Imaging Science, PhD (IS)

Requirements

To complete the PhD in Imaging Science, students must do the following:

- Maintain an average grade of B (3.0 grade-point average) for all 72 units (up to 24 graduate units may be transferred with approval)
- Complete courses with no more than one grade below B-
- Complete at least one semester-long research rotation
- Become integrated with a research group
- Pass a qualifying exam
- Successfully defend a thesis proposal
- Present and successfully defend a dissertation
- Complete one mentored teaching experience, including workshops and other related requirements

Courses

Required Core Courses (19 units)

Code	Title	Units
BME 5700	Mathematics of Imaging Science	3
BME 8992	Research Rotation	3
ESE 5130	Large-Scale Optimization for Data Science	3
or BME 5910	Biomedical Optics 1: Principles	
ESE 5200	Probability and Stochastic Processes	3
ESE 5933	Theoretical Imaging Science	3
ESE 5981	Seminar in Imaging Science and Engineering	1
ESE 5970	Practicum in Imaging Science	3
Total Units		**19**

Elective Imaging Courses from any of the Following Categories (at least 12 units):

- Computational Imaging & Theory
- Imaging Sensors & Instrumentation
- Image Formation & Imaging Physics
- Translational Biomedical Imaging
- Medical Physics

Typical Progression of Courses

Course	Fall Units	Spring Units
First Year		
BME 5700 Mathematics of Imaging Science	3	—
ESE 5981 Seminar in Imaging Science and Engineering	1	—
BME 8992 Research Rotation	3	—
Elective	3	—
ESE 5890 Biological Imaging Technology	—	3
Elective or optional second research rotation	—	3
Machine learning elective	—	3
	10	**9**
Second Year		
ESE 5130 Large-Scale Optimization for Data Science	3	—
ESE 5933 Theoretical Imaging Science	3	—
Doctoral research	3	—
ESE 5970 Practicum in Imaging Science	—	3
Elective and/or doctoral research	—	6
	9	**9**

Elective Options

Elective Courses — Computational Imaging & Theory

Code	Title	Units
CSE 4102	Introduction to Artificial Intelligence	3
CSE 5103	Theory of Artificial Intelligence and Machine Learning	3
CSE 5105	Bayesian Methods in Machine Learning	3
CSE 5107	Machine Learning	3
CSE 5109	Advanced Machine Learning	3
CSE 5403	Algorithms for Nonlinear Optimization	3
CSE 5406	Computational Geometry	3
CSE 5504	Geometric Computing for Biomedicine	3
CSE 5509	Computer Vision	3
CSE 5606	High Performance Computer Systems	3
ESE 5230	Information Theory	3
ESE 5240	Detection and Estimation Theory	3

Elective Courses — Image Formation & Imaging Physics

Code	Title	Units
BME 5910	Biomedical Optics I: Principles	3
BME 5940	Ultrasound Imaging	3
BME 5XX	Imaging in Nuclear Medicine (to be developed)	
BME 5XX	Magnetic Resonance Imaging (to be developed)	

Elective Courses — Medical Physics

Code	Title	Units
BME 5070	Radiobiology	3
BME 5075	Radiation Therapy Physics	3

Approved Life Science Courses

Code	Title	Units
BME 5300	Molecular Cell Biology for Engineers	3
BME 5380	Cell Signal Transduction	3
BME 5900	Cellular Neurophysiology	3
BIOL 4040	Laboratory of Neurophysiology	3
BIOL 5068	Fundamentals of Molecular Cell Biology	4
BIOL 5053	Immunobiology I	3
BIOL 5146	Principles and Applications of Biological Imaging	3
BIOL 5147	Contrast Agents for Biological Imaging	3
BIOL 5224	Molecular, Cell and Organ Systems	3
BIOL 5319	Molecular Foundations of Medicine	3
BIOL 5285	Current Topics in Human and Mammalian Genetics	3
BIOL 5352	Developmental Biology	3
BIOL 5480	Nucleic Acids & Protein Biosynthesis	3
BIOL 5488	Genomics	3
BIOL 5651	Neural Systems	3
BIOL 5663	Neurobiology of Disease	2

Approved Mathematics Courses

Any graduate-level course within the Department of Mathematics and Statistics is approved.

Research Rotations

During their first semester, students are required to register for and complete at least one research rotation (3 units) with program faculty mentors. The research rotations allow students to sample different research projects and laboratory working environments before selecting the group in which they will carry out their PhD dissertation research.

A rotation will be chosen in consultation with program faculty and must be mutually agreeable to both the student and the mentor. At the completion of each rotation, the student must submit to the mentor and director a written report approved by the mentor.

Qualifying Exam

The qualifying exam will be administered during the spring of the student's second year of graduate school. The examining committee, which will develop and grade the exam, will consist of three members of the Imaging Science PhD Program Committee. The director of the graduate program will approve the committee, the members of which will be suggested by the student and thesis advisor.

Finding a Thesis Research Mentor

Because the PhD is a research degree, the student is expected to become integrated within a research group. By the end of the first semester of study, students should find a thesis advisor who will oversee their PhD research and assume financial responsibility for their stipend, tuition, health insurance and student fees. The thesis advisor must be a faculty member on the Imaging Science PhD Program Committee with the title of professor, associate professor or assistant professor. Failure to find a research advisor will result in the student being placed on probation. During that time, the student must continue to seek a research advisor. Failure to find a research advisor will lead to dismissal from the PhD program and termination of funding.

Research Presentation/Thesis Proposal

Before the end of their third year, the student will give an oral presentation of their proposed PhD project — with the necessary background to support it — to the Research Advisory Committee. This committee must follow all guidelines for PhD degrees in the McKelvey School of Engineering and consists of five members (the dissertation research mentor plus four other members) with the following requirements:

- No more than three faculty members with primary appointment from any one department;
- Four of the members must be tenured or tenure-track faculty at Washington University;

- Three of the members must be imaging science program faculty members;
- If requested by the research mentor and approved by the co-directors, a sixth member may be added to the committee.

The committee will be chaired by the PhD mentor. At least two weeks prior to the presentation, the student will present a written document outlining the research background, proposed procedures, preliminary results and plans for completion. The required document will typically be between 15 and 30 pages in length, and it must contain a comprehensive bibliography.

The student will be placed on probation if they fail to pass their thesis proposal by the sixth semester. The student will be given a second opportunity to pass the exam during their seventh semester. If the student passes the second exam and meets the other program requirements (e.g., grades), they may continue the program without prejudice. If the student fails the exam a second time, they will be terminated from the PhD program.

Dissertation

The student will prepare a written dissertation for examination by the Research Advisory Committee, now referred to as the Dissertation Defense Committee. The student will defend the dissertation before this committee. Should a member of this committee be unable to participate, the director of the graduate program, in consultation with the Associate Dean, will choose a replacement. If the committee members feel that the dissertation has deficiencies, they may recommend that the candidate address them and send the revised dissertation to the committee members for approval. The committee may also recommend that the candidate present another oral defense of the modified work. The Committee will inform the director of the graduate program, and they will warn the student in writing that the student must submit a revised dissertation and pass the oral defense (if recommended) in order to complete the PhD program. If, after revision and reexamination, the Committee still finds deficiencies and cannot reach unanimous agreement to approve the dissertation, the policy from the Office of the Provost on Dissenting Votes will apply.