REPORT OF ACADEMIC STANDARDS COMMITTEE
Report #W2016–4; May 3, 2016

In this report the Academic Standards Committee (ASC) brings to Senate its evaluation and recommendation on the following items:

- **Medical Physics Periodic Program Review, Faculty of Science**
- **Certificate in Health Services Management: Revision of Certificate Graduation Requirements; Repositioning CCMN 279**
- **Certificate in Health Studies: Addition of Health Data Analytics Stream (CHIM 301 and CHIM 408)**
- **Certificate in Infrastructure Asset Management and Renewal: Discontinuation**
- **For Information: Chang School Certificates (4)**
- **For Information: Chang School Course Series (6)**

A. MEDICAL PHYSICS PERIODIC PROGRAM REVIEW

1. BASIC INFORMATION

1.a Program Description

Medical Physics is defined by the American Association of Physicists in Medicine as a branch of Physics concerned with the application of the concepts and methods of Physics to the diagnosis and treatment of human disease. The Canadian Organization of Medical Physics defines medical physicists as health care professionals with specialized training in the medical applications of physics. Their work often involves the use of X-rays, ultrasound, magnetic and electric fields, infra-red and ultraviolet light, heat and lasers in diagnosis and therapy. Most medical physicists work in hospital diagnostic imaging departments, cancer treatment facilities, or hospital-based research establishments. Others work in universities, government, and industry.

The Bachelor of Science program in Medical Physics focuses on the convergence of knowledge, methods and skills emanating from the basic sciences in a multidisciplinary context that is being applied to innovation and new technologies for the benefit of human health. The very nature of this applied, multidisciplinary program emphasizes the development of skills that will equip students for the workforce in specific types of jobs supporting the field of medicine or for post-graduate training and research.

1.b Program History

In 1994, the Physics Planning Group of the former Department of Mathematics, Physics and Computer Science documented a strategic plan to develop research and graduate programs in the field of Medical Physics at Ryerson University. The Department started hiring faculty members with expertise in this field in 1996. Between 1996 and 2005 seven faculty members were hired with combined expertise in: biomedical optics; ultrasound imaging and therapy; clinical; X-ray fluorescence, neutron activation analysis and in-vivo trace element analysis; biostatistics and X-ray fluorescence; finite element modeling of biophysics; and image processing and electromagnetic fields.

The new Department of Physics was created in 2005 and two new programs were approved to start in the Fall of 2006: an undergraduate B.Sc. program in Medical Physics and a graduate Master of Science program in Biomedical Physics.

The Department of Physics now houses one of the largest university-based Medical/Biomedical Physics groups in Canada, and thus has considerable infrastructure to support strong teaching and research in these areas of applied Physics; this is an essential prerequisite for the delivery of a multi/interdisciplinary program such as Medical Physics. Coupled with in-house expertise in science education, the Department of Physics at Ryerson has positioned itself to offer one of the largest and most recognized undergraduate degrees in Medical Physics in Ontario.

2. DEVELOPMENTS SINCE PREVIOUS PROGRAM REVIEW

Since the undergraduate Medical Physics Program started in 2006, this is its first Periodic Program Review. Nevertheless, over the last seven years, the Program has been updated. While many small changes were implemented as the need arose, more in-depth curriculum reviews were conducted in 2007 and 2010. The changes implemented in 2008/2009 were proposed with the goal of strengthening the physics content and at the same time satisfying the multiple requirements imposed by the multidisciplinary nature of the Medical Physics Program. The changes implemented in 2011/2012 were proposed to guide program students by developing a stricter course pre-requisite path.

3. SOCIETAL NEED

The BSc program in Medical Physics has been developed with the objective of preparing students to work in the health care sector or the cancer diagnosis/management services fields or to enter graduate programs that will train them as medical physicists. Some of the graduates from the Medical Physics program have entered the work force in industry and health-care organizations; some have gone on to graduate studies in Biomedical Physics and some have entered professional institutions such as medical schools. Students graduating from this program acquire training in fields that are of critical importance to Canada, such as the application of physics and technology to radiation exposure testing or radiation cancer treatment/management services and research.

At the time the Ryerson Medical Physics Program was implemented there were only three institutions in Ontario offering professionally oriented undergraduate education in Medical Physics: the University of Western Ontario, McMaster University and Laurentian University. The role played by our undergraduate program in addressing societal need has been recognized by other universities who have started new programs (Windsor) or revised their existing one (McMaster) and basically replicated Ryerson's Medical Physics Program, thus acknowledging that our Program addresses societal need effectively.

3.a Current and Anticipated Societal Need

According to the Canadian Organization of Medical Physicists (COMP) website, there are approximately 400 medical physicists working in Canada: 75% work in hospitals and hospital-based research establishments, 7% work for government, 8% for industry, and an additional 10% are university faculty who are not hospital-based.[1] The number of Medical Physics positions has generally increased by about 5-10% per year.

Within the health care sector in Canada, cancer diagnosis/management services employ the greatest number of medical physicists. Cancer Care Ontario has been working to meet this increased demand by expanding cancer care services in the province.

According to the COMP website, a prospective clinical medical physicist should have an honours degree in physics with courses in computing, electronics, with mathematics being advantageous.[2] A prospective medical physicist then undertakes graduate training (MSc and PhD) in medical

[1] Calculation from Statistics Canada's "Population Projections for Canada, Provinces and Territories 2000-2026", Cat. No. 91-520.
[2] Ibid.

physics, biomedical physics or a related area of physics followed by one or two years of clinical training in the discipline. As the profession becomes more regulated through accreditation by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP), most employers of medical physicists in Canada require certification as a condition of employment or clinical career progression. The Canadian College of Physicists in Medicine (CCPM) requires that (as of January 1, 2016) all applicants for certification in Radiation Oncology Physics, the main employment subspecialty for clinical Medical Physics, must have graduated from either a graduate program (typically at the PhD level) or a residency program which is accredited by CAMPEP. A student with a physics or engineering-related background who has completed a minimum of three upper-level undergraduate physics courses (offered in the third or fourth year) can apply to these accredited graduate programs.

The Ryerson Medical Physics undergraduate program is designed to feed into graduate programs in Medical Physics, Medical Biophysics or Biophysics as well as to allow students to apply directly to professional schools such as Medicine, Dentistry, Pharmacology, Education, Business, and Law. A "Search for Occupational Projection Summaries (2011-2020)" on the groups "Medical Technologists and Technicians" and "Radiation Therapists" includes the occupations:

Radiation Therapists	Medical Radiation Technologists
Medical Laboratory Technologists and Pathologists' Assistants	Medical Sonographers
Medical Laboratory Technicians	Cardiology Technologists
Animal Health Technologists	Electroencephalographic and Other Diagnostic Technologists
Respiratory Therapists and Clinical Perfusionists	Other Medical Technologists and Technicians

Over the 2008-2010 period, these occupations experienced solid employment growth while their unemployment rate, among the lowest of all occupations, remained virtually unchanged. According to key labour market indicators, the number of job seekers was insufficient to fill the job openings; and over the 2011-2020 period, job openings (arising from expansion demand and replacement demand) are expected to total 40,304 with 41,321 job seekers (arising from school-leavers, immigration and mobility) expected to be available to fill the job openings.

Ryerson's Medical Physics program provides a uniquely focused and specialized set of upper level courses that will prepare graduates to enter professional schools and colleges. It includes innovative and unique training in Health Physics (a sub-discipline of Medical Physics), which expands students' ability to seek a highly paid position immediately after graduation. Although the number of graduates who choose to follow this path after graduation is small, it shows that Ryerson's Medical Physics program prepares its graduates well to succeed in their careers even without proceeding to graduate schools.

Of the nine responses received from the graduate survey, three of the students went on to graduate studies (currently one in the PhD program and two at the MSc level), while six entered the workforce. Six of the nine respondents obtained employment or entered graduate school after graduation in less than three months. Though the sample is small due to the small number of responses received, the employment reported by alumni shows that the Medical Physics program is very effective in preparing graduates for a variety of jobs.

Fields of Employment and # of Graduates		Time Frame between Graduation and Employment		
Graduate program	3	**Time frame**	**Job related to training**	**Obtain job after graduation**
Nuclear Engineering/Health Physics	1	Less than 3 months		6
Health sector	1	Less than 6 months	4	
Healthcare, physician training and management	1	6 months to 1 year	1	1
Health Physics	1	1 to 2 years	2	2
Financial services/insurance industry	1	Not directly	2	

As anecdotal evidence, one of the students in the program entered Medical School after completing three years of the program and another, also at the end of third year, proceeded to the Michener Institute to specialize as a radiation therapist.

3.b Existing and Anticipated Student Demand

The ratio of applicants to registrants has varied between a low of 4.6 in 2013/14 and a high of 10.1 in 2009/10 (Table 1).

UPO TABLE 1 Applications (all choices) to registrants								
	2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**
Ryerson	10.2	10.4	10.2	10.0	9.2	8.7	8.5	8.4
Engineering Architecture & Science	8.1	7.7	8.1	8.1	-	-	-	-
Faculty of Science	-	-	-	-	8.5	8.1	8.0	7.4
Medical Physics	7.3	8.9	6.6	10.1	7.1	7.4	6.0	4.6

Although the entering grade averages are slightly lower than the overall Ryerson average, these values are comparable to those of Engineering and the other science programs, clearly demonstrating the demand for our Program (UPO Table 2).

UPO TABLE 2 Entering Averages (%)								
	2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**
Ryerson	79.8	80.2	80.6	81.5	81.4	81.9	82.2	83.1
Engineering Architecture & Science	78.5	78.4	79.3	79.8	80.1	-	-	-
Faculty of Science	-	-	-	-	-	77.9	78.3	80.4
Medical Physics	75.7	78.0	79.1	77.6	77.5	77.4	77.9	78.5

The percentage of students entering the Medical Physics Program with a grade average greater or equal to 80% is lower than the corresponding ones for Engineering and Ryerson as a whole, but again comparable to those of the other Science programs.

The data available (2006 – 2014) for the Fall headcount by school year are displayed in UPO Table 3. From 2009 onward the program shows a steady increase in the total Fall headcount and is ~8.5 % of the total headcount of all Science programs.

UPO TABLE 3 - Undergraduate Total Fall Headcount Enrolment									
YEAR	**F2006**	**F2007**	**F2008**	**F2009**	**F2010**	**F2011**	**F2012**	**F2013**	**F2014**
Medical Physics	49	90	115	128	137	145	168	184	190

The female/male headcounts' average ratio in Medical Physics is 0.87 which is atypical of traditional Physics programs in Canada and more in line with the female/male enrollment ratios for Biology and Chemistry programs. The female/male headcounts' average ratio calculated for all other Science programs is 0.62. It can be concluded that there is a great demand for the Ryerson Medical Physics program from the female population.

In order to attract applicants to the Medical Physics program and thus increase demand, the Department organizes many outreach initiatives. In collaboration with the Faculty of Science outreach office, we offer "Discover Ryerson Days" and information sessions (for parents and students). The program holds, on demand, Open Houses for grades 11 and 12 where the visiting students are engaged in stimulating experimental activities appropriate for their level. The Physics Outreach Program is intended to promote, in particular, the Department of Physics to high schools within the Greater Toronto Area. The program is administered by the Faculty of Science's Office of Science Outreach and Enrichment (OSOE).

Since students in other Science programs at Ryerson share many of the courses in the Medical Physics Program, transfer of students among different programs occurs often, particularly at the end of the first or second year of study. The number of students who transferred into our Medical Physics Program (13) as compared to the number who left it (4) was the highest in 2012/13. The Program interprets this as a sign of student perceived satisfaction with the Physics teaching methods and student support.

4. LEARNING OUTCOMES

4.a Program Learning Outcomes

Graduates of Medical Physics will be able to

Learning Outcome 1*:* Demonstrate knowledge of general physics in the core areas of

1a. Mechanics
1b. Optics
1c. Thermodynamics and Statistical Mechanics
1d. Classical Electricity and Magnetism
1e. Modern/Quantum Physics
1f. Nuclear Physics

Learning Outcome 2: Demonstrate knowledge of Medical Physics in the core areas of

2a. Radiation Therapy
2b. Medical Imaging
2c. Nuclear Medicine Physics
2d. Health Physics

Learning Outcome 3:

3a. Demonstrate general knowledge of Biology and Chemistry as supporting areas of Medical Physics particularly in Biology: Cell structure and function, metabolism, anatomy and physiology, ecology, genetics, immunology and in Chemistry: Chemical equilibrium, thermochemistry, structure of inorganic and organic materials, chemical reactions.

3b: Demonstrate general knowledge in Mathematics as a supporting area of Medical Physics, particularly in Calculus, Vector Calculus, Differential Calculus, Statistics.

3c: Demonstrate knowledge in Scientific Computing a supporting area of Medical Physics, particularly in programming principles and skills).

Learning Outcome 4: Demonstrate the ability to apply the methodology of scientific inquiry in the areas of problem solving, analytical and critical thinking, logical reasoning and experimental techniques

Learning Outcome 5: Demonstrate the ability to present scientific arguments and analyses clearly and concisely, to the general public, government and within the scientific community itself both

5a. orally
5b. in written form.

Learning Outcome 6: Demonstrate the ability to integrate and synthesize interdisciplinary knowledge as well as summarize and interpret research results in Medical Physics. (in particular, to be able to apply critical thinking and analytical skills and to synthesize knowledge from Physics, Mathematics, Biology and Computer Science, as applied to the Medical Physics field.)

Learning Outcome 7: Demonstrate the ability to understand the implications of Medical Physics in broader societal issues in order to be able to make sound judgements on issues in health care where Medical Physics plays a role.

Learning Outcome 8: Demonstrate autonomy (confidence and perseverance) and professional competence, including being able to demonstrate accountability, ethical and professional integrity, time management and interpersonal skills

4.b Program Consistency with other Academic Plans

The Department of Physics' plans and strategies are driven by priorities that closely follow those of the University as outlined in Ryerson's Academic Plan. The Medical Physics undergraduate program is a high quality societally-relevant program by design. Students are trained in the application of science to the prevention, diagnosis and cure of disease. The Program strives to convey knowledge in the fundamental areas of Physics and in core areas of Medical Physics (LEARNING OUTCOMES 1 and 2). The Program is of very high quality fuelled by the excellent research of our departmental faculty members and by close collaborations with the clinical establishments in the Greater Toronto Area. These collaborations enable students to take advantage of experiential learning in hospital settings, thus reinforcing Learning Outcomes 6 – 8.

The Department of Physics has been a leader in the implementation of modern teaching technologies aimed at maximizing student engagement and student learning. Our impact in Science Education is recognized at the national and international levels. Learning and Teaching Excellence is a priority in the Department Plan. A faculty member who specializes in Science Education research, was chosen in 2010 to be the first Ryerson Teaching Chair (reappointed in 2013) and actively promotes teaching and learning methodology among her peers. The Department is committed to the development and implementation of new methodologies for our courses. Novel methods such as video-based motion analysis, real-time data acquisition, computer simulations, personal response systems and on-line tutoring systems are being used in some of our courses to enhance student critical thinking and logical reasoning (Learning Outcome 4).

The current (2009-13) Strategic Plan document listed detailed strategies aimed at enhancing and developing all aspects that contribute to the success of our undergraduate program of Medical Physics. In particular, the modernization of the undergraduate physics laboratories made possible the purchase of modern, computer-based equipment for Physics courses offered to engineering students and to science students. This new equipment enables a variety of novel laboratory experimental inquiries (Learning Outcome 4).

The faculty is also committed to revising current courses as well as developing new courses in order to promote depth in fundamental Physics areas (Learning Outcome 1). The table of professionally-related courses has been augmented primarily by student demand (Learning Outcome 3).

One advantage of the Medical Physics program is its size. This not only enables a "family-type" relationship between faculty and students but also provides an opportunity for students to join departmental or hospital research groups and acquire hands-on experience in Medical Physics projects thus achieving Learning Outcomes 6 - 8. The co-op option further emphasizes these Learning Outcomes.

In line with the University/Faculty academic plan, the Department of Physics is also involved in the teaching of physics and scientific concepts to non-science audiences.

5. ACADEMIC QUALITY

5.a Description of the Program Curriculum and Structure

The Medical Physics Program is a full time undergraduate program and consists of a total of 41 courses from which 32 are required courses, 6 are liberal studies electives and 3 are professionally-related electives.

In the co-op option, students have, in addition to the eight four-month academic terms of study, a maximum of five four-month work terms. The first work term takes place at the end of the fourth semester and work terms 2 – 4 follow the fifth academic semester. Thus, Industry has access to students having different levels of experience after second year and third year. To date, nine students have completed the co-op option and thirteen are currently enrolled in the option.

The Optional Specialization in Management Sciences (OSMS) allows students to gain a solid foundation in management courses, and prepares them for a career in applied science management or for graduate studies in management-related specializations (e.g. MBA).

Medical Physics Program curriculum as shown in the Ryerson 2014/15 Calendar

YEAR 1 Semester 1	**Semester 2**
BLG 143 Biology I	BLG 144 Biology II
CHY 103 General Chemistry I	CHY 113 General Chemistry II
MTH 131 Modern Mathematics I	MTH 231 Modern Mathematics II
PCS 120 Physics I	PCS 130 Physics II
CPS 118 Intro. Programming for Scientists	Liberal Studies Elective (Table A)
SCI 180 Orientation	
YEAR 2 Semester 3	**Semester 4**
MTH 380 Probability and Statistics I	PCS400 Quantum Physics I
MTH 330 Calculus and Geometry	PCS 230 Photonics and Optical Devices
PCS 229 Introduction to Medical Physics	PCS 227 Biophysics
CHY 142 Organic Chemistry I	MTH 430 Dynamic Systems Differential Equations
PCS300 Modern Physics	Liberal Studies Elective (Table A)*
YEAR 3 Semester 5	**Semester 6**
BLG 311 Cell Biology	BLG 700 Anatomy
PCS352 Nuclear Physics/Radiation Protection	PCS 228 Electricity and Magnetism
MTH501 Numerical Analysis I	PCS335 Thermodynamics and Statistical Physics
Liberal Studies Elective (Table A)	PCS 350 Modeling in Medical Physics
Professionally-related Elective (Table I)	Liberal Studies Elective (Table B)
YEAR 4 Semester 7	**Semester 8**
PCS 040A/B Medical Physics Thesis	PCS 040A/B Medical Physics Thesis
PCS 405 Medical Imaging	MTH 820 Image Analysis
BLG 600 Physiology	Professionally-related Elective (Table I)
PCS354 Radiation Biology	Liberal Studies Elective (Table B)
Professionally-related Elective (Table I)	Liberal Studies Elective (Table B)

The first year curriculum is common to the Biology, Chemistry and Undeclared Science programs and establishes the basic fundamentals of scientific knowledge. The three mathematics courses taken in the second year, namely Calculus and Geometry, Probability and Statistics I and Differential Equations, are essential prerequisites for the upper Physics and Mathematics courses. The five Physics/Medical Physics courses taken in the second year, Biophysics, Introduction to Medical Physics, Modern Physics, Quantum Physics I and Photonics and Optical Devices reinforce Learning Outcomes 1 and 3 and introduce Learning Outcomes 2, 4, 6 and 7. The course "Introduction to Medical Physics", offered in the second year, exposes students to multidisciplinary studies in a meaningful manner.

In third and fourth years, Medical Physics students continue to develop expertise and acquire technical skills in fundamental physics areas (Nuclear Physics, Electricity and Magnetism, and Thermodynamics and Statistical Physics), as well as in other sciences that support this interdisciplinary program. Courses, such as Cell Biology, give the students breadth of knowledge and prepare them to learn the material of program courses (which address Learning Outcomes 4, 6 and

7) offered in the last year of the Program such as Radiation Biology, Modeling in Medical Physics, Medical Imaging, Health Physics and Radiation Therapy.

In the fourth year of the program, the PCS40A/B course gives students the opportunity to consolidate and apply what they've learned by undertaking an independent, faculty-supervised research thesis project in an area that interests them. PCS40A/B involves either lab work or theoretical work on a topic in Medical Physics (or related topic). A thesis document and an oral/poster presentation are required to complete this course. Since Fall 2012, a student may petition to have this course replaced by two other courses chosen in consultation with the Program Director. To date only two students have opted out of the thesis work.

Courses to Program Learning Outcomes

The Medical Physics program is truly interdisciplinary and, as such, the Learning Outcomes identified for this program span quite a broad range. In each course one has to balance breadth and depth of knowledge and sometimes the concept of proficiency in a Learning Outcome is difficult to define clearly. In order to maintain consistent input from all physics teaching faculty members, we have agreed on the following definitions for the qualifiers *Introductory*, *Reinforced* and *Proficient*:
Introductory (**I**) refers to basic concepts/skills introduced for the first time in the program,
Reinforced (**R**) refers to either basic concepts/skills covered for a second time at a higher level or medium difficulty concepts/skills introduced for the first time,
Proficient (**P**) refers to medium difficulty concepts/skills either covered for a second time or complex concepts/skills introduced for the first time.

For Learning Outcomes 1.a – f, which are about general knowledge in fundamental areas of Physics, the mapping shows consistency between the progression of levels **I-R-P** and the sequence of the courses with one exception. For Learning Outcome 1a (Mechanics) there is an apparent regression. The two courses PCS400 (Quantum Mechanics I) and PCS335 (Thermodynamics and Statistical Mechanics) address different aspects of mechanics and no doubt quantum mechanics is a harder subject to grasp. Within the limitations of time that an interdisciplinary program such as Medical Physics is constrained, the fundamental areas of Physics are not, and cannot be expected to be, as developed as they would be in a typical Bachelor of Science in Physics program. The Medical Physics program provides a well-balanced set of physics courses when compared to similar programs in Ontario.

Learning Outcomes 2a–d address knowledge in core areas of Medical Physics. For these Learning Outcomes the students reach proficiency level in the elective courses PCS406 and PCS407, if not before, as is the case of Learning Outcomes 2b to 2d. It appears that no course addresses Learning Outcome 2b at the **R** level which is a situation that must be rectified.

Learning Outcomes 3.a–c address knowledge in Chemistry, Biology, Mathematics and Scientific Computing. It is worth mentioning here that we left to the discretion of the faculty members in other Departments at Ryerson to define the **I-R-P** levels for the courses they teach. Thus, it may seem as a discrepancy that, in these professionally-related disciplines, students in fourth year only reach **R**-level. The knowledge in a Biology course that may be considered "**R** level" for a student majoring in Biology can safely be deemed "proficient" for a Medical Physics student.

The introductory and reinforced Biology and Chemistry knowledge is delivered throughout the program, while knowledge of Scientific Computing and Computer Literacy, essential for Medical Physics, is not well integrated into the program. While reviewing the Program Learning Outcomes and generating the program mapping data, the faculty members and the PPR team identified an additional problem underlying Mathematics knowledge (Learning Outcome 3b). Instructors' expectation of Mathematics knowledge (a desirable outcome of the previous mathematics courses in the program) for the upper level medical physics/physics courses is not in line with the students'

actual knowledge. This observation initiated further investigation resulting in identifying a set of mathematics topics that are not included in the Mathematics courses, but are essential for the students' success in the upper year core program courses.

Learning Outcome 4, the ability to apply the methodology of scientific inquiry to the areas of problem solving, analytical/critical thinking, logical reasoning and experimental techniques, is well imbedded in the program, having the expected progression from the introductory to the proficient levels.

Learning Outcome 5a and 5b show an overall consistency between the **I-R-P** levels' progression and the sequence of courses. Instructors in the upper level program courses expressed concern with the students' writing skills, especially evident in the fourth year thesis document required in the thesis course PCS40A/B. This suggests that the program is not achieving a desirable outcome as far as this Learning Outcome is concerned.

Learning Outcomes 6 and 7 show an overall consistency between the **I-R-P** levels progression and the sequence of courses. These Learning Outcomes are not integrated into many program courses and affect students' ability to integrate and synthesize interdisciplinary knowledge obtained in the courses. In line with the issues identified with Learning Outcome 3b above, the students are missing the integration of mathematics and physics knowledge, essential to the Medical Physics program.

Learning Outcome 8 shows an overall consistency between the **I-R-P** levels' progression and the sequence of courses.

Course Prerequisite Structure

The prerequisites are carefully chosen so that the courses taught can rely on previously-acquired knowledge. Whenever a Learning Outcome is reinforced, it is required that a pre-requisite course has introduced it. In particular, upper level Physics courses require knowledge of introductory Physics and Mathematics topics, while the Medical Physics courses, being interdisciplinary in nature, rely not only on fundamental Physics courses but also on the knowledge acquired in Mathematics, Biology, Chemistry and Computing.

Elective Liberal Studies Courses

According to Ryerson policy, students in the Medical Physics program are required to take three lower level and three upper level Liberal Studies courses. Though recognizing that these six Liberal Studies courses give students breadth of knowledge (particularly in the Arts), we recognize that the number of such courses required is somewhat excessive for the Medical Physics Program (which, because of its unique nature, is very interdisciplinary) and comes at the expense of courses more relevant to a degree in Medical Physics. We note that the comparator programs at the University of Windsor and Laurentian University require only a minimum of two and four electives from the Arts, respectively.

Professionally-related Elective Courses

Students in the Medical Physics Program take three professionally-related elective courses (until 2012 only two such courses were required). Currently, students select from eighteen courses distributed as follows:

- Mathematics: 1
- Chemistry: 1
- Computer Science: 3
- Medical Physics/Physics: 6
- Biology: 4
- Biochemistry: 2
- Occupational Health: 1

Other than Medical Physics/Physics courses, the popular choices of professional electives are Probability and Statistics II, Biochemistry and Occupational Health and Safety. These choices signal the importance of these topics for pursuing jobs in the Medical/Health areas. Students who want

to apply to Medical School need to have in their curriculum some specific Biology and Chemistry courses which have been included in the elective PR courses Table with the purpose of addressing such need.

Openness of Physics Courses to Ryerson Students

As part of the Department of Physics Strategic Plan and in line with the University/Faculty Academic Plan, the Department is involved in the teaching of physics and scientific concepts to non-science audiences. Although these courses lie outside of the Medical Physics courses and Program, they are within the expertise of the Department. Besides PCS181 (Fundamentals of Astronomy) which has been successfully running for many years now, two new courses (PCS182 –Life in the Milky Way Galaxy and PCS581 –Advanced Topics in Astronomy) were approved with starting terms of September 2013 and January 2014, respectively. A proposal for a new liberal studies course entitled Physics in the News has been accepted by the Liberal Studies Committee and is due to start in January 2015. Moreover, the Department is considering developing other courses such as: Physics of the Arts, Physics of Music and Sound, Debunking Science Fiction, Physics of the Impossible, and Physics and the Human Body. All courses offered by the Department of Physics are open to students in other programs provided that they have the required pre-requisites.

The Department offers a Minor in Physics which is open to any student (except those in Medical Physics, Biology with Biophysics option and Chemistry with Applied Physics option programs). The Physics Minor targets students in Engineering, Mathematics, and in branches of Science other than Physics (or Science with Physics specializations) who wish to deepen their understanding of physical concepts and acquire problem solving skills which may allow them to diversify in their choice of graduate program or career after graduation.

Minors Taken by Medical Physics Students

Of the three students who opted for a minor in a different discipline, one has already graduated with a minor in Mathematics and two are currently pursuing a minor in Biology and a minor in Mathematics.

Programs Comparable to Ryerson Undergraduate Medical Physics

Six universities offer a Bachelor of Science in Medical Physics degree in Ontario:

- Laurentian University
- University of Windsor
- University of Western Ontario
- University of Ontario Institute of Technology
- McMaster University
- Ryerson University

At Laurentian University, Biomedical Physics is defined as a discipline which integrates the study of human biology with the aspects of physics that apply to health sciences and technology. Three-year (general) and four-year programs (honours) lead to a Bachelor of Science in Biomedical Physics at Laurentian University. These two undergraduate programs have in common the first three years.

The University of Windsor offers an Honors Physics degree with a specialty in Medical Physics. This program requires only three Medical Physics courses, two elective courses in the Arts, one science elective and one elective from any area. This program requires its students to take seven mathematics courses.

The University of Western Ontario offers nine undergraduate programs, majors and minors that are potentially similar to the Medical Physics Program at Ryerson. In their Department of Physics, Faculty of Science, three programs are available: 1) Honors Specialization in Medical Physics, 2) Major in Medical Physics and 3) Specialization in Medical Physics. In their Biomedical Department, within the School of Medicine and Dentistry, the Bachelor of Medical Science (BMSc) degrees with Medical Biophysics concentrations are: 1) Honors Specialization in Medical Biophysics (Clinical Physics Concentration), 2) Honors Specialization in Medical Biophysics (Medical Science Concentration) and 3) Specialization in Medical Biophysics. The Biomedical Department offers

stand-alone degrees in: 1) Honors Specialization in Medical Biophysics (Physical Science Concentration), 2) Major in Medical Biophysics and 3) Minor in Medical Biophysics.

The University of Ontario Institute of Technology offers a Bachelor of Science (Honours) in Health Physics and Radiation Science, a specialized education program in Health Physics. This applied area of Physics has a wide range of applications in many industries, such as nuclear power, non-destructive examinations, health care, agriculture, research, education, environmental protection and the enforcement of government regulations.

After it was revised in 2012, the Honours in Medical Physics at McMaster University is the most similar to Ryerson's Medical Physics program. The McMaster program was the only Medical Physics undergraduate program in the province of Ontario at the time Ryerson launched its own program (2006). The program at McMaster was revised to include more Medical Physics courses (currently 13), lower the number of physics courses (currently 7) and increase the number of elective courses (currently 7), without any requirement for a prescribed number of Arts courses.

Ryerson's Medical Physics Program requires the greatest number of Liberal Arts elective courses. Students at Ryerson are required to take six Liberal Arts courses, compared with only two Arts courses at Windsor and four Humanities or Social Sciences courses at Laurentian. McMaster University's Honours Medical Physics program seems not to impose any requirements on the number of non-science or Arts courses. In our view, the higher number of Liberal Arts courses required at Ryerson impacts negatively on the Medical Physics Program, (an interdisciplinary program by nature), preventing a well-balanced curriculum between the science disciplines supporting Medical Physics and the core courses.

5.b Diversity and Inclusion

The majority of students entering our Program come directly from high school in the GTA. Our student base is diverse and reflects Toronto/Canada demographics. According to the admissions requirements, applicants are only required to have two science courses, and therefore a significant number of Medical Physics freshmen did not take the grade 12 and/or grade 11 Physics in high school. To promote inclusivity and diverse academic background, the teaching and assessment methods planned for the introductory physics courses (PCS120 and PCS130) do not have the expectation that all the students have learned the material previously.

Moreover, many of the courses offered in the Medical Physics Program address different learning styles by using a variety of approaches to teaching and assessment methods. Physics labs and equipment are accessible. Lecture materials and tutorials are made available to students in electronic format; laboratory sessions incorporate experimental hands-on activities, computer- based experiments, and computer data handling, thus exposing students with different backgrounds /experiences or interests to different activities in order to trigger their engagement with the learning process.

The Department of Physics collaborates with the Access Centre to promote inclusion to all students with disabilities who take Physics courses. Faculty and staff are committed to promote an inclusive environment. To address further the important issues of diversity and inclusion the Chair and Program Director meet regularly with Student Union representatives and/or hold Town Hall meetings to get feedback from the student body. The Departmental Council as well as the Undergraduate Affairs Committee has undergraduate student representatives who voice students' concerns and aspirations whether academic or otherwise.

5.c Curriculum and Structure – Undergraduate Degree Level Expectations (UDLES)

The Medical Physics Program conducted a mapping of the Program Learning Outcomes defined for Medical Physics versus the Undergraduate Degree Level Expectations (UDLE) and the courses that address them.

- Program LEARNING OUTCOMES 1, 2, 3, 4, 6 and 7 address the requirements "Depth and Breadth of Knowledge" (UDLE # 1) and "Critical Evaluation of Qualitative and Quantitative Information" (UDLE # 3);
- Program LEARNING OUTCOMES 1, 2 and 4 address "Understanding/Application of the Inquiry Method in the Student's Primary Area of Study" (UDLE # 2);
- Program LEARNING OUTCOMES 4, 5, 6 and 7 address the requirement "Communication Skills" (UDLE # 4);
- Program LEARNING OUTCOMES 1, 2 and 3 address the requisite "Awareness of Limits of Knowledge" (UDLE # 5);
- in general, all LEARNING OUTCOMES but in particular Program LEARNING OUTCOMES 8, address the requirement "Autonomy and Professional Capacity" (UDLE # 6).

