INTERDISCIPLINARY STUDIES: SPECIALIZATION IN TRANSLATIONAL BIOENGINEERING (PHD)

Doctor of Philosophy in Interdisciplinary Studies, specialization in Translational Bioengineering

Unit: Graduate School (http://louisville.edu/graduate/) (GI)
Program Webpage (https://louisville.edu/translational-bioengineering/)
Academic Plan Code(s): IS_PHDTBE

Program Information

The Interdisciplinary Studies in Translational Bioengineering (ISSTBE) PhD program is designed to provide multidisciplinary training in translational bioengineering preparing students to lead research and development in academia, industry and governmental agencies and/or to advance bioengineering technologies through start-up companies as entrepreneurs or within established biomedical companies. This program is a collaborative effort between J.B. Speed School of Engineering, the School of Medicine, the School of Dentistry, and the College of Business.

In this PhD program, students will have the opportunity to pursue graduate-level training in one of three tracks:
• Traditional Bioengineering Research
• Clinical Translational Research
• Advancement of Bioengineering Technologies through Entrepreneurship

Students must also choose one of the following concentration areas:
• Bioelectronics and Biomedical Devices
• Bioimaging and Biocomputational Modeling
• Biomechanics and Rehabilitation
• Molecular and Tissue Engineering

Students will initially be assigned an advisor to aid in course selection, to identify a primary research mentor and to choose a laboratory where they will conduct their research. Dissertation committee members will be assembled from participating faculty in the Schools of Engineering, Dentistry or Medicine, or the College of Business, representing opportunities to conduct research within a broad range of bioengineering topics and/or develop technology for a wide variety of clinical applications. Students who successfully complete the program will demonstrate excellence in designing and conducting research leading to an intellectual contribution to the field, demonstrate in-depth knowledge of their concentration area and associated scientific literature, have an understanding of the clinical relevance and ethical implications of their research, have the ability to critically analyze, evaluate and interpret research methods and findings, and have the ability to effectively communicate knowledge of their concentration area.

Admission Requirements

The Graduate School has rigorous standards for admission into doctoral programs, and those standards apply to the ISSTBE PhD program as well.

Applicants must meet Graduate School admission requirements along with additional program requirements.

Applicants must, as a minimum, have completed a bachelor’s degree in Engineering or Medical Physics from an accredited program with a 3.25 cumulative grade point average to be considered for admission. The ideal applicant will have completed a master’s degree in engineering (MS or MEng) at the time of application.

Applicants must submit the following:
1. Graduate Application (http://louisville.edu/graduate/apply/)
2. Official transcripts of all college-level courses
3. Three letters of recommendation
4. A written statement by the applicant describing previous experience related to bioengineering
5. A statement as to how the PhD ISSTBE will allow them to fulfill their career goals as identified by their focus area of interest
6. Official Graduate Record Exam (GRE) verbal, quantitative, and writing assessment-analytical scores. Competitive scores on the verbal and quantitative sections will be required for admission.
7. Students whose native language is non-English or degree is from a non-US accredited institution are required to submit TOEFL scores (administered by the Educational Testing Service). A minimum TOEFL score of 79 or higher on the internet-based test is required. Alternatively, a minimum of 6.5 on the International English Language Testing System will be accepted or a Duolingo score of 105.

Program Requirements

To earn the Doctor of Philosophy in Interdisciplinary Studies with a specialization in Translational Bioengineering (ISSTBE), students are required to successfully complete the following:
• 47 credit hours of course work beyond their bachelor’s degree (18 Core credit hours, nine (9) Concentration credit hours, 20 Specialization credit hours)
• Participate in the Bioengineering Seminar Series (75 percent attendance rate and one presentation/year as a Doctoral Candidate)
• Pass the Preliminary Examination
• Pass the Comprehensive Examination
• Successfully defend a dissertation
• Submit three or more peer-reviewed journal papers representing their original dissertation research

Coursework

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE 601</td>
<td>Bioengineering Seminar</td>
<td></td>
</tr>
<tr>
<td>BE 603</td>
<td>Bioengineering Research Ethics</td>
<td></td>
</tr>
<tr>
<td>BE 621</td>
<td>Bioinstrumentation</td>
<td></td>
</tr>
<tr>
<td>BE 654</td>
<td>Advanced Physiology for Engineers</td>
<td></td>
</tr>
<tr>
<td>BE 695</td>
<td>Bioengineering Research Design &amp; Methods</td>
<td></td>
</tr>
<tr>
<td>ME 565</td>
<td>Advanced Engineering Mathematics I</td>
<td></td>
</tr>
</tbody>
</table>

Concentration Area - nine (9) credit hours in one of the following areas

Molecular and Tissue Engineering
BE 553 Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering

BE 552 Introduction to Tissue Engineering

BE 605 Tissue and Molecular Biology Techniques Laboratory

BE 650 Advanced Biomaterials

BIOC 611 Techniques in Biomolecular Interactions

BIOC 668 Molecular Biology

BIOC 680 Biomolecular Interactions

Bioimaging and Biocomputational Modeling

BE 542 Medical Image Computing

BE 540 Machine Learning in Medicine

BE 685 Modeling of Biological Phenomena

BE 640 Computational Methods for Medical Image Analysis

CSE 622 Simulation and Modeling of Discrete Systems

CSE 627 Digital Image Processing

Bioelectrical and Biomedical Devices

BE 524 LabVIEW for Bioengineers

BE 581 Advanced Computer-Aided Design and Manufacturing for Bioengineers

BE 611 Cardiovascular Dynamics

BE 650 Advanced Biomaterials

BE 683 Artificial Organs

ECE 543 Fundamentals of Microfabrication and MEMS

ME 640 Optimum Design Methods

ME 647 Advanced Design Methods

Biomechanics and Rehabilitation

BE 630 Biomechanical Computer Modeling and Simulation of Human Movement

ME 651 Kinematics and Kinetics of Human Movement

BE 611 Cardiovascular Dynamics

BE 639 Injury Biomechanics

BE 658 Rehabilitation Engineering and Assistive Technology

ME 650 Biofluid Mechanics

ME 652 Advanced Human Biodynamics

ME 638 Computational Methods in Fluid Flow and Heat Transfer

Specialization Area Elective Coursework (see below) 20

Minimum Total Hours 47

Specialization Area Guided Electives

Courses in Specialization must be unique from those taken to fulfill the Concentration Requirement, and must follow either Track A, B or C below. Students must work with their advisor to establish a Plan of Study for Specialization Courses. All Specialization courses must be approved by the student’s advisor prior to registration.

