).