5.d Curriculum Development

Changes to the curriculum are initiated by a faculty member(s) or a student(s) at meetings of the Undergraduate Affairs Committee (UAC), a standing committee of Departmental Council. All curriculum revisions have to be approved by Departmental Council before being implemented.

5.e Enrolment in Program Courses

According to the data presented in Figure 5.1, the required Medical Physics Program courses show an increasing class size trend. This trend does not appear in upper level courses' class size, particularly in third and fourth years, likely due to the fact that not all students take the same sequence of courses because either they choose to take electives or because they lack the pre-requisites. The second reason for this trend is that many students from other Science programs select lower level Physics courses as PR elective courses, but do not enroll in the upper level courses due to their academic rigor.

Required Courses	Class Size at end of Year			Required Courses	Class Size at end of Year		
	2010/11	2011/12	2012/13		2010/11	2011/12	2012/13
PCS120	270	342	398	MTH330	83	80	110
PCS130	218	256	313	MTH380	162	172	154
BLG143	410	447	465	MTH430	35	64	78
BLG144	231	258	260	PCS352	14	17	24
MTH131	298	370	430	PCS335	28	28	34
MTH231	231	246	297	PCS350	22	21	14
CHY103	377	263	413	PCS228	24	28	33
CHY113	255	276	282	BLG311	151	165	180
CPS118	276	269	311	BLG600	173	175	53
SCI180	357	383	423	BLG700	119	154	83
PCS300	30	38	49	MTH501	54	56	74
PCS229	39	41	45	PCS405	27	20	18
PCS227	46	49	38	PCS354	55	22	24
PCS230	40	36	43	MTH820	42	56	47
PCS400	62	37	46	PCS40A/B	23	17	16
CHY142	160	187	191				

Figure 5.1 – Class size for all required courses in the Medical Physics program

5.f Relationship to Current Discipline and Profession

All course instructors are PhD professionals who maintain currency in their respective fields. In particular, specialized Medical Physics courses are taught by faculty members who are actively engaged and up-to-date in research in Medical Physics and related fields. In addition, most of the adjunct faculty members in the Department of Physics hold appointments in local hospitals and are engaged as visiting lecturers and supervisors of the fourth-year thesis projects, thus exposing the Program students to the latest advances and trends in clinical Medical Physics.

With Toronto being a well-recognised world research center in Medical Physics, our students are privileged to have the opportunity to learn about the cutting-edge research carried out both at local leading hospitals associated with the Program and in the Department. This opportunity is notably embedded in the courses PCS229 (Introduction to Medical Physics), PCS407 (Radiation Therapy) and PCS406 (Health Physics).

5.f.i Professional Practice

As early as after completion of first year, students in the Medical Physics Program have many opportunities to work with faculty members, graduate students and post-doctoral fellows, in diverse research projects. Paid summer research assistant programs, either internally or externally funded, give Program students the opportunity to be part of a research project either in the Department or in clinical settings.

The advanced fourth-year course, PCS354, is taught by a medical physicist who enables students' access to the hospital facilities where he works full-time. As another example, PCS407 has a lab component through which students may access hospital facilities.

Fourth-year thesis work and directed study courses enhance professional experiential learning. Moreover, many students have asked to be part of our research groups on a volunteer basis, since they see the value of the experience. In these groups, students learn to integrate the different disciplines (Learning Outcomes 4, 6 and 7) and are required to demonstrate social responsibility and professional integrity (Learning Outcome 8). Students engaged in research are encouraged to participate and present at undergraduate conferences, thereby acquiring and practicing communication skills (Learning Outcome 5). All courses stress academic integrity (Learning Outcome 8), while ethical and legal responsibilities in the Medical Physics profession are an integral part of PCS229, PCS407 and PCS406 lectures.

5.f.ii Accreditation

Accreditation of an undergraduate Medical Physics program is not presently available in Canada.

5.g STUDENT ENGAGEMENT

5.g.i Teaching Methods & Innovative or Creative Content or Delivery

The strategic arrangement of lecture, laboratory and/or tutorial modes through the curriculum, as appropriate for each course, is the best approach to deliver conceptual, theoretical and experiential learning to Medical Physics students, while achieving the Program Learning Outcomes and Undergraduate Degree Level Expectations (UDLE). These pedagogical modes of instruction are commonly employed in most science-based programs at Ryerson and in comparator academic universities in Ontario.

Other methods used are concept mapping, films and videos, video analysis, small group discussion, just-in-time teaching, peer instruction supported by the personal response systems (clickers), and online self- tutoring/homework systems.

Generally, introductory course lectures in Years 1 and 2 deliver relevant foundational concepts and theories, explain the theories, and highlight the limitations of commonly employed methods and tools

in the area of instruction. In contrast, course lectures in Years 3 and 4, including most electives, will not only expand on these foundational concepts but will aim to integrate and synthesize models of knowledge, conveying the current state of information in the relevant area and stressing the use of relevant primary literature. All program courses have a lecture component and most of them have a laboratory and/or a tutorial component.

Almost all medical physics, physics and science courses have an online presence through the learning management system where the instructors' postings include lecture and other course-related materials, useful links and announcements. In addition, several of the introductory level science courses make extensive use of online tutoring homework/assignments systems which enable students to learn at their own pace.

The Department of Physics is in the forefront of using research-informed pedagogies supported by the use of appropriate educational technologies to improve the learning outcomes in our courses. Although lecture remains the prevailing teaching mode for large sections of introductory Physics courses for all Science and Engineering programs, various active learning interventions and strategies have been implemented in those courses. Personal Response Systems (clickers) are routinely employed in several large enrollment introductory science courses as well as in some upper year courses. Introductory science courses also use online tutoring and homework systems to improve students' problem-solving skills (UDLE 2).

Many of the upper year Program courses use problem-based learning and stress the importance of synthesizing and evaluating information from different fields of science (UDLE #3). For instance, in the courses PCS352, PCS700 and PCS358 lectures are delivered in a period of three hours during which students have the opportunity to learn new concepts and apply them immediately in problem solving tasks. PCS229, PCS352, and PCS40A/B, among others, require students, following an in-depth scientific literature review, either to write an assignment or to present a research topic to their peers. In these courses students are also introduced to critical reasoning through an assessment of the current scientific literature, to the rules of referencing and citation used in the discipline and to communication to an audience with diverse backgrounds (UDLE 1, 2, 3, 4 and 5). Teaching methods in the upper year courses promote student autonomy (UDLE # 6), the use of different and appropriate approaches to a topic (UDLE # 2), critical thinking and reasoning (UDLE # 2 and 3) and communication skills (UDLE # 4) as well as understanding the limits of knowledge in the discipline (UDLE # 5)

Many of our instructors now use tablets for their lectures. The inking technology allows them to avoid lecturing from static PowerPoint presentations – instead they can solve problems and do derivations in class, in real time, at a pace that suits the students. In many courses, annotated lecture notes are made available to students through the learning management system.

The laboratory format is the second most important mode of delivery in the Medical Physics curriculum. Most year 1 and 2 courses consist of both lecture and laboratory components that are carefully coordinated to complement each other in terms of concepts, theories and methodology. The laboratory format is ideal for experiential learning in the sciences by giving students the opportunity to apply experimental methods, acquire, analyse and interpret scientific data, and understand the concepts of reproducibility, accuracy and the essential role of experimental controls. Laboratories also represent an opportunity for students to practice advanced preparedness, to follow directions and safety guidelines, to acquire data-recording skills, to engage in group collaboration and discussion and develop interpersonal skills. The mandatory laboratory reports are an important avenue for students to acquire written communication skills by translating the knowledge gained in the lab into written form, thus enhancing their abilities in planning, literature research and critical interpretation of data. Laboratory work is a component of eighteen courses throughout the Program and provides students with relevant practical

experiences, thus, reinforcing key concepts, as well as Understanding/Application of the Inquiry Method in the Student's Primary Area of Study (UDLE 2).

In the Fall of 2011, the Department of Physics deployed state-of the-art undergraduate digital equipment, utilizing probes and sensors (with award-winning Vernier's LoggerPro software) that allow students to collect, store and manipulate data in real time,. The new improved procedures for data collection, streaming and storage mean that the students now are able to collect more data and perform more experiments during lab time. Some courses, where appropriate, also use video analysis to record an experiment and then retrieve experimental data from the videos. Overall, the laboratory format is an integral tool to achieve LEARNING OUTCOMES 4 and 8 (UDLE 1 to 6).

The tutorial format (a component of six courses) is selectively employed as a mode of instruction in specific courses to provide a more intimate venue for students to learn, discuss, perform group work and present to their peers using various formats including digital and chalk presentations. The tutorial sessions also provide an opportunity to assess and better guide student progress in PCS352 and PCS335, thus further advancing Depth and Breadth of Knowledge (UDLE 1), Awareness of Limits of Knowledge (UDLE 5) and communication skills (UDLE 4). Thus, the tutorial format is an integral delivery mode that best achieves Learning Outcomes 4, 5 and 8. (ULDE 1 to 6).

5.g.ii Partnerships or Collaborative Agreements

Presently, there are no formal partnerships or collaborative agreements with other teaching institutions or industry groups. Several of our Department's adjunct professors are Medical Physicists from the hospital system (e.g. Sunnybrook, Princess Margaret and St. Michael's), and they offer supervision or co-supervision of some of the fourth-year thesis projects. Clearly, this external thesis supervision offers students the possibility of becoming involved in clinical research projects and benefiting from professional experience in a hospital setting.

In 2012 Ryerson signed an Affiliation Agreement with the University Heath Network (UHN) to support the learning experiences of students enrolled in Ryerson's programs, by providing them with the opportunity to participate in educational experiences at one or more facilities operated by the UHN thus offering the possibility of developing more laboratory experiments and significantly expanding our Program into professional/clinical settings. The Department of Physics will continue to integrate these new opportunities into our Program courses and thesis projects.

The Department of Physics is also actively pursuing an Affiliation Agreement with Sunnybrook Health Sciences Center. Once signed, this agreement will expand the learning experiences of our undergraduate students and provide them with a greater opportunity to work with clinical Medical Physicists and, from them, learn professional, legal and ethical responsibilities.

5.g.iii Experiential Learning Opportunities

Eighteen program courses have a laboratory component which enables students to conduct experiments, share and discuss the observations, reflect on the results and synthesize conclusions in a report. Some of our courses use computer simulations to explore the outcomes of different physical scenarios (PCS120, PCS130, PCS352, and PCS358) and computer modelling is integral to PCS350. Radiation Therapy (PCS407) and Radiation Protection/Health Physics (PCS406) include field trips and field observations.

In 2012, the Department of Physics recognized an opportunity to create an optional extracurricular experiential learning situation for students that is, at the same time, an opportunity for social activity. Headed by a Departmental technologist and mentored by Physics staff and faculty members, a group of students have become part of the so- called "Society of the Awesome". The students in the "Society of the Awesome" collaborate on technical and artistic projects. For

example, in 2012 the group was chosen to participate in Toronto's Nuit Blanche, successfully building an interactive LED installation, called Lightseeds, which invited audience participants to draw colorful etch-a-sketch-like images onto the side of a glass pedestrian bridge. In 2013, the group developed electronic illuminated Rubik's Cubes.

The optimal experiential learning opportunity is the employment experience of a student who selects the co-op option of the Medical Physics Program. In the 2011 National Survey of Student Engagement (NSSE) a greater percentage of students in first year Medical Physics, as compared to FEAS or Ryerson as a whole, stated that they would choose the co-op option because they see it as a valuable experience.

In the fourth-year thesis project, students undertake an independent research project, involving either experimental or theoretical work, which is evaluated by means of an oral and poster presentation as well as a written paper which includes the literature review, materials and methods, results of the research, discussion and conclusion.

Many students in the Medical Physics program have the chance to work as research assistants and be involved in research projects in the Department or in hospital settings.

5.h Student Assessment

The assessment tools in the Medical Physics curriculum consist of standard methods that include the use of examinations (multiple-choice and/or written-format tests and final exams), laboratory reports, essays, literature review, research proposals, oral presentations in various formats, poster presentations, group work and peer-based evaluations. These varied methods are applied, as appropriate, in each required and elective course to ensure student growth and achievement in the core competencies. Medical Physics/Physics course assessment methods are carefully aligned with the teaching methods. All courses have a comprehensive final exam along with one or two midterm tests.

In upper-year courses. group work on projects/presentations is often a component of assessment. In the fourth year, the thesis course (PCS40A/B) teaches the students research skills and assesses them based on the ability to work independently, show diligence, confidence and perseverance, professional capacity, accountability, adherence to deadlines, safe work practices, and ethical and professional management (Learning Outcomes 4 – 8). Students prepare a thesis document, a scientific poster and give an oral presentation (Learning Outcome 5) on their research projects which are assessed by a group of scientists. The mark is based on work-in-progress evaluations at various stages throughout the project.

5.i Student Success and Achievement

The greatest marker of student success and achievement for the Medical Physics program is the successful completion of the fourth year thesis course, PCS40A/B. In UPO Table 4, the fourth year enrollment refers to the number of students who were enrolled in the thesis course, PCS40A/B in the corresponding year, while the graduation count refers to the students graduating in the Spring and Fall convocations of the corresponding year.

UPO Table 4 – Graduation count					
Graduating year	**Fourth year enrollment**	**Graduation count**	**Graduating year**	**Fourth year enrollment**	**Graduation count**
2008	11	6	2011	37	17
2009	37	22	2012	24	12
2010	33	15	2013	47	22

The percentage of students who graduate versus the enrollment in fourth year is around 50%. This is likely due to the fact that many students fail to complete the requirements of the program and need to take the courses for which they lacked pre-requisites. A more aggressive advising method for students to stay on the proper curriculum path is recommended.

Compared to FEAS students and Ryerson as a whole, the number of Medical Physics students in Clear Academic Standing in year 1 is much less but by year 4, it becomes the same. Compared to FEAS students and Ryerson as a whole, the number of Medical Physics students on academic probation is much higher in year I. It evens out with FEAS in years II and III but shows a higher percentage in year IV which raises concern. At the end of 2010-11, no students were required to withdraw in the last two years of the Program.

The Medical Physics program has the third highest mean GPA overall after the Contemporary science and Mathematics programs. When compared to the Science programs and Ryerson overall, the GPA of students upon graduation is higher by 0.13 marks and 0.11, respectively.

The percentage of students with a Clear standing after one year, varies from 48% to 76% depending on the year and this is comparable to the other Science programs (UPO Table 5).

UPO Table 5 - Clear Academic Standing after One Year for Medical Physics Students							
Year	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Medical Physics	58.1	55.2	70.3	76	56.8	48.6	49.6

5.j Variation from GPA Policy

Until July 2012, the Department of Physics was part of the Faculty of Engineering, Science and Architecture (FEAS) and the GPA was determined by the FEAS grading system, which was different from the rest of Ryerson. The transition of the Department to the Faculty of Science (FOS) did not change the GPA scale. As approved by the Ryerson Senate, there is now only one grading system throughout Ryerson and any variation has been eliminated.

5.k Library Resources

The Ryerson Library is well equipped to support the undergraduate Program in Medical Physics through electronic resources access as well as through journals and scholarly sources available via participation in national and provincial sharing consortia. The Interlibrary Loan requests for Physics Journals and filled requests from Physics totalled 30 from May 1, 2011 to April 30, 2012.

Ryerson is a member of two major consortia: the Canadian Research Knowledge Network (CRKN) and the Ontario Council of University Libraries (OCUL). The combined purchasing power of these consortia allows Ryerson to negotiate the licenses for content from most major academic publishers. Moreover, suggestions for purchases from the Department of Physics faculty have always been welcomed and accommodated.

The Library's monograph collection in Physics continues to grow. Approximately 50% of monographs in the collection were published since 2000. Because of continuing base-budget reductions since 2008, there has been a decline in investment in collections.

The Library offers instruction, information and research skills support to the Medical Physics Program with Drop-In Workshops including Mastering the Library's Electronic Resources, Creating Bibliographies with RefWorks and research Seminars where the subject librarian provides instruction related to research methods. Custom Orientation/Workshop sessions are also available by request.

5.l Student Surveys, Focus groups and Graduate Surveys

5.l.i Program Review Student Satisfaction Survey

The standard Ryerson Program Review Student Satisfaction Survey was conducted in Winter 2013 to students in the second, third and fourth years of the Medical Physics Program.

My program is academically challenging:
Second year (strongly agree; agree; disagree; strongly disagree) – 13, 10, 1, 0
Third year (strongly agree; agree; disagree; strongly disagree) – 6, 14, 0, 0
Fourth year (strongly agree; agree; disagree; strongly disagree) – 2, 4, 0, 0

My program provides good preparation for a career:
Second year (strongly agree; agree; disagree; strongly disagree) – 4, 15, 4, 1
Third year (strongly agree; agree; disagree; strongly disagree) – 3, 11, 5, 1
Fourth year (strongly agree; agree; disagree; strongly disagree) – 0, 4, 2, 0

The content of the courses is well organized:
Second year (strongly agree; agree; disagree; strongly disagree) – 4, 17, 2, 1
Third year (strongly agree; agree; disagree; strongly disagree) – 2, 12, 5, 1
Fourth year (strongly agree; agree; disagree; strongly disagree) – 1, 2, 3, 0

Program is of high quality:
Second year (strongly agree; agree; disagree; strongly disagree) – 7, 14, 2, 1
Third year (strongly agree; agree; disagree; strongly disagree) – 2, 15, 2, 1
Fourth year (strongly agree; agree; disagree; strongly disagree) – 1, 4, 1, 0

How manageable is the academic workload? :
Second year (excessively high, manageable, too low) – 5, 18, 0
Third year (excessively high, manageable, too low) – 4, 15, 0
Fourth year (excessively high, manageable, too low) – 2, 4, 1

"*To what extent has your program helped you to improve?*" The partial results corresponding to (a great deal, very much, very little, not at all) are given in parentheses below with the corresponding year depicted as second year / third year / fourth year.

Problem-Solving/Critical Thinking (4,13,6,1,0 / 5,11,4,0,0 / 1,4,1,0,0)
Creativity (3,1,13,7,0 / 1,3,7,3,3 / 0,2,2,0,0)
Written communication (3,4,9,5,3 / 2,5,9,3,0 / 1,1,3,0,1)
Oral communication (3,19,5,5,1 / 1,2,9,6,2 / 0,0,5,0,1)
Research skills (6,7,7,1,2 / 3,5,6,5,1 / 2,2,2,0,0)
Leadership skills (4,1,13,4,2 / 5,5,6,4,0 / 1,2,1,2,0)
Computer proficiency (2,3,6,9,2 / 2,10,0,6,2 / 2,1,1,1,1)
Understanding professional/ethical responsibilities (2,5,10,5,0 / 4,8,5,2,0 / 3,1,1,0,0)
Entrepreneurship (0,2,3,9,9 / 1,2,6,4,7 / 0,0,3,0,3)
Understanding the international content of career field (2,10,6,3,3 / 2,7,3,4,3 / 1,2,2,0,1)
Understanding people with different cultures (2,10,6,3,3 / 1,7,3,4,5 / 1,4,0,0,1)
Developing a broader knowledge of your career field (3,9,9,1,1 / 3,9,4,3,1 / 1,3,1,0,1)
Mastering specific employment related skill/knowledge (2,9,7,4,1 / 3,5,6,6,0 / 1,2,2,0,1)
Working in teams (6,8,8,2,0 / 4,8,6,2,0 / 2,2,2,0,0)
Responding to technological innovations (3,7,9,4,1 / 3,8,5,2,2 / 0,0,2,2,1)

"*How effective is your program in contributing to your learning?*" The partial results corresponding to (very effective, effective, ineffective, very ineffective, not applicable) are given in parentheses below with the corresponding year depicted as second year / third year / fourth year.

Test, examinations, etc. (2, 17, 5, 0, 0 / 2, 14, 2, 1, 0 / 0, 4, 2, 0, 0)
Written assignments (5, 16, 2, 0, 0 / 6, 11, 2, 0, 0 / 1, 3, 2, 0, 0)
Learning materials (3, 16, 4, 0, 0 / 2, 11, 2, 4, 0 / 1, 4, 1, 0, 0)
Classroom instructions (4, 16, 4, 0, 0 / 4, 12, 1, 1, 0 / 1, 5, 0, 0, 0)
Laboratory experiences (9, 9, 5, 1, 0 / 5, 10, 3, 1, 0 / 0, 3, 2, 1, 0)
Studio experiences (2, 2, 12, 0, 18 / 1, 2, 3, 0, 14 / 0, 1, 0, 0, 5)
Experiences with computer based technology (2, 10, 7, 5, 0 / 3, 9, 3, 2, 2 / 2, 0, 1, 3, 0)
Group work (7, 11, 6, 0, 0 / 5, 9, 3, 1, 1 / 0, 5, 0, 1, 0)
Co-op program (3, 4, 7, 1, 10 / 3, 4, 1, 1, 10 / 1, 1, 0, 1, 3)
Print-based library resources (2, 7, 8, 1, 4 / 1, 9, 3, 1, 5 / 2, 1, 0, 0, 3)
Computer-based library resources (4, 14, 4, 0, 1 / 2, 10, 1, 1, 5 / 1, 2, 1, 0, 2)

Student responses to the performance of the instructors in the Program - the partial results corresponding to (strongly agree, agree, disagree and strongly disagree) are given in parentheses below with the corresponding year depicted as second year / third year / fourth year.

Most of my professors are current and knowledgeable in their field (13, 10, 1, 0 / 9, 8, 1, 1 / 2, 3, 1, 0)
Most of my professors are well organized in their teaching (4, 15, 5, 0 / 6, 10, 2, 1 / 2, 2, 2, 0)
Most of my professors are available outside class time to help students (9, 12, 3, 0 / 12, 7, 0, 0 / 4, 2, 1, 0)
Most professors' teaching is intellectually challenging (6, 17, 2, 0 / 8, 9, 2, 0 / 2, 4, 0, 0)
Generally, the teaching I have experienced is of high quality (3, 15, 4, 1 / 6, 10, 3, 1 / 2, 2, 1, 1)
Most of my professors provide useful feedback (4, 13, 4, 2 / 6, 10, 3, 1 / 2, 4, 0, 0)

Student responses to the effectiveness of the Program Department - the partial results corresponding to (very effective, effective, ineffective, very ineffective, not applicable) are given in parentheses below with the corresponding year depicted as second year / third year / fourth year.

Providing helpful academic advising (3, 13, 4, 2, 2 / 6, 6, 3, 0, 4 / 1, 3, 2, 0, 0)
Directing to useful sources (3, 11, 5, 2, 3 / 4, 6, 4, 1, 4 /1, 1, 3, 0, 1)

The percentage of students who said they would recommend the program to others is 83.3% in second year, 95% in third year and 57% in fourth year. This significantly lower recommendation for Medical Physics from students in fourth year may be justified by poor statistics, since only six students in this category responded and one of them was in his fifth year.

5.l.ii Supplementary Survey

At the end of the Winter 2012 term, we administered an informal survey to the then fourth year students who were enrolled in the thesis course and eight students out of 24 responded. The survey consisted of three parts: (1) student learning experience, (2) skills learned, and (3) the top three learning experiences and the top three skills most important to them. The majority of the respondents "Agreed" or "Strongly Agreed" that the learning experience in the Program was worthwhile. Similarly, the majority of students "Agreed" or "Strongly Agreed" that they learned important skills in the Program.

Three out of eight students were neutral in the categories "Class participation being actively encouraged", "The Program has a good balance between theory and practice", "Generally able to enroll in the non- Program-specific courses I wanted", "Lab facilities allowed me to master the use of relevant scientific tools", "Library resources on campus addressed my needs", and "Academic advising within the Program addressed my needs".

Four out of eight students were neutral with respect to "Creative thinking" and "Computing skills". Three out of eight were neutral about "Oral communication", "Critical thinking", "Understanding science-related ethics issues" and "Understanding of health and safety issues".

The responses to *the top three learning experiences and the top three skills* most important to students, could be summarized as follows:
The most important *learning experiences*: Balance of theory and practice, the learning stimulation, critical thinking, written and oral communication skills.

The most important *skills acquired*: Research skills, critical thinking, written and oral communication skills, confidence in their ability to apply scientific knowledge outside classroom and university, ability to apply mathematical knowledge to scientific problems in their field of specialization.

The overall data indicate that the overall experience of the students in the Medical Physics Program is enjoyable and worthwhile. Students find the instructors friendly and helpful and they feel involved in the life of the Department.

5.l.iv Graduate Survey

The survey sent to alumni in 2014, was prepared by the Contemporary Science Program for their program review and adapted to our Program. Unfortunately this survey had a very low response rate, since only nine alumni replied. Of the nine respondents, seven are currently employed, six took less than six months to find employment, and four took less than six months to find a job related to their training in Medical Physics. As for the question "Would you recommend the Medical Physics BSc. Program at Ryerson, five alumni responded "yes without reservation", three responded "yes, but with reservation" and one said "no".

5.l.v Employer Survey

The survey sent to employers was also common to all Science programs. Due to the fact that no employer replied to the survey, we have analyzed the reports of the employers of our co-op students from 2008-09 to 2012. At the end of each work term the employer evaluates the student's work according to Excellent, Good, Satisfactory, Marginal, or Inadequate. There were no rankings as marginal or inadequate.

Summary of co-op employers' evaluations of Medical Physics program							
	Excellent	**Good**	**Satisfactory**		**Excellent**	**Good**	**Satisfactory**
Dependability	11	3		Initiative	6	8	
Interpersonal Behaviour	9	4	1	Planning and	6	7	1
Response to Supervision	14			Ability to Learn	7	6	1
Written Communication	2	12		Quality of Work	9	5	
Verbal Communication	4	10		Creativity	1	12	1
Leadership Qualities	4	8	2	Judgement	7	7	
Adaptation to Formal Organization, Rules, Policies	13	1		Technical Skills	6	8	
Interest in Work	9	4	1	Problem Solving Skills	4	9	1

5.l.6 NSSE report

In the NSSE section on student satisfaction distribution of selected responses that were deemed to be relevant to this review were analysed. Although the number of Medical Physics respondents in fourth year is only five, it is encouraging to note that the "very often" option for "*worked on a paper or project that required* integrating ideas and information from various source" more than doubled from first year to fourth, supporting that Program Learning Outcome 6 (integration of ideas and information from various sources) is being adequately addressed. The percentage increase of those who chose

"often" for "*Talked about career plans with a faculty member or an adviser* "indicated that students feel encouraged to talk about their career plans with faculty members.

NSSE questions about learning experiences regarding memorization, synthesis of material learned, making judgements and applying theories or concepts – it can be concluded that the Medical Physics students' responses are in line with FEAS and Ryerson as a whole and that the Medical Physics Program is successful in fostering the particular learning skills of analysis, judgement, and application of knowledge acquired. The percentage associated with the synthesis of knowledge requires further investigation and improvement.

6. ACADEMIC QUALITY INDICATOR ANALYSIS

6.a Faculty

6.a.i Faculty Qualifications

As of September 2015, the Department of Physics had fifteen full time faculty members teaching courses in the undergraduate Medical Physics Program, supervising 4th year thesis projects and participating in the delivery of the Program through various other activities. Along with this core faculty the Department has many adjunct members (21) from local hospitals and faculty members from other Ryerson Departments (14) participating in the curriculum delivery.

The Program actively extends student experience by engaging more collaborators and professionals in the supervision of thesis projects from such institutions as the Odette Cancer Centre of Sunnybrook Health Sciences Centre and Princess Margaret Cancer Centre.

The Department of Physics faculty complement is providing equal opportunity for female faculty members. This addresses the higher demand for female students in the Medical Physics Program and shows the unusually high female to male ratio for a physics-based undergraduate Program.

6.a.ii. Scholarly, Research and Creative Activities

In the last seven years faculty members pursuing research in Biomedical and Medical Physics have published more than 225 papers in relevant peer reviewed journals, have produced 322 conference presentations and have had 14 patents issued. This research covers most of the spectrum of Medical Physics and Biomedical Physics including:

- novel reconstruction algorithms for computed tomography,
- preclinical micro-CT imaging in rodent models of disease,
- quantification of the amount of trace toxic elements stored in human bone and teeth,
- imaging using ultrasound backscatter techniques,
- functional MRI of the brain and near infrared measurements of oxygen consumption in the brain,
- imaging the electrical properties of tissue,
- optimization of intensity-modulated radiation therapy (IMRT),
- ultrasound targeted drug delivery,
- image-guided HIFU surgery and low-intensity pulsed ultrasound in bone healing,
- modeling infectious diseases within an individual,
- modeling bio-heat transfer, blood flow, and ultrasound scattering.
- ultrasound signal processing and image processing.

In addition, the Department of Physics pursues Physics/Science Education research. The faculty leaders in this research have gained, in a very short time, a national and international reputation for the Department in this area.

6.b Students and Graduates

6.b.i Admission Requirements

In order to be admitted to the Medical Physics Program, students need an Ontario Secondary School Diploma indicating completion of six Grade 12 University courses, including English (ENG4U/EAE4U are the preferred English courses), Advanced Functions (MHF4U) and two of the three following science courses: Biology (SBI4U), Chemistry (SCH4U) or Physics (SPH4U). Thēse requirements are in common with the Biology and Chemistry programs. Physics is strongly encouraged for entry into the Medical Physics Program and recommended for all other Science programs. The admission requirements have not changed since the beginning of the Program in 2006.

Since Medical Physics is a multi/interdisciplinary program, applicants with an aptitude for science and mathematics are expected to succeed better in achieving the Learning Outcomes of the Program. Students entering the Medical Physics Program are not required to have the grade 12 Physics course, which is typically a requirement for the Honours and Major in Physics programs. The admission requirements of Ontario Science programs with a common first year platform are in line with the admission requirements of Ryerson's science programs. The Medical Physics Program is competing with the Science programs rather than with the Honours and Majors in Physics in Ontario. A high student enrollment in Ryerson's Medical Physics Program over the last seven years is attributed to this approach to the admission requirements.

We have undertaken a statistical analysis of our students' academic success in first year courses and concluded that the best predictor of students' success in the program is the high school average rather than individual grades of high school courses.

6.b.ii Student Qualifications

The entering grade average of the students admitted to Medical Physics from 2006/2007 to 2013/2014 is shown in UPO Table 8. While it is evident that the entering grade average is increasing, it is comparable to the other Faculty of Science programs at Ryerson Medical. Physics had marginally higher entering grade averages of Sciences compared to other programs offered by the Faculty.

UPO Table 8 Students' Entrance Averages (%) for the Medical Physics Program from 2006 to 2014

	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Medical Physics	**75.7**	**78.0**	**79.1**	**77.6**	**77.5**	**77.4**	**82.2**	**83.1**
Faculty of Science						77.9	78.3	80.4
Engineering, Architecture and Science	78.5	78.4	79.3	79.8	80.1			

UPO Table 9 indicates the percentage of students admitted to the Medical Physics Program with an average greater than 80%.

UPO Table 9 Percentage of Students Entering with Averages Greater than or Equal to 80%

	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Medical Physics	**22.7**	**30.0**	**44.0**	**26.7**	**27.6**	**23.3**	**36.8**	**29.4**
Faculty of Science						30.9	32.8	51.1
Engineering, Architecture and Science	38.5	36.6	42.8	48.0	48.8			

As the Medical Physics Program became more known, the percentage of students entering the Program with averages greater or equal to 80% increased steadily reaching 44% in 2008-09. Starting in 2009-10 the percentage of highly qualified students dropped and, in subsequent years,

remained in the range of 23% to 37%. When compared with Science programs, Medical Physics attracted fewer students with averages greater than or equal to 80% in this period, except in 2012-13.