Track A

Traditional Bioengineering Research PhD: 18 credit hours from those listed below with a minimum of six (6) credit hours in engineering courses + Teaching Practicum (two (2) credit hours)

Track B

Clinical-Translation Research PhD: 12 credit hours from list below designated as BIOC, ASNB, PSYC, BIOL, MBIO, OBIO, OBIO or EXP; remaining six (6) credit hours from BE, CECS, ECE, IE, or ME + Clinical Practicum (two (2) credit hours).

Track C

Advancing Bioengineering Technologies through Entrepreneurship PhD: 12 credit hours from list below designated as ENTR or IMBA; remaining six (6) credit hours from BE, CECS, ECE, IE, ME + Teaching Practicum (two (2) credit hours).

Code Title Hours
Guided Electives 20

ASNB 602 Fundamentals of Neuroscience 4

ASNB 614 Molecular Neuroscience 4

ASNB 617 Seminar on Developmental Neurobiology 3

ASNB 671 General and Oral Histology 5

BE 522 Biomedical Acoustics 3

BE 524 LabVIEW for Bioengineers 3

BE 540 Machine Learning in Medicine 3

BE 542 Medical Image Computing 3

BE 552 Introduction to Tissue Engineering 3

BE 553 Nanoscale Bioengineering: Application and Methodology of Nanobiomaterials in Bioengineering 3

BE 581 Advanced Computer-Aided Design and Manufacturing for Bioengineers 3

BE 600 Advanced Topics in Bioengineering 1-6

BE 605 Tissue and Molecular Biology Techniques Laboratory 3

BE 611 Cardiovascular Dynamics 3

BE 630 Biomechanical Computer Modeling and Simulation of Human Movement 3

BE 639 Injury Biomechanics 3

BE 640 Computational Methods for Medical Image Analysis 3

BE 650 Advanced Biomaterials 3

BE 658 Rehabilitation Engineering and Assistive Technology 3

BE 683 Artificial Organs 3

BE 692 Bioengineering Clinical Rotation 2

BE 693 Independent Study in Bioengineering 1-6

BIOC 611 Techniques in Biomolecular Interactions 4

BIOC 645 Advanced Biochemistry I 4

BIOC 668 Molecular Biology 4

BIOC 680 Biomolecular Interactions 2

CSE 535 Introduction to Databases 3

CSE 545 Artificial Intelligence 3

CSE 619 Design and Analysis of Computer Algorithms 3

CSE 622 Simulation and Modeling of Discrete Systems 3

CSE 627 Digital Image Processing 3

CSE 628 Computer Graphics 3

CSE 632 Data Mining 3

CSE 633 Computer Vision 3

CSE 635 Data Mining with Linear Models 3
CSE 660 Introduction to Bioinformatics 3
ECE 520 Digital Signal Processing 3
ECE 521 Digital Signal Processing Laboratory 1
ECE 523 Introduction to Biometrics 3
ECE 543 Fundamentals of Microfabrication and MEMS 3
ECE 544 Microfabrications/MEMS Laboratory 1
ECE 564 Fundamentals of Autonomous Robots 3
ECE 565 Fundamentals of Autonomous Robots Lab 1
ECE 614 Deep Learning 3
ECE 661 Sampled-Data Control Systems 3
ECE 662 Introduction to Optimum Control 3
ECE 676 Foundations of Polymer MEMS 3
ENTR 600 Introduction to Entrepreneurship 3
IE 563 Experimental Design in Engineering 3
IMBA 652 Venture Accelerator I 3
IMBA 654 Venture Accelerator II 3
IMBA 664 Venture Accelerator III 3
MBIO 601 Molecular Microbiology 2
MBIO 602 Immunology 3
MBIO 610 Methods and Analysis in the Biomedical Sciences 2
MBIO 618 Topics in Advanced Microbiology 1-3
ME 566 Advanced Engineering Mathematics II 3
ME 638 Computational Methods in Fluid Flow and Heat Transfer 3
ME 640 Optimum Design Methods 3
ME 647 Advanced Design Methods 3
ME 650 Biofluid Mechanics 3
ME 651 Kinematics and Kinetics of Human Movement 3
ME 652 Advanced Human Biodynamics 3
ME 671 Advanced Fluid Mechanics 3
ME 675 Advanced Topics in Mechanical Engineering 1-6
OBIO 611 Craniofacial Osteology 1-3
OBIO 612 Craniomaxillofacial Diagnostic Imaging 2-4
OBIO 617 Advanced Oral Pathology 1
OIID 604 Oral Microbiology 3

Dissertation Committee
By the end of the first semester, it is expected that the student has identified their Dissertation Chair. The student (under the guidance of his or her advisor) must select a Dissertation Committee of five or more persons, for approval by the Program Director. The committee must consist of the student’s advisor from the Department of Bioengineering (who will act as the Dissertation Committee Chair), at least two additional faculty members from within the Department of Bioengineