PHYSICS (from 2020)
Formerly Biomedical Physics

CURRICULUM

Master of Science

DEGREE REQUIREMENTS		**Credits**
Master's Thesis		Milestone
BP8201	Master's Seminar I	Pass/Fail
BP8202	Master's Seminar II	Pass/Fail

PLUS the requirements of ONE of the following fields

BIOMEDICAL PHYSICS

BP8103	Fundamentals of Radiation Physics	1
	OR	
BP8115	Medical Imaging	1
Three elective credits from the Electives List with a minimum of 2 credits from Table A		3

CAMPEP MEDICAL PHYSICS

BP8115	Medical Imaging	1
BP8103	Fundamentals of Radiation Physics	1
BP8104	Radiation Therapy	1
BP8107	Radiation Protection and Dosimetry	1
BP8112	Radiobiology	1
BP8114	Anatomy and Physiology for Medical Physicists	1
AND as required to meet CAMPEP accreditation requirements		
	CAMPEP – Clinical Shadowing	Milestone
	CAMPEP – Radiobiology Bridge	Milestone

COMPLEX SYSTEMS

BP8116	Many-body Theory	1
BP8117	Dynamical Systems	1
BP8118	Complex Networks & Applications	1
One elective credit from the Electives List from either Table A or B		1

Doctor of Philosophy

DEGREE REQUIREMENTS		
Doctoral Candidacy Examination		Milestone
Doctoral Dissertation		Milestone
BP9101	Science Communication	1
BP9201	Doctoral Seminar I	Pass/Fail
BP9202	Doctoral Seminar II	Pass/Fail
BP9203	Doctoral Seminar III	Pass/Fail
BP9204	Doctoral Seminar IV	Pass/Fail

PLUS the requirements of ONE of the following fields

BIOMEDICAL PHYSICS

Two elective credits from the Electives List from either Table A or B	2
If deemed necessary to ensure an adequate background in Biomedical Physics, a student may be required to take either BP8115 or BP8103	1

CAMPEP MEDICAL PHYSICS

Any or All of the following courses not previously taken in the MSc program

BP8115	Medical Imaging	1
BP8103	Fundamentals of Radiation Physics	1
BP8104	Radiation Therapy	1
BP8107	Radiation Protection and Dosimetry	1
BP8112	Radiobiology	1
BP8114	Anatomy and Physiology for Medical Physicists	1

AND as required to meet CAMPEP accreditation requirements

	CAMPEP – Clinical Shadowing	Milestone
	CAMPEP – Radiobiology Bridge	Milestone

COMPLEX SYSTEMS

Two elective credits from the Electives List either Table A or B	2
If deemed necessary to ensure an adequate background in Complex Systems, a student may be required to take up to three of the required courses in the MSc – Complex Systems (BP8116, BP8117, BP8118)	1-3

Elective List		**Credits**
Table A		
BP8103	Fundamentals of Radiation Physics	1
BP8104	Radiation Therapy	1
BP8105	Comp Modeling in Biomed Phys	1
BP8107	Radiation Protection and Dosimetry	1
BP8110	Biomedical Ultrasound	1
BP8115	Medical Imaging	1
BP8116	Many-body Theory	1
BP8117	Dynamical Systems	1
BP8119	Bioclinical Optics and Biophotonics	1
Table B		
BP8101	Stats for the Health Sciences	1
BP8108	Special Topics I	1
BP8109	Special Topics II	1
BP8112	Radiobiology	1
BP8114	Anatomy and Physiology for Med. Phys.	1
BP8118	Complex Networks & Applications	1

Note: with permission from Supervisor and Program Director, Master's and PhD students may use one graduate course from a relevant program in place of one elective credit from Table B.

COURSE LISTING

Doctoral Candidacy Examination
The aim of the candidacy exam is to assess the originality and appropriateness of the proposed research, its relevance to the program, and the students' ability to complete the research and the program. The exam consists of a written and oral component. This is a "Milestone."