6.b.iii Enrolment, Retention and Graduation Data

Since its launch in 2006 the Medical Physics Program has met or exceeded the enrolment targets set by the University. Data regarding retention percentages for students in the Medical Physics Program are recorded in UPO Table 10. It is clear that Medical Physics has the highest retention rates for all indicators when compared to all other Science programs, but lower than for Ryerson in general.

UPO Table 10 – Retention percentages for students in Medical Physics						
Indicator 5d: % retained in same program after one year						
	Fall 2006	**Fall 2007**	**Fall 2008**	**Fall 2009**	**Fall 2010**	**Fall 2011**
Medical Physics	**76.7**	**75.9**	**86.1**	**92.0**	**77.8**	**76**
Faculty of Science					73.5	72
Ryerson University	81.3	82.1	80.0	81.0	82.3	82.1
Indicator 5e: % retained in same program after two years						
	Fall 2006	**Fall 2007**	**Fall 2008**	**Fall 2009**	**Fall 2010**	**Fall 2011**
Medical Physics	**-**	**65.5**	**61.1**	**80.0**	**75**	**No data**
Faculty of Science				66.9	66.3	No data
Ryerson University	81.1	79.4	78.1	80.5	79.9	No data
Indicator 5f: % retained in same program after three years						
	Fall 2006	**Fall 2007**	**Fall 2008**	**Fall 2009**	**Fall 2010**	**Fall 2011**
Medical Physics	**63.3**	**55.2**	**61.1**	**76.0**	**No data**	**No data**
Faculty of Science			56.6	58.3	No data	No data
Ryerson University	71.3	70.3	70.4	69.9	No data	No data

The percentage of students in Medical Physics, who graduated in four years in 2012 (52.6%) is the highest when compared to Biology, Chemistry, Computer Science and Contemporary Science. The average number of years Medical Physics students took to graduate was 4.6 years in 2012, lower than for Chemistry, Computer Science and Contemporary Science, but higher than for the Biology program.

7. RESOURCES

7.a Human Resources

As of September 2015, the Department has sixteen full time faculty members. Two faculty members with expertise in astronomy, and nuclear physics, are the only two remaining members of the initial Physics Planning Group and still active in the Department of Physics. With the departure of a faculty member in 2013, the Program lost expertise in radiation physics/radiation therapy; however a new faculty member with the same expertise was hired 2015. The search to replace another faculty member was also concluded by a hire 2015.

The faculty complement is effective in meeting the Program Learning Outcomes and objectives based on the expertise, but is not adequate to teach all Program courses yearly. Accounting for the future enrolment growth in all science and engineering programs at Ryerson as well as in Medical Physics, one can anticipate that the Department of Physics will need one new faculty member in 2016/17, if not earlier, to support Medical Physics program and Physics courses.

Academic and administrative leadership of the Department of Physics is the responsibility of the Department Chair. An Undergraduate Program Director reports through the Chair to the Dean on all matters related to the management of the undergraduate program and a Co-op Program Director is responsible for the co-op program's related activities and serves as a liaison between the Program and the Ryerson co-op office.

Since 2015, the undergraduate Program, the graduate Program and Physics faculty members have been supported by three administrative assistants. Technical assistance is provided by one computer system administrator, two technologists responsible for undergraduate lab and computer support, and a senior technical officer who coordinates all undergraduate laboratories and technologists. Additional support for the undergraduate 4th year thesis research is provided by one technical officer who oversees research and graduate labs. The existing technical support for undergraduate Physics laboratories is at the maximum capacity or in some cases, insufficient.

The Departmental and Undergraduate Program Council consists of all faculty members as well as representatives from each of the following: staff (1 member), post-doctoral fellows (1 member), and undergraduate students in a ratio of one to four active faculty members.

Teaching Assistants and Graduate Assistants (GAs) have been hired over the years to guide the students in the tutorials and laboratory sessions. Over the past four years, a Graduate Assistant has been assigned to every section of 24 students. They conduct the tutorial sessions, mark all the reports and assignments and assist the students with their laboratory experiments.

Only Graduate Assistants are hired for all undergraduate labs and tutorials. These GAs are all trained to answer questions about the theory demonstrated in the lab or discussed in the tutorials. They also instruct students in the safe and proper use of lab equipment and assist in the interpretation of their experimental results.

Since its start the Medical Physics program established a Program Advisory Committee composed of six members, five of whom are external to Ryerson, (from other academic institutions hospitals and/or industry), and one faculty member from a program at Ryerson who is familiar with our Program's mandate. In 2012, two alumni of the Medical Physics Program were invited to be external Advisory Committee members. The Advisory Committee meets, on average, once per school year.

All faculty members in the Department of Physics are continuously involved in advising the Program's undergraduate students throughout their various semesters of study. In particular, the Department's Chair, the Undergraduate Program Director, the Co-op faculty advisor, and the 4th-year thesis course coordinator are actively involved in advising undergraduate students in various curriculum and career choice and development endeavours.

Due to the specialized nature of the program, in the current curriculum, a large number of courses are predetermined. The curriculum advising is mostly needed for those students who a probationary academic standing or for the choice of the professionally related courses. Moreover, an important role of the academic advising is making sure that students adhere to the official curriculum course sequences. The career choice and development advising is mostly provided to upper-level students who are getting close to graduation, to 4th-year thesis course students, and to co-op students. The counseling on career choices is also imbedded in the curriculum; for example, students are exposed to the Medical Physics career options during the first week of the third semester in PCS229 the "Introduction to Medical Physics" course.

In late 2014, the Faculty of Science acquired its own Career Consultant. To date Medical Physics students have had multiple introductions to this support including visits by the Career Consultant and staff to program courses to discuss career advising and the help available to the students.

7.b Physics and Financial Resources

The Department of Physics is located on the second and third floor of the south east corner of Kerr Hall, part of the main quad building in the center of the Ryerson campus. As of June 2013, rented

space in the adjacent Merchandise Building will accommodate three research laboratories and office space for graduate students.

Due to the extensive collaborations with investigators not only in Toronto but also in other institutes across Ontario, some of the research instrumentation used by students is off campus. For example, our thesis students have dedicated access to laboratories at the Princess Margaret Hospital, St. Michael's Hospital and the Sunnybrook Health Sciences Center.

Since 2011, new faculty members have been assigned less than adequate office space or their offices are in a different building entirely. There are no offices available for visiting professors or scholars.
Other space concerns include:

- Further alterations and improvements to our existing Departmental offices and undergraduate laboratories cannot properly accommodate the ongoing growth trend in student enrollment and faculty complement. New office and undergraduate laboratory space is urgently needed to continue supporting the Medical Physics Program along with the undergraduate and Continuing Education Programs for which the Department of Physics is responsible.
- In order to continue improving the academic quality of our Programs along with upgrading our teaching laboratories, it is important to acquire space that will accommodate specific dedicated experimental setups required in the upper level courses, e.g., an Optics teaching laboratory cannot be used for experiments in Mechanics.
- All computers and the associated sets of interfaces and sensors used in the "dda" experiments (Vernier and Spectrum Tech) have a lifetime estimated as the maximum warranty at the time of purchase. Computers and the associated sets of interfaces and sensors will require replacement no later than 2015.
- The purchase of twelve new experimental setups for The Parallel Plate Capacitor, The Wheatstone Bridge and The Hall Effect experiments offered in PCS228 is requested, which will allow updating the laboratory component for this course as well as supporting the on-going growth in Science enrolment and programs.
- The Department of Physics supports an inventory of over 340 computers for faculty, students, staff, postdoctoral fellows, research assistants and teaching laboratories. In addition there are a number of lab computers for use with research equipment (at last count, 42 computers in eight research labs). There are six computer labs available for administrative, teaching and research purposes. Five of these labs were upgraded in 2010 to support the integration of computers for data acquisition and analysis into our undergraduate program. All machines have similar software applications installed including Logger Pro, Matlab, Maple, Comsol, MS Office, Acrobat Pro. All six computer labs will need to have the computers replaced before September 2015. From 2014 onward there will be increased support costs as the Department will need to repair/replace equipment as it fails.

8. STRENGTHS, WEAKNESSES AND OPPORTUNITIES

With a bold vision in mind for continued growth in high quality career-related undergraduate education in Medical Physics, while driving innovation and supporting economic development in Ontario, the **strengths** of the Medical Physics Program include**:**

1. Program plans and strategies driven by priorities that closely follow those of the University as expressed in Ryerson's Academic Plan.
2. The Medical Physics undergraduate Program is a high quality societally-relevant program, with a well-balanced Science curriculum that achieves all Program and UDLE Learning Outcomes.
3. The Program implements modern teaching technologies, as well as the traditional teaching modes, aimed at maximizing student engagement and student learning, while addressing diverse learning styles.
4. The size of the Medical Physics Program enables a "family-type" relationship between

faculty and students, and also opens up the opportunity for students to join Departmental or hospital research groups.

5. The existing demand for Medical is excellent and could be used as a predictor of future demand.
6. The Program not only meets the planned enrolment targets but regularly exceeds them. The entering grade average is steady in recent years.
7. There is a great demand for the Ryerson Medical Physics program from the female population, which is atypical for physics undergraduate programs in Canada.
8. Since 2009 the Program has shown a steady increase in the total Fall Headcount.
9. Faculty members bring a Medical Physics perspective to the program courses and relevant links to the profession; therefore the expertise of the faculty members is relevant in meeting the program objectives.
10. Existing program collaborations and agreements enable students to have dedicated access to laboratories at the Princess Margaret Hospital, St. Michael's Hospital and the Sunnybrook Health Sciences Center for experiential learning, co-op positions and thesis projects, along with increased exposure to the profession.
11. Student surveys praise the program as effective in delivering high quality program content, providing a manageable academic workload, helping students improve their knowledge, contributing to student learning, and providing a curriculum taught by faculty members who are active and knowledgeable in their respective fields providing helpful academic advising.
12. The NSSE student survey indicates that the Medical Physics Program is successful in fostering important learning skills such as strong analytical ability, good judgment and the application of acquired knowledge.

Some of the **challenges** to the Medical Physics Program include:

1. The instructors' expectation of mathematical knowledge for upper level Medical Physics/Physics courses is not in line with the students' actual knowledge, signaling a discrepancy between the Program Learning Outcomes. This observation initiated further investigation which resulted in identifying a set of mathematical topics that are not included in present Mathematics courses, but are essential for the students' success in upper year core program courses.
2. The number of professionally-related elective courses and the frequency of their availability are a concern, since the comparator programs offer from two to thirteen elective courses. Due to the low faculty complement in the Department of Physics, the PR courses cannot be offered yearly, which further limits students' options.
3. The NSSE student survey points out that the Medical Physics program is not successful in teaching students to synthesize knowledge.
4. The large number of Liberal Studies elective courses (6) is viewed as a weakness of this interdisciplinary program when compared to competitor Ontario programs.
5. An inconsistency in students' writing skills is noted and is especially evidenced in the thesis course (PCS40A/B) in which students write their fourth year thesis document. This inconsistency signals a discrepancy between the Program Learning Outcomes.
6. Knowledge of scientific computing and general computer literacy, essential for Medical Physics, is not well integrated in the Program's curriculum and Learning Outcomes.
7. The percentage of students entering the Medical Physics program with a grade average greater than or equal to 80% is lower than the corresponding ones for Engineering programs and Ryerson as a whole, but comparable to those of other Science programs.
8. The faculty complement is not enough to teach all program courses. The Department of Physics needs a new faculty member in 2016 to support the Medical Physics Program and other Physics courses.
9. The Department of Physics needs an additional technical support staff member in 2015 or 2016 to provide laboratory modules for the Program, as well as labs for all other programs at Ryerson.

10. The Department of Physics space allocation is at its maximum capacity, thus posing a challenge to further enrolment growth and adequate office and research space for faculty members, sessional instructors and TA/GAs.
11. The continuing base-budget reductions since 2008 have caused a decline in the Library collections.

The SWOT analysis provides the following **opportunities** for Program improvement and enhancement:

1. The percentage of third year students who regard the Program content and quality to be low and consider the workload to be light is quite high, indicating the necessity to reposition/add some core courses to the third year of the Program.
2. The program should improve the quality of entering students by requiring grade average greater than or equal to 80%.
3. The program could explore strategies to lower the average time (4.6 years) to complete the Medical Physics degree.
4. Of the six Liberal Studies courses, consider including at least three courses that are of relevance to Science and particularly to the Medical Physics Program's Learning Outcomes. A list of appropriate Liberal Studies courses would be provided to students.
5. Improve the application of mathematical knowledge to Medical Physics/Physics courses by re-evaluating required Mathematics courses and selecting those which contain appropriate content for the Program. Develop lower/upper level Program courses with integrated mathematics and physics content to improve the synthesis of knowledge.
6. Student surveys indicate interest in greater knowledge of fundamental Physics topics. This is an opportunity to create new upper courses and more Program PR courses, thus enabling students to further their education and tailor their careers.
7. Revise the co-op option in Medical Physics to allow more flexible work terms, thus making it more attractive and relevant to potential employers.

Aside from the above-mentioned opportunities, the Program identified potential **threats/challenges/obstacles:**

1. Student interest and retention in the Medical Physics Program could be negatively affected due to the launch of the Biomedical Science Program and existing Biomedical Engineering Program at Ryerson.
2. Medical Physics is vulnerable to course changes in the supporting Science courses, such as Mathematics, Chemistry and Biology courses required/offered in other honours/major programs, which may not take into account our Program-specific needs.
3. The upper year Program laboratories are sparsely equipped due to the ongoing budget cuts and aging equipment. The ongoing budget cuts will definitely impact all undergraduate laboratory experiments supported by computers and the associated sets of interfaces, sensors and equipment that will require replacement no later than in 2015.

9. DEVELOPMENTAL PLAN

Students are asking for a more versatile Program that will give them more options to enter graduate school programs and thus have access to a greater range of employment options. The accreditation of the graduate program in Biomedical Physics, now offered by the Department of Physics (launched in 2013), also requires the applicants to have a stronger Physics background. These issues call not only for an expansion and strengthening of fundamental Physics courses, but also for a restructuring of the curriculum with integrated mathematics-physics content and more professionally-related elective course options. This Periodic Program Review addresses these challenges as the greatest priority for the Program, together with the opportunities presented in Section 8.

1. Curriculum revision, with an increased number of professionally-related elective courses

We have an immediate opportunity to implement three different paths in which skills can be strengthened. The three paths are for students who want to pursue further education and careers in (1) clinically-oriented Medical Physics, (2) Traditional Physics and (3) Computational Medical Physics. We are planning to increase the number of these electives from three to five, offered in the fifth, sixth, seventh and eighth semesters. This increase in the professionally-related electives will provide the opportunity for Program students to plan ahead in the selection of their elective courses, knowing that some of these Physics and Medical Physics courses can only be offered every second year. It is anticipated that the students will require guidance when choosing the courses that will enable them to follow the different educational and career paths, though all will graduate with a BSc degree in Medical Physics.

2. **Integration of Mathematics-Physics Content**

In a multidisciplinary program like the Medical Physics Program, students must be exposed to and acquire skills in many areas (Learning Outcomes 1, 2, 3, 4 and 5). A mathematics background is essential for the program, but the program cannot afford to be inundated with existing Mathematics courses which only partially fulfil the program needs. This could be remedied by either introducing a new mathematics (Linear Algebra) course into the curriculum or by revising one of our Physics courses to include a logical and straightforward presentation of this topic.

This Periodic Program Review has allowed the Program to uncover additional problems concerning the readiness of Program students for the upper level Physics courses. These problems are rooted in the absence of some mathematical topics and/or inadequate math skills and knowledge (Learning Outcome 3b). The ability to integrate and synthesize multi/interdisciplinary knowledge (Learning Outcome 6) is core to the Program and needs to be reinforced. We will be proposing to introduce two new required courses: Mathematical Physics and Mathematical Methods in Medical Physics. To address the identified challenges further, we propose replacing MTH 380 (Probability and Statistics I) in third semester with a new specialized course for the program, PCS 623 (Biostatistics).

The Program and the PPR team believe that this approach to curriculum and course structure will significantly strengthen the vitality of the Medical Physics Program (Learning Outcomes 1 – 6). Besides addressing the identified gaps (challenges 1 and 3), it will also expose students to mathematics as a tool in solving Physics/Medical Physics problems (Learning Outcomes 3b, 6 and 7), and thus better prepare them for the upper year program courses. This is in agreement with the Program's vision of the convergence of knowledge, methods and skills emanating from the basic sciences. These courses will prepare our students for graduate programs in Medical Physics, Biophysics, Physics and related areas. This Learning Outcome is, of course, core to the mission of the Medical Physics Program which strives to equip graduates with skills for careers or post-graduate training and research.

3. Liberal Studies Course Groups of Relevance to Medical Physics Students

To address the high number of Liberal Studies courses in the Program we propose to assist students in their selection of the lower and upper level Liberal Studies courses. Because the Medical Physics students are required to take three lower level and three upper level Liberal Studies courses, these courses ought to support and enforce the Learning Outcomes (as well as UDLES) of the Program.

4. Other Program Challenges and Opportunities

Inconsistences in students' writing skills, especially evident in the fourth-year thesis documents, are identified as a challenge. The improvement in students' writing skills can be achieved by (1) increasing faculty members' awareness of specialized in-class support provided by the Ryerson Library which can be included as part of a course, (2) including essay/report writing in a greater number of core Program courses and (3) advising students to take at least two LS courses that have a significant writing component.

To enhance knowledge of scientific computing and computer literacy, essential knowledge for Medical Physics, the following steps are proposed: (1) integrate more computer- based laboratory experiments, reports and data analysis, (2) structure and require more frequent use of Matlab software in the core Program courses, and (3) offer week-long workshops teaching software packages.

Strategies to attract better quality students into the Medical Physics Program will include, but are not limited to (1) collaboration with the Ryerson recruitment team to develop a plan that promotes the Program as an attractive and competitive Science major with a very good prospect for employment, (2) increased collaboration with the Faculty of Science Outreach Office and the use of high school visits to promote the Program to grade 11 and 12 students, (3) the deployment of the department's expertise in science education to continue fostering collaboration with the Ontario Physics Teachers Association, (4) the promotion of career advancements to high school teachers with emphasis on Medical and Biomedical Physics (5) approaching high school physics and science teachers with materials to advertise the Program.

The number of years a student takes to graduate and retention rates need to be addressed. For that we are proposing to (1) improve the quality of entering students by raising the cut-off percentage, (2) increase enrollment by 5% to 7% which, while keeping the Program's size, will offset the number of students who leave or transfer out after first year, (3) work closely with the Admissions Office to advise on which students are admitted to the Program, (5) add upper year courses to the Spring Transition Program (which currently offers first year courses), to give students the opportunity to complete the necessary pre-requisites to graduate in four years and (6) encourage students to consult with the Program Director on academic issues.

5. Proposed Changes to the Co-op Medical Physics Option

Employers have expressed an interest in possibly hiring co-op students for a longer period than just one semester, while students have experienced difficulty in finding co-op positions as early as after the second year of the Program. In order to have greater flexibility, we are looking to propose four different options for the sequence of academic and work terms for a co-op student in Medical Physics.

6. Resources to Support the Medical Physics Program over the next Two Years

The Chair of the Department of Physics will continue informing the Dean and upper administration that, financed either by the yearly one-time-only funding or other funding opportunities available at Ryerson, the Department of Physics has an acute need for continuous upgrading of outdated laboratory equipment and an increase in faculty members and technical staff. Faculty complement is not enough to teach all program courses; therefore, the addition of one new faculty member in 2016/17 will allow the Program to offer professionally-related courses in Physics more often than every second year, which is presently a challenge. One Program course, PCS724 (Condensed Matter Physics/Materials), has never run, while PCS358 (Mechanics) was offered only once in 2013/14 due to the low faculty complement. To support the addition of the three new core Program courses another new faculty member will be required from 2017/18.

One additional technical staff member is needed, and hiring has been approved in connection with the 2013 launch of the Biomedical Science Program. The existing technical support for undergraduate Physics laboratories is at its maximum capacity or in some cases, insufficient. The Biomedical Science program has been supported by the Department of Physics with the understanding that an additional technical support staff member will be hired in 2014 or 2015. Along with the accreditation of our graduate program in Biomedical Physics in 2013, which required the addition of twenty new laboratory experiments in four graduate courses, the need for this technologist is further magnified to allow the successful continued delivery of Medical Physics, Biomedical Science and all Physics service courses.

The upper year laboratory experiments are sparsely equipped due to the ongoing budget cuts and aged equipment. Immediate resources are needed to upgrade the inadequately-equipped undergraduate experiments for PCS228 (Electricity and Magnetism). Six physics undergraduate laboratories have digital/computer-based equipment (75 desktops), which are used for running multiple experiments and/or for data collection and storage for all Physics course offered by the Department. The computers and the associated sets of interfaces and sensors will require replacement no later than 2015. Regular laboratory equipment maintenance and upgrades are required over the next two years.

With the creation of the new Faculty of Science in 2012, and the hiring of a new Dean with the mandate to secure funding and to work with the upper administration on the advent of a new Science and Innovation Building, all Science programs and Medical Physics are looking forward to the planned expansion. In the meantime, two new faculty offices and undergraduate laboratory space are urgently needed to continue delivering the Medical Physics Program along with the undergraduate, graduate and Continuing Education Programs for which the Department of Physics is responsible. A large common office for sessional and graduate student instructors is also urgently needed because the Department has been seven to ten desks short during the last two academic years.

10. REPORT OF THE PEER REVIEW TEAM (PRT)

Reviewers:

Dr. C. Rangan, Associate Professor and Head Department of Physics, University of Windsor
Dr. D. Fleming, Professor, Physics Department, Mount Allison University
Dr. S. Krishnan, Associate Dean (Research and Development), Faculty of Engineering and Architectural Science, Ryerson University

1. Outline of the visit

The schedule of the PRT's visit shows that the Team met a variety of constituents ranging from University administrators, faculty instructors in the program, staff, students and alumni. We also toured some of the undergraduate teaching labs and research labs, where students in the program do their thesis work. We met with some graduate teaching assistants, who lead the undergraduate laboratories.

2. General Overview

The Medical Physics (B.Sc.) program at Ryerson University provides a student-centered educational environment with strong enrolment trends. The program provides career-specific training and education for future growth into the health professions. The program is relevant to society at large and produces graduates capable of moving into a variety of fields. The curriculum is comprehensive and includes well-organized lab components for many courses. Clinical connections are available and used to good effect within the program. The thesis component for senior students is a commendable part of the Medical Physics program and provides a "capstone" educational experience. An option for co-op placement exists within the program.

Notable strong and creative attributes – The most impressive features of the program are:

- Opportunities for students to engage with real-world medical practitioners via formal partnerships between the Department/University and Hospitals/cancer centers. In particular, the student projects with adjunct faculty at the hospitals provide a high quality learning opportunity where students can apply the content learned in the classroom to real-life problems.
- High-quality experiential training in the laboratories. The quality of equipment and the level of rigour in the experiments are commendable. The newly developed Modular Multipurpose (M4) room provides unique opportunities for integrating laboratory and problem-based learning.
- Research opportunities (both funded and volunteer) for students with faculty that can lead to a thesis.

Strengths, areas for improvement, opportunities for enhancement – In addition to the strengths and creative attributes outlined above, it is notable that the female/male student ratio for the program is typically around 1. This distinguishes the program in a positive way from other Physics undergraduate programs in Canada. Possible areas for improvement include fostering better student engagement and community within the first year of the program. Overall weaknesses have been identified by the PPR self-study document with regard to student command of certain topics in mathematics, scientific computing, and writing skills. Opportunities for enhancement could include program connections with first year students through class components, video links (through web site), or perhaps a program social meeting specific to the first year. The gaps identified in mathematics, computing, and writing point out opportunities for creative restructuring of curriculum.

Recommended specific steps to improve the program – The proposed curriculum revisions suggested by the Program should be advanced and supported by the University. In particular:

- The targeted steps outlined in the PPR document to improve computing and writing skills should be given high priority.
- Changes in the co-op program that introduce more flexibility and placement options for students should be supported by the University. If student uptake of the co-op option does not improve, consideration should be given to its future direction and viability.
- Social programming to introduce specific topics in Medical Physics in year one will attract high-achieving students to the program.
- University investment in the long-term future of the program is encouraged through the steps outlined in Section 5, Summary and Recommendations.

3. Feedback on Evaluation Criteria

3.1 Objectives (alignment with institution's plans)

The B.Sc. Medical Physics program unequivocally aligns with this mission with its aim to educate students who can apply the principles of Physics in medicine and address society's need of improved biomedical technologies and treatment methods due to the aging demographic. The program balances theory in multiple disciplines with application in Radiotherapy, Medical Imaging, and Health Physics. Students are prepared to enter professional programs such as Medical Physics and Medicine, but also pursue quasi professional career tracks such as those of Radiation Therapist, Health Physicist, etc. The program also supports the preparation of students who wish to enter into the Software and Manufacturing industry sectors both as technical experts and as management trainees.

The Program's activities also support the Faculty of Science's academic plan priorities:

- Enhanced Student Success – The Program recognizes the importance of high-school teacher outreach in communicating entry requirements to applicants, and organizes high-school teacher outreach events.
- Enhanced SRC - Students in the Program are encouraged to pursue scholarly activities and research via a number of opportunities such as research projects, theses, and volunteer research. The level of research conducted in conjunction with community organizations such as hospitals and cancer centers is impressive in quality and quantity.
- Increased Outreach and Community Engagement - Students in the Program are engaged in several outreach opportunities such as Science Rendezvous, and Nuit Blanche. In the process, they also gain interdisciplinary knowledge of automation and robotics.

The program requirements are clear. The faculty proposes to strengthen the connection between program requirements and career pathways via streaming and counseling. The learning outcomes for the program as a whole are appropriate, and are aligned with the University's undergraduate degree-level expectations.

The proposed curriculum revisions suggested by the program should be advanced and supported by the university. In addition, the targeted steps outlined in the PPR document to improve computing and writing skills should be given high priority. Changes in the co-op program to introduce more flexibility and placement options for students should be supported by the university. If student uptake of the co-op option does not improve, consideration should be given to its future direction and viability. Finally, university investment in the long-term future of the program is encouraged through the steps outlined below in Section 5, Summary and Recommendations.

3.2 Admission Requirements

The admission requirements are appropriately aligned with the learning outcomes established for completion of the program. The Medical Physics program is truly multidisciplinary, and it attracts students with a breadth of interest in science. While some alumni recommended requiring high-school physics as an admission requirement, students without this preparation do not appear to be disadvantaged. The program proposes to raise the entrance average to 80%, and we support this proposal.

3.3 Curriculum

This program is a truly multidisciplinary program that trains students for technical careers in the health and biomedical section. Towards that end, the curriculum is thoughtfully designed combining didactic knowledge in a variety of disciplines (physics, biology, chemistry, mathematics, etc.) in addition to hands-on, real-life learning opportunities. The Introduction to Medical Physics course that introduces second year students to cutting edge problems is innovative - typically such courses are taught later in the program. Also, the requirement of a thesis course for all students is a creative way of giving all students (rather than an elite few) hands-on opportunities. The program uses a mixture of traditional "chalk and talk" and modern "active learning" methods of delivery. Discussion with alumni and students indicate that this mixed approach is favoured by the students for achieving their learning goals.

3.4 Teaching and Assessment

The methods used to assess student achievement of the program learning outcomes and degree level expectations were deemed to be appropriate and effective. The program learning outcomes for graduates of Medical Physics were presented as Goals 1-8, while the degree level expectations were presented as the Undergraduate Degree Level Expectations (UDLEs 1-6). The mapping of specific program courses and experiences to the Goals and UDLEs was demonstrated effectively. The Introductory/Reinforced/Proficient (I/R/P) qualifiers were helpful in reviewing program learning outcomes. The self-study document effectively identifies some select areas for program improvements, such as greater student exposure to certain mathematical concepts and development of writing skills.

The means of assessment to were found to be appropriate and effective in the students' final year of the program and for the program in general. While as noted above, the self- study document is very effective in its assessment of the program outcomes and expectations, it would be useful to supplement this analysis with a greater level of student feedback through survey mechanisms. The number of students responding to the NSSE 2011 survey was 15 for first year Medical Physics students and 5 for fourth year Medical Physics students. The number of responses to the Ryerson Program Review Student Satisfaction Survey appeared to be slightly better for students in second and third year, but low for students in fourth year. A supplemental informal survey of fourth year students resulted in 8 responses from 24 students. If student survey results are to play a meaningful role in future program reviews, it is recommended that a different mechanism for survey implementation be pursued (such as allocating time each year within a dedicated class or classes for students to complete surveys).

3.5 Resources

The appropriateness and effectiveness of the Medical Physics unit's use of human, physical and financial resources were found to meet or exceed expectations. The faculty and staff are well trained and demonstrate expertise within their fields. The use of innovative human resource arrangements, such as emerging partnerships with local hospitals, is a positive feature. The optimization of the limited laboratory space available is also noteworthy. Physical space allocation is a challenge and could become a greater issue in the future. To some extent this has been mitigated by recent arrangements for new lab space through a local hospital. Financial resources are used well, as available. Overall, commitments by the university to the growth and support of the Medical Physics undergraduate program and the Department of Physics are commendable.

The appropriateness and effectiveness of academic services were judged to be a strong component of the Medical Physics undergraduate program. In particular, the level of commitment toward teaching lab technology was evident through the acquisition of lab experiment equipment, digital acquisition systems (Vernier), and computers. The recently secured commitments to replace computers within the teaching labs, and to acquire replacement equipment for PCS228 (Wheatstone Bridge, Hall Effect, and parallel plate capacitor), are notable. The library resources appear to be adequate for the time being, although reductions in base budget have been noted and these reductions will likely not be sustainable for the long-term without adverse effects. The availability of the co-op option is an important service for students in the Medical Physics undergraduate program at Ryerson, although it appears student uptake of this option has not been particularly strong. Computing facilities and services within the Department of Physics and for the Medical Physics undergraduate program are very strong.

3.6 Quality Indicators

Students in the Medical Physics program are assessed by using standard methods and tools, and those include mid-term/final examinations, reports, laboratory work, presentations, and peer evaluations. In terms of overall student achievements, the data that was presented for 2010-2011 shows that for the first year students, the number of probation students in physics is higher compared to Ryerson as a whole. The proposed increase in the entrance average will probably address this problem. The data also shows that the medical physics students graduate with the highest mean GPA within Faculty of Science. Many students have won prestigious scholarships and awards.

Faculty

All faculty members hold terminal degrees. The research record of faculty members is very good. Most faculty members have active research collaborations with clinicians, and this is very valuable for the interdisciplinary experience of the students. As per 2009-2010 stats, the average value of grants held by Medical Physics faculty members was ~$50,000. Some faculty members are not holding NSERC Discovery Grant, and it is advisable to have a mechanism in place to support them and engage them in research.

Students

Retention rates in the Medical Physics program are best in Faculty of Science but below Ryerson averages. Percentage of students who graduate in four years is 52.6% and this is highest among the Faculty of Science programs (2012 data). Average time to graduate for medical physics program has been 4.6 years and it is slightly higher than the Ryerson average of 4.3 years.

Graduates

Approximately only 50% of the students in the fourth year seem to graduate. Mechanisms and strategies to improve the graduate rates should be in place. The mean GPA of the students graduating from the medical physics program is 3.1, and is the highest among the comparator programs at Ryerson. The employment data that was presented is sparse with only 9 respondents. Among the nine respondents seven are currently employed, and six of them took less than six

months to find employment. The employer satisfaction survey results are typically in the excellent and good range for a wide variety of questions posed in the survey.

3.7 Quality Enhancement

The developmental plan presented by the program addresses a number of strategies to improve the quality of the program, and the associated learning and teaching environment.

4. Other observations

The program is a high-quality, multi-disciplinary program that is thriving and attracting a diverse range of students. The resources are managed well, although we note that space utilization and human resources (faculty members) are at, or have exceeded, capacity. The program maintains a close-knit atmosphere keeping morale amidst the students and faculty high.

5. Summary and Recommendations

1. If student-survey results are to play a meaningful role in future program reviews, it is recommended that a different mechanism for survey implementation be pursued (such as allocating time each year within a dedicated class or classes for students to complete surveys). The survey results presented in the Periodic Program Review (PPR) document did not reflect a high enough participation rate to provide a good picture of overall student opinion.