Doctoral Dissertation:
Students are required to conduct advanced research in the area of Physics. A specific research topic must be chosen in consultation with the student's supervisor(s) and with advice from the supervisory committee. The student will conduct the research under the direction of the supervisor(s) with guidance from the supervisory committee. In order to complete the course, the student must, upon approval from the supervisory committee, submit a written dissertation to an examination committee, and make an oral presentation and defence of the dissertation to this committee. Through the dissertation, the student must demonstrate an original contribution of new knowledge to the field of research, competence in research and a deep understanding of knowledge in the area of research. This is a "Milestone."

Master's Thesis
This a laboratory-based research project. Students are required to conduct research, submit their completed research in a thesis format to an examination committee, and make an oral presentation and defence of the research thesis and results to this committee. Through the thesis, students are expected to demonstrate competence in oral and written communication, experimental design and scientific thought processes, as well as a sound understanding of the specialty area associated with the research. This is a "Milestone."

CAMPEP -- Clinical Shadowing
Clinical shadowing is designed to give the Medical Physics Option students exposure to the clinical practice of Medical Physics. It is broken up into several components. Each component is supervised by a clinical medical physicist at a regional cancer centre. Students are responsible for contacting the responsible medical physicist to schedule a clinical shadowing session. The course will have a Pass/Fail grade, where a Pass will be assigned based on attendance and participation in all components. This is a "Milestone."

CAMPEP – Radiobiology Bridge
Students who took an anti-requisite of BP8112 will have to complete and pass any components in the CAMPEP accredited version that were missing from the anti-requisite course they took. Other students meet this milestone by virtue to taking BP8112. This is a "Milestone."

BP8101 Stats for the Health Sciences
This course is designed as a first course in biostatistics with emphasis on relevance in biomedical physics applications. Topics include nonparametric statistics, linear regression, errors and structural analysis of linear relationships between variables, nonlinear estimation, survival analysis and multivariate analysis of data. A statistics computer package will be used. 1 Credit

BP8103 Fndmntls of Radiation Physics
This course is designed for students with an undergraduate background in radiation physics. Topics include the Bohr atomic model, Rutherford scattering, emission of photons, x-ray spectra, Bremsstrahlung and characteristic radiation, homogeneous and heterogeneous photon beams, thin and thick x-ray targets, absorption and scatter of photon beams, beam attenuation, Thomson scattering, Photoelectric effect, Rayleigh scattering, Compton effect, pair production, interaction of neutrons with matter, radiation quantities and units, radiation decay, exposure, kerma, dose, and dose equivalent. 1 hour lab/week. 1 Credit

BP8104 Radiation Therapy
This course is an introduction to radiation therapy physics, including topics such as radiation teletherapy units; interaction of radiation with tissue; dosimetry of a single beam of x-ray; beam calibration and patient dose calculation; combination of beams and treatment planning, brachytherapy; radiation detection. Prerequisite: BP8103. 1 hour lab/week. 1 Credit

BP8105 Comp Modeling in Biomed Phys
The course will focus on the use of computational modeling techniques for hypothesis driven investigation of problems in biomedical physics. The student will apply and integrate fundamental knowledge of mathematics, physics and life sciences to design and implement appropriate models and to analyse and interpret simulation results. Emphasis will be placed on simulation methods such as Monte Carlo methods, and finite element and finite difference techniques. 1 Credit

BP8107 Rad Protection and Dosimetry
The course will focus on health physics, radiation safety and radiation protection (shielding). Students will learn the essentials of determining radiation doses from internal and external ionizing radiation sources. A survey of sources, applications, risks and control of environmental radiation will be presented. The final part of the course will review microdosimetry. Prerequisite BP8103 1 hour lab/week. 1 Credit.