2. The B.Sc. in Medical Physics at Ryerson University is still a relatively young program. The PPR outlines a number of potential career directions and occupations for program graduates. To this point in the program's brief history, however, it is not yet clear where the majority of graduates are ultimately finding employment. It is recommended that the Department of Physics, possibly in conjunction with Alumni office at Ryerson University, institute a comprehensive plan to connect with senior students prior to graduation and follow up with them after graduation to gain a better understanding of career paths. This information could, in turn, inform future planning within the Medical Physics program.

3. It is noted that six faculty members have left the Department of Physics for other universities over a span of about 10 years. Although the department is fairly large in size, this seems to be a high rate of turnover. The peer review team did not see evidence during the site visit of any possible contributing factors toward this trend, so this may simply be attributable to the very strong credentials of recent faculty hires. The PPR document does note that "since 2011, new faculty members have been assigned less than adequate office space or their offices are in a different building entirely". It is recommended that space allocation be set as a top priority in future hiring processes, with careful attention to the goal of quickly and seamlessly integrating new faculty into the department.

4. It is recommended to proceed with the major curriculum revision proposed by the program. Such a revision will expose students to modern electives, and will also give the students the necessary breath of topics in physics.

5. The quality of student intake needs to be addressed by taking a collaborative approach between the program, Faculty and University outreach and recruitment teams. The retention rates are on the lower side, and this needs to be improved with some dedicated efforts.

6. The program needs to expand professional development opportunities for students and that includes enhancement of opportunities for scientific computing, adequate math preparation, and written and oral communication skills.

7. Because the program is so multidisciplinary in nature, students have already acquired a breadth of knowledge not typically found in traditional programs. The program's suggestion to reduce the

number of liberal studies courses from six to four seems reasonable, as long as there is a mechanism provided for students to learn scientific communication/technical writing skills.

8. The program has described the need for new courses to be developed in conjunction with the above changes. The addition of two faculty members will provide adequate resources to effectively execute these changes that improve the program.

11. PROGRAM RESPONSE TO THE REPORT OF THE PEER REVIEW TEAM (PRT)

The peer review team submitted their formal written report on July 24, 2015. Overall, the review is very positive and supportive of the program recommended curriculum revision as outlined in the Medical Physics self-study document, namely to increase the quality of student intake, to secure requested resources to effectively execute the proposed curriculum changes and to add two faculty members to support the growth and addition of new program courses. In addition, the PRT's concerns relate to a change and/or improvement of the mechanism for student surveys, to the development of a plan to better understand career paths of program graduates, to set space allocation as a top priority in the future hiring process.

The Department of Physics and Medical Physics program is grateful for the detailed and constructive report. In the following we present our summary of the report with a response to the expressed concerns, recommendations and required improvements.

General Overview

The PRT concluded that the 'The program is relevant to society at large and produces graduates capable of moving into a variety of fields. The curriculum is comprehensive and includes well-organized lab components for many courses. Clinical connections are available and used to good effect within the program'. The PRT report states that 'the program is a high-quality, multi-disciplinary program that is thriving and attracting a diverse range of students' and 'the resources are managed well, although we note that space utilization and human resources (faculty members) are at, or have exceeded, capacity.' The PRT report mentions that the notable program features are 'opportunities for students to engage with real-world medical practitioners', and 'high-quality training in the laboratories' which provide "research opportunities for students."

Possible areas for improvements stated in the report are 'fostering better student engagement and community within the first year of the program' and 'weaknesses identified by the PPR self-study document with regard to student command of certain topics in mathematics, scientific computing, and writing skills'.

The recommended steps to improve the Medical Physics program are: 1) the proposed curriculum revisions suggested by the Program should be advanced and supported by the University, 2) the proposed co-op program changes, 3) introduction of Medical Physics topics in the first year courses to attract high-achieving students to the program and 4) University investment in the long-term future of the program is encouraged through the steps outlined in Section 5, Summary and Recommendations of the PRT report.

The PPR team and the program agrees with the stated areas in the PRT report of improvements and recommendations, most of which are suggested in the self-study document, and which are in line with our efforts in implementing and developing strategies to further enhance the Medical Physics program at Ryerson.

Summary and Recommendations:

1. Student-survey results: The PPR team agrees with the comment of the PRT that the results of the student surveys are meaningless due to very low student participation. This was acknowledged in the

self-study document. The PPR team made an effort to collect additional student feedback by developing and administrating an informal in-house survey, which did not significantly improve the student response. It is worth noting this informal survey was conducted in-class, as the PRT report suggests. Note also, that this problem is not unique to the Medical Physics program, and the Department will work with other science Departments and Ryerson to develop new strategies to address this recommendation.

2. Graduate career paths: We agree that the Medical Physics is still a young program and that more data would be beneficial for the next periodic review to better evaluate the societal need. Although program alumni numbers are still small, the program will strengthen its connections with the Alumni office at Ryerson as well as develop tools to collect these data independently in the future.

3. Space allocation: As stated in the self-study document and further reinforced in the PRT report, the Department of Physics and the Faculty of Science recognize that top priority should be given to space allocation consideration in the process of future hiring. The Department will continue working with the Dean and Provost in finding the best solutions, while strongly advocating for a new Science building at Ryerson.

4. The major curriculum revision: The PPR team and the program members of the Department invested a lot of time and effort in developing the curriculum changes proposed in the self-study document. We are very grateful for the unconditional support the PRT report gives to the proposed curriculum changes of the Medical Physics program.

5. Quality of students: As pointed out in the self-study document, we are planning on developing new strategies and collaborative approaches to increase the quality of the incoming students as well as in improving the retention rates, especially in the first year of the program. Some initial approaches are outlined in the self-study document and will be implemented as soon as possible.

6. Professional development opportunities: The need for the enhancement of scientific computing, math preparation, and written and oral communication skills is identified in chapter 8 of the self-study document. We agree with the recommendation to include and/or expand such opportunities in the program. Since there are not any specific suggestions regarding this issue in the PRT report, we understand that the proposed curriculum changes are fully endorsed by the external reviewers as a way to address this recommendation and the PPR team would like to proceed by implementing these changes as soon as possible.

7. The number of liberal studies courses: Based on the multidisciplinary nature of the Medical Physics program, the PRT report recommends lowering the number of Liberal Studies courses from six to four. The PPR team is in favour of this recommendation. We are proposing that two lower level and two upper level Liberal Studies courses be included in the new, proposed Medical Physics curriculum. This could be achieved by removing the two upper level Liberal Studies courses in semesters 7 and 8 and replacing them with two Professionally-Related courses. The lower level Liberal Studies courses offered in semester 3 should be changed to the upper level Liberal Studies course. In this case we are proposing removing the suggested sub-list of the liberal arts courses and allowing the program students to freely choose the lower and upper level Liberal Studies courses.

8. Addition of two faculty members: To implement the proposed Medical Physics curriculum changes (point #4) the Department needs to hire two full time faculty members in the 2016/2017 and 2017/2018 school years. This need is recognised and recommended by the external PRT reviewers as well as described in detail in the self-study documents.

12. DEAN'S RESPONSE (Dr. Imogen Coe)

This document comprises the response of the Dean, according to the directions of the Periodic Program Review Manual, Part II: Peer Review (2014). The site visit by the external Peer Review Team (PRT) for the Program Review for the Bachelor of Science in Medical Physics was conducted in May 2015 and the report received by the Department in July 2015. The response from the Department was submitted to the Dean on August 18th 2015.

1) Overall comments:

The external review is generally very positive about the state of the Medical Physics program and comments/recommendations/observations made by the review team are consistent with those of the self-study. The findings and recommendations in both cases represent an awareness of the opportunities and challenges associated with a new and growing program and the departmental response to external review is positive and forward looking. The Department is well aware of areas that need attention while continuing to build on established strengths.

This is a combined response to 2) Plans and recommendations proposed in the self-study report, 3) Recommendations of the PRT and 4) response by Department since there is a striking consistency across all of these elements.

i) Student-survey results

Our ability to measure student satisfaction though student surveys and conventional approaches continues to be challenged by the very low response rate, particularly in the smaller programs such as Physics. This is a not a problem exclusive to Physics and, as the Department notes, will require additional or alternative strategies to address. It is an on-going challenge across the faculty to improve response rates and obtain meaningful data and we will continue to work on this problem, perhaps by engaging with the course unions or student science society to highlight the value of responses to our future planning.

ii) Graduate Career Paths

The need to clearly present the various career pathways that can be followed after graduation with a degree from the Faculty of Science, at either the undergraduate or graduate level, has been widely recognized and is reflected nationally and internationally in dialogue, debate and initiatives to address the apparent disconnect between graduating students who chose not or are unsuccessful in pursuing a career in academic science (e.g. http://blogs.scientificamerican.com/doing-good-science/careers-not-just-jobs-for-phds-outside-the-academy/).

In late 2014, the Faculty of Science acquired its own Career Consultant, Rebecca Dirnfeld, who is supported centrally and embedded in the faculty, and had split duties with the Faculty of Arts. Very recently (Nov 2015), Rebecca was assigned exclusively to Faculty of Science and thus is now positioned to work on career development, support, career pathways and trajectories, for all undergraduate and graduate students within the Faculty of Science, including Physics. Rebecca has become very familiar with the various programs and is now working closely with Chairs and Program Directors to support career planning and development.

In addition, my office, in conjunction with Dean Jennifer Mactavish, (Yeates School of Graduate Studies) and Caroline Konrad, (Career Centre) have committed funding in support of a pilot project to develop professional skills training and career development programming specifically targeted at graduate students within the Faculty of Science and we believe this will assist all departments towards providing better professional development and multiple career trajectories for their students in all programs.

3. Space allocation:
Space is perhaps the single greatest challenge facing the Faculty of Science as it moves forward – for all programming, undergraduate and graduate and virtually all SRC activities. I have advocated strongly in support of net new space, reallocation of current space and reorganization of space in order to facilitate all activities in Physics. I will continue to work closely with the Chair of the Department of Physics on cataloguing, assessing, assigning and maximizing space allocations and needs. The Department has been fully involved in on-going discussion and decision making around space for the program and faculty and has provided leadership in terms of developing new innovative teaching space. Relocation of occupants of Kerr Hall to the new Health Sciences Building on Church St. (which will not house any Faculty of Science-related programming or faculty) will provide opportunities for more strategic and deliberate space planning, institutionally and divisionally, and we will work to ensure that the Department of Physics is well supported, particularly in its research space requirements, going forward.

4. The major curriculum revision:
The Department of Physics takes curricular innovation very seriously and is a faculty leader in this area. One of the biggest challenges we face continues to be the level of understanding of some basic principles of physics and math by many of our incoming students. Curricular innovation and development continues to be discussed institutionally and, no doubt, new and different approaches may be proposed and adopted. The Faculty of Science is committed to producing well-rounded global citizens who possess a solid and rigorous foundational knowledge in science with an understanding of the way that science permeates every aspect of life and the recognition of the natural synergies between the sciences and the arts and humanities. While new programs would appear to be currently less attractive in terms of ministerial support (with the new SMA and funding formula structures), opportunities for creative joint programming, for example with Laurentian University who also deliver programming in Medical Physics, may provide new avenues of curricular innovation.

There are also institutional barriers to curricular innovation in the Faculty of Science. Issues relating to the number of required Liberal Studies courses are raised in section 7. Moreover, we appear to be unable to recognize student volunteer activities – which are often research-intensive, innovative, experiential and sometimes entrepreneurial, in the form of a Research Practicum, which is widely used at other institutions. Like unpaid internships, student volunteering, particularly in laboratory sciences, is fraught with liability issues, lack of oversight and lack of recognition of work for both the student and the faculty member. A Research Practicum is a formal recognition of some type of activity – usually a research assistant-like, often within a research setting. This Practicum is non-credit and optional but provides a) security for both student and faculty member, b) formal transcript recognition for student work/research and c) provides recognition of the contributions of faculty members (since they would be supervising students enrolled within the Research Practicum course). Institutionally, this type of course appears to be impossible to implement at Ryerson, despite being common at other institutions and despite having very high student satisfaction. We have proposed a structure that will allows us to offer a faculty-wide Research Practicum for all science students who are interested in volunteer activities as an optional non-credit (pass/fail) and will continue to work towards this goal.

5. Quality of students:
The Faculty as a whole has a priority to attract students with stronger backgrounds and basic skills in science and we are working with Admissions to ensure that the criteria for admission are appropriate and rigorous. Incoming averages (proxy indicators for student preparedness) are climbing slowly (from 76.4 in 2006 to 80.4 in 2015) suggesting we are admitting stronger students, there is clearly more to be done to attract and retain students with sound science and math and we will continue to support Physics in its curricular innovations.

6. Professional development opportunities:
There is wide recognition for the need for more professional development for all science students and there are a number of on-going initiatives with the Faculty of Science in all programs, some of which have already been described in this document. The Department of Physics recognizes this and has appropriate plans and ideas for implementation.

7. The number of liberal studies courses
This is a perennial issue for students and faculty in the Faculty of Science. While mandated breadth is a noble endeavor, the reality is that it is not possible to legislate breadth and our observations are that many students will take courses simply to meet the numerical requirement of 6 liberal studies courses for their program, with primary motivations for choice being i) ability to enroll ii) ability to fit into their schedule iii) perceived reputation for being less demanding academically or "easier". We know that most science students are taking liberal studies courses towards the end of their degree programs, because that is when they have the space in their schedules and we also know, anecdotally, that students cannot get into desirable courses since they have capped enrollments. While I am well aware of the issues around potential financial implications for some divisions of reducing the number of required courses for liberal studies for science students, the reality of the situation for our students is that the liberal studies requirements, as they currently stand (and which impact science students considerably more heavily than engineering students) are a barrier to achieving a number of the goals that the Faculty of Science, as a collective, has for all of its students. Mandated breadth and a closer integration of science and arts/humanities is a noble goal – however, I do not believe that the current system achieves either to the level that we should aspire institutionally.

8. Addition of two faculty members
The department is currently approved for a hire of an LTF for the 16/17 academic year and I anticipate that this will lead into a full time faculty hire for 17/18. On the basis of the very strong research record of the department, I have also presented the department with the option of using an external hire for to recruit a highly qualified individual a CIHR CRC Tier 1 (nomination to be submitted in October 2016). The department is considering this option. On-going hiring plans will be subject to the budgetary/enrollment situation of the department and faculty as a whole, as well as factors such as retirement. However, I believe the department is well positioned to be able to recruit more faculty in the future and support this aspiration.

13. SUPPLEMENTARY RESPONSE to Dean Coe's letter dated January 15, 2016 on the Program Review of the Bachelor of Science in Medical Physics.

Dean Coe approved the Periodic Program Review (PPR) report of the BSc in Medical Physics for submission to the Academic Standards Committee and provided her response to the VP Academic and the PPR team on January 15, 2016. Overall, the Dean's review is very positive and supportive of the program's self-study report and the suggested modifications to the Program curriculum. This supplementary response letter is intended to provide some clarification and additional relevant information to the Dean's letter mostly due to the prolonged time associated with this PPR review and some new information included in the Dean's letter.

1. Update of the renewal and upgrade of Physics' laboratory equipment – The Department of Physics would like to extend its gratitude to Dr. Coe, FOS Dean, for providing additional funding to the Department and Program to renew the PCS228 laboratory equipment and to replace and/or update 75 old desktop computers with an additional investment. As of today, all of these upgrades to the Physics undergraduate laboratories are in place and in full use as of the fall 2015 term.

2. Creative joint programming, for example with Laurentian University who also delivers programming in Medical Physics – The Department of Physics and the Medical Physics program are open for creating new undergraduate programs with other Universities. Discussion about a joint

program between Ryerson and Lakehead University has taken place by the upper administration of both Universities during 2015. The Chair and the Assistant Chair of the Department of Physics met with colleagues from Lakehead in July and December of 2015 to discuss this initiative. While many ideas and opportunities were discussed, such a joint program that Dr. Coe's refers to in her letter dated January 15, 2016, was not mentioned in the PPR self-study report, but it is rather a recent development.

It has been suggested that students enrolled in the joint BSc of Physics programs will spend the first three years at Ryerson followed by one year at Lakehead University. It was also discussed that this new program could be based on the existing Medical Physics undergraduate program at Ryerson only if the student enrolment is increased. However, this approach could potentially impact negatively the revenue of the Department. Without a full analysis and support from Ryerson's upper administration on the joint programs, the Department of Physics and the PPR team is not at this time proposing any additional modification of the Medical Physics undergraduate program other than those stipulated in the self-study report and accompanied documentation of the PPR process.

3. Addition of two faculty members – The Department of Physics and PPR team believes it would helpful to clarify some of the information provided in Dean Coe's letter dated January 15, 2016 regarding the hiring of Faculty members. In August of 2015, a full time tenure-track faculty member resigned from her position at the Department of Physics (effective September 1, 2016) to take a faculty position at another University. The knowledge of this resignation was not known at the time of preparation of the self-study report and the external team site visit.

To help the Department to bridge the gap until a tenure-track faculty member is hired as a replacement, the VP, Faculty Affairs and FOS Dean allocated a one-year LFT position (teaching and service) to the Department of Physics for the 2016/2017 school year. The hiring committee is actively working on hiring the LTF RFA member with an anticipated start date of July 1, 2016. The hiring of a full time tenure-track faculty member replacement is expected to be done during the 2016/17 school year, with a start date of August 1, 2017.

As stated in the self-study report we estimate that there is a need for two new faculty members to support the proposed new curriculum of Medical Physics and teaching of Physics courses to other programs. Presently, the faculty complement is not enough to teach all Program courses; therefore, the addition of one new faculty member in 2016/17, other than the replacement discussed above, will allow the Program to offer professionally-related courses more often than every second year, which is presently a challenge. To support the addition of the three new core Program courses, another additional faculty member will be required for 2017/18.

4. A new technical support staff member – With the complexity and length of the PPR process we noticed that our request for one technical support staff member to be hired in 2015/2016 had been overlooked. Our technical staff is working at its maximum capacity supervising and offering laboratories from 8 a.m. to 10 p.m. in the fall and winter terms as well as supporting the growing research and graduate programs at the Department.

We would like to reiterate that due to on-going growth in all undergraduate and graduate courses delivered by the Department of Physics and limited laboratory space, it is crucial that we hire an additional technical support staff member to be added to the existing technical support for Physics laboratories.

In conclusion, the PPR team would like to extend its gratitude to our students, the external peer review team, Dean Coe and members of the Department of Physics for their support, vision and trust during this review process.

14. ASC EVALUATION

The Academic Standards Committee (ASC) assessment of the Periodic Program Review indicated that the review provided a reflective and in-depth analysis of the program. The ASC commended the student projects with adjunct faculty at hospitals, the rigour of the laboratories, the opportunities for integrating laboratory work and problem-based learning, and the research opportunities for students with faculty.

The Academic Standards Committee recommends that the program provide a one-year follow-up report on the status of the initiatives outlined in the Developmental Plan and the Supplementary Response.

The Academic Standards Committee also recommends a two-year follow-up report on the results of a student, alumni, and employer survey. The employer survey could include co-op employers.

Follow-up Report

In keeping with usual practice, the one-year follow-up report which addresses the recommendation stated in the ASC Evaluation Section is to be submitted to the Dean of the Faculty of Science, the Provost and Vice President Academic, and the Vice Provost Academic by the end of June, 2017. The two-year follow up report is due by the end of June, 2018.

Date of next Periodic Program Review

2023 - 2024

Recommendation

- Having satisfied itself of the merit of this proposal, ASC recommends: *That Senate approve the Medical Physics Periodic Program Review, Faculty of Science*

B. CERTIFICATE IN HEALTH SERVICES MANAGEMENT: REVISION OF CERTIFICATE GRADUATION REQUIREMENTS; REPOSITIONING CCMN 279

Description and Rationale

The Certificate in Health Services Management is designed for students who want to complement their professional health background and/or experience with management skills and knowledge enabling them to perform management roles in the health services sector. It is offered by the School of Health Services Management (TRSM) which delivers part-time, Bachelor of Health Administration (BHA) degree completion programs in Health Services Management and Health Information Management. Students may begin taking this Certificate and later transfer to the BHA.

The need for health service management skills is growing as providers and funders struggle to match growing demands with available resources. Effective managers typically bring complementary capabilities to their jobs. Clinically experienced people leverage their background when they acquire management skills and learn about the broader context of their fields. People with experience in other sectors can bring their skills and insights to healthcare when they become more familiar with how that sector works.

The overarching intent of the revisions is to reduce the total Certificate course number from nine (six required, three electives) to seven (five required, two electives). The new graduation requirement is more aligned with most CE Certificates, which can have a six-course graduation requirement. The required course list is also modified slightly, to acknowledge substitutability of financial management courses offered by the School's degree programs. It is necessary to ensure the Certificate is substantive,

providing students with a basic introduction to the healthcare environment and organizations, while allowing them to get breadth or depth through electives. To address the second goal, and to allow flexibility, the elective will list be expanded from seven to fifteen courses.

Current certificate students will be advised that as of Fall 2016, the Ryerson University Senate has approved revisions to the certificate that affect graduation requirements. To move to the revised certificate, students must contact the G Raymond Chang School of Continuing Education. The Chang School will review and assess which courses the student must take to complete the certificate. The assessment will then be forwarded to Academic Advising for final approval.

1. Required course changes: From six to five

CURRENT REQUIRED COURSES (6)	**REVISED REQUIRED COURSES (5)**
CHSM 301 The Healthcare Systems CHSM 305 The Management Cycle CHSM 407 Financial Management **or** CVNU 321 Financial Management CHSM 437 Human Resources Management in Healthcare CLAW 326 Law for Health Managers CCMN 279 Introduction to Professional Communication	CHSM 301 The Healthcare Systems CHSM 305 The Management Cycle CHSM 407 Financial Management **or** CHIM 403 Managerial Accounting & Finance CHSM 437 Human Resources Management in Healthcare CLAW 326 Law for Health Managers

- CCMN *279 Introduction to Professional Communication* is removed from the required course list and placed on the elective list (see below). This repositioning will provide students with choice in their Elective Category, which otherwise would not be available if the Required Category is pegged at six course requirements.
- CVNU 321 Financial Management (for nurses) is removed from the certificate as it is not regularly offered through the Chang School.
- CHIM *403* is added as an alternative to *CHSM 407*. *CHIM 403* and *CHSM 407* are required in the HIM and HSM BHA programs, respectively. They are often used as substitutes because only one, *CHIM 403*, is delivered by distance. The School does not have sufficient student numbers to justify offering both courses for Certificate or Degree students in both in-class and distance formats several times a year. CACC 100 is removed as a prerequisite for CHIM 403 and CHSM 407 since the latter two courses introduce basic accounting principles and apply them in a healthcare context. CHIM 301 (Health Information Analysis) is removed as an pre-requisite for CHIM 403 and CHSM 407 as students can handle CHIM 403 and CHSM 407 without CHIM 301.

This action streamlines administration because course substitutions will no longer be necessary.

2. Revised elective list: Increase elective list from to seven to fourteen

Students in the revised structure will select two electives, down from three. The elective list was previously restricted to seven CHSM (Health Services Management) courses.

REVISED ELECTIVE LIST (Students choose two)	
CACC 100 Introductory Financial Accounting *****	CHSM 306 Management Leadership and Decision-Making
CCMN 279 Introduction to Professional Communication *****	CHSM 307 Health Services Management: Principles of Long Term Care Service Delivery
CHIM 300 Managing Health Information Services *****	CHSM 308 Project Management Long Term Care
CHIM 301 Healthcare Information Analysis *****	CHSM 330 Managerial Epidemiology for Healthcare *****
CHIM 305 Introduction to Health Informatics *****	CHSM 309 Trends in Long Term Care Service Delivery
CHIM 404 Health Economics *	CHSM 310 Institutional Structure
CHIM 408 Statistics for Health Services Managers *****	CHSM 408 Program Planning and Evaluation
	CHSM 417 Research Methodology
Courses added to the elective list are marked with asterisks (*****).	

Recommendation

- Having satisfied itself of the merit of this proposal, ASC recommends: *That Senate approve the Certificate in Health Services Management: Revision of Certificate Graduation Requirements; Repositioning CCMN 279*

C. CERTIFICATE IN HEALTH STUDIES: ADDITION OF HEALTH DATA ANALYTICS STREAM (CHIM 301 AND CHIM 408)

Rationale

The Certificate in Health Studies is designed for students who wish to fill gaps in their health background to achieve professional development and/or transition careers into the health field. The demand for healthcare professionals with data analytical skills is growing in both health-specific and health-related fields, especially with the increase in accountability policies and the requirement of many Health graduate programs that students have courses in this area to be admitted.

Revisions

Effective Fall 2016, two courses will be added that comprise a **Health Data Analytics Stream** within the Certificate as follows:
CHIM 301 Healthcare Information Analysis (Prerequisite(s): CHSM 301)
CHIM 408 Statistics for Health Services Managers

CURRENT **CERTIFICATE IN HEALTH STUDIES**	**REVISED** **CERTIFICATE IN HEALTH STUDIES**
Required Course CHSM 301 The Healthcare Systems	**Required Course** CHSM 301 The Healthcare Systems
Electives (select five) Students select a total of five electives from one or more of the five streams. **Open to all streams** CCMN 279 Introduction to Professional Communication **or** CCMN 314 Professional Presentations	**Electives (select five)** Students select a total of five electives from one or more of the five streams. **Open to all streams** CCMN 279 Introduction to Professional Communication **or** CCMN 314 Professional Presentations
Health Informatics Stream CHIM 305 Introduction to Health Informatics CHIM 306 Healthcare Interoperability CHIM 307 Human-Computer Interfaces in Healthcare CLAW 402 Health Information Access and Privacy	**Health Informatics Stream** CHIM 305 Introduction to Health Informatics CHIM 306 Healthcare Interoperability CHIM 307 Human-Computer Interfaces in Healthcare CLAW 402 Health Information Access and Privacy
Health Services Management Stream CHSM 305 The Management Cycle CHSM 306 Management Leadership and Decision-Making CHSM 330 Managerial Epidemiology for Healthcare CHSM 437 Human Resources Management in Healthcare CKPM 202 Fundamentals of Project Management	**Health Services Management Stream** CHSM 305 The Management Cycle CHSM 306 Management Leadership and Decision-Making CHSM 330 Managerial Epidemiology for Healthcare CHSM 437 Human Resources Management in Healthcare CKPM 202 Fundamentals of Project Management
Health Ethics Stream Students may only select one of CPHL 302 or CPHL 509. CPHL 302 Ethics and Health Care	**Health Ethics Stream** Students may only select one of CPHL 302 or CPHL 509. CPHL 302 Ethics and Health Care

CPHL 334 Ethics in Professional Life CPHL 444 Ethics in Health Services Mgmt CPHL 509 Bioethics CPHL 602 Health Policy: Ethics and Justice	CPHL 334 Ethics in Professional Life CPHL 444 Ethics in Health Services Mgmt CPHL 509 Bioethics CPHL 602 Health Policy: Ethics and Justice
Gerontology Stream CINT 904 Health Promotion and Community Development CVGE 140 Aging and the Individual CVGE 141 Aging and Society	**Gerontology Stream** CINT 904 Health Promotion and Community Development CVGE 140 Aging and the Individual CVGE 141 Aging and Society
Psychology Stream Students may only select one of CPSY 102 or CPSY 105. CPSY 102 Introduction to Psychology I CPSY 105 Perspectives in Psychology CPSY 325 Psychological Disorders CPSY 605 Psychology of Health and Health Care CPSY 607 Drugs and Human Behaviour CPSY 802 Death, Dying and Bereavement CPSY 805 Adjustment, Stress and Coping CPSY 808 Community Psychology	**Psychology Stream** Students may only select one of CPSY 102 or CPSY 105. CPSY 102 Introduction to Psychology I CPSY 105 Perspectives in Psychology CPSY 325 Psychological Disorders CPSY 605 Psychology of Health and Health Care CPSY 607 Drugs and Human Behaviour CPSY 802 Death, Dying and Bereavement CPSY 805 Adjustment, Stress and Coping CPSY 808 Community Psychology
	Health Data Analytics Stream (new) CHIM 301 Healthcare Information Analysis CHIM 408 Statistics for Health Services Managers

Recommendation

- Having satisfied itself of the merit of this proposal, ASC recommends: *That Senate approve the Certificate in Health Studies: Addition of Health Data Analytics Stream (CHIM 301 and CHIM 408)*

D. CERTIFICATE IN INFRASTRUCTURE ASSET MANAGEMENT AND RENEWAL: DISCONTINUATION

The Certificate in Infrastructure Asset Management and Renewal is a certificate program delivered through The Chang School's Engineering, Architecture & Science area. To date there has not been as significant a demand for the certificate compared to the level originally anticipated during course development and none of the courses has run since the certificate's inception in Fall 2012. There are no certificate candidates in the certificate. Approval was granted by Chang School Council on March 18, 2015 to place this certificate "on pause," pending a program review of the certificate. The discontinued curriculum is now part of a proposed Dept. of Civil Engineering Optional Specialization in Infrastructure Management.

The process of reviewing the certificate began in late Spring 2015 and the certificate program review and self-study document have been completed, approved by the certificate's curriculum committee and includes letters of support from the Civil Engineering Chair, the certificate academic coordinator, FEAS Dean and Chang School Dean. The review and self-study document indicate agreement that the certificate be discontinued, commencing in the 2016-17 academic year.

Certificate in Infrastructure Asset Management and Renewal (to be discontinued)
Required Courses
CKAM 100 Infrastructure Asset Management Fundamentals
CKAM 110 Infrastructure Asset Financial Management and Practices
CKAM 120 Engineering Risk Management
CKAM 130 Infrastructure Asset Maintenance, Planning and Scheduling
CKAM 140 Infrastructure Asset Evaluation and Rehabilitation
CKAM 150 Infrastructure Project Evaluation

Recommendation

- Having satisfied itself of the merit of this proposal, ASC recommends: *That Senate approve the Certificate in Infrastructure Asset Management and Renewal: Discontinuation.*

E) *For Information*: CHANG SCHOOL CERTIFICATES (4)

i. Certificate in Robotics and Embedded Systems: Course Deletion; Course Addition
ii. Certificate in Accessibility Practices: AODA and Beyond: Deletion of Elective CSWP 402
iii. Certificate in Community Engagement, Leadership, and Development: Deletion of Elective CPHL 334
iv. Certificate in Graphic Communications: Course Addition; Course Deletion (Elective Category)

F) *For Information*: CHANG SCHOOL COURSE SERIES (6)

i. Course Series: Introduction to Health Data Analytics: new series
ii. Course Series: Leading and Planning for Patient Experience: new series
iii. Course Series: Patient Safety and Nursing Informatics: new series
iv. Chartered Institute of Logistics and Transport (CILT) Course Series: Changes in Course Hours
v. Course Series in Internationally Trained Medical Doctors (ITMD) Bridging Program: In-Class Course and Practicum Placement Hours Addition
vi. Course Series in Science, Technology, Engineering and Math (STEM): Course Deletion

Respectfully Submitted,

Marcia Moshé

Marcia Moshé, Chair for the Committee

ASC Members:
Charmaine Hack, Registrar
John Turtle, Secretary of Senate
Marcia Moshé, Chair and Interim Vice Provost Academic
Denise O'Neil Green, Assistant Vice President/Vice Provost, Equity, Diversity and Inclusion
Anne Marie Singh, Faculty of Arts, Criminology
Kinga Zawada, Faculty of Arts, Languages, Literatures and Cultures
James Nadler, Faculty of Communication & Design, RTA School of Media
Wendy Freeman, Faculty of Communication & Design, School of Professional Communication
Thomas Tenkate, Faculty of Community Services, Occupational and Public Health
Medhat Shehata, Faculty of Engineering and Architectural Science, Civil Engineering
Eric Harley, Faculty of Science, Computer Science
Vadim Bostan, Faculty of Science, Chemistry & Biology
Tina West, Ted Rogers School of Management, Business Management
Jim Tiessen, Ted Rogers School of Management, Health Services Management
Jay Wolofsky, Library
Nenita Elphick, Chang School of Continuing Education
Des Glynn, Chang School of Continuing Education