BP8108 Special Topics I
This course examines selected topics in areas related to the program that are not covered by existing courses. The topic(s) will vary depending on the needs and interests of the students and the instructor. The course description will be announced prior to scheduling the course. 1 Credit

BP8109 Special Topics II
This course examines selected topics in areas related to the program that are not covered by existing courses. The topic(s) will vary depending on the needs and interests of the students and the instructor. The course description will be announced prior to scheduling the course. 1 Credit

BP8110 Biomedical Ultrasound
This course covers the essential elements in the physics of ultrasound and its current applications in medicine and biology. Topics include: physics of ultrasound, linear and non-linear ultrasound field calculations, scattering of ultrasound, ultrasound transducers, ultrasound imaging systems, Doppler ultrasound, and therapeutic ultrasound. Lec. 3 hrs/w, Lab. 1 hr/w 1 Credit

BP8112 Radiobiology Fundamentals of physics and chemistry of radiation interactions, free radicals, oxidation and reduction. Subcellular and cellular effects: killing, repair, sensitization and protection. Measurement methods. Survival curves and their significance. Modification of the radiation response. Tissue effects, genetic and carcinogenic effects, mutations, hazards. Antirequisite: PCS354. 1 Credit

BP8114 Anatomy and Physiology for Med. Phys
An overview of the structure of the main regions of the human body including the thorax, abdomen, bones, brain and central nervous system. Function of respiratory, circulatory, nervous, digestive, urinary and reproductive systems. Anatomical nomenclature and a radiographic appearance of different body regions will be discussed. 1 Credit

BP8115 Medical Imaging
This course will cover the fundamentals of diagnostic medical imaging, including x-ray radiography, x-ray computed tomography (CT), magnetic resonance imaging, ultrasound, and nuclear medicine imaging. The mathematical models and image reconstruction methods will also be introduced.1 hour lab/week. Antirequisite: BP8113, BP8102. 1 Credit

BP8116 Many-body Theory
This course covers core topics in the study of systems with many degrees of freedom, including network models and out-of-equilibrium phenomena. Topics include a review of thermal equilibrium and partition functions, mean-field theory, Markov processes, the master equation, the Fokker–Planck equation, the Langevin approach, diffusion, random networks, percolation and epidemics, metastability and glassiness, disorder and replicas. 1 Credit.

BP8117 Dynamical Systems
This course is an introduction to the analytical and numerical study of systems whose state changes in time, with an emphasis on qualitative behaviour. Topics to be covered include phase space, invariant sets, linear stability, bifurcations, fractal geometry, and chaos. Concepts will be illustrated first with canonical nonlinear systems in low dimensions including the Henon map, Lorenz equations, Duffing oscillator, etc., to be augmented by numerical studies of high-dimensional nonlinear systems. 1 Credit

BP8118 Complex Networks & Applications
An interdisciplinary introduction to the emerging science of networks and their applications to diverse fields. Topics to be covered include graph theory and topological measures, random network models, the scale-free and small-world properties, community detection, degree correlations, and applications to biology, sociology, technology, and other fields. Students will learn about ongoing research in the field, and ultimately demonstrate what they have learned in a final project in which they conduct a novel analysis of a network data-set of their choosing. 1 Credit.

BP8119 Bioclinical Optics and Biophotonics
This course is designed for learning basic applications of advanced optical technologies in biology and clinics including basics, advanced topics, and clinical/industrial project management skills. The course contains lectures and final individual presentation. 1 Credit

BP8201 Master's Seminar I
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the first year of the program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

BP8202 Master's Seminar II
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the second year of the program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

BP9101 Science Communication
The course is designed for students who are interested in pursuing an academic career as well as those intending to work outside the academic environment after graduating. Specific course goals are to provide graduate students with insight into, and practice in effective means of science communication as well as an awareness of ethical issues in research and professional environments. This will be done through various activities that include writing and reviewing research grant proposals, teaching physics mini-lessons, literature and presentation critiques, manuscript and thesis/dissertation preparation, and oral presentation for a range of audiences (scientist, media, lay audience, school children) and subjects (including research-related and more general topics). This course is suitable for students in other scientific or engineering disciplines. 1 Credit.

BP9201 Doctoral Seminar I
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the first year of the Doctoral Program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

BP9202 Doctoral Seminar II
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the second year of the Doctoral Program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

BP9203 Doctoral Seminar III
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the third year of the Doctoral Program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

BP9204 Doctoral Seminar IV
This course consists of weekly seminars with an emphasis on current research in the specialization fields and emerging areas of physics. This is a two-term course (Fall and Winter) in the fourth year of the Doctoral Program and is generally one hour per week. Presentations will be given by graduate students, faculty members, visiting scholars and guest speakers. Pass/Fail.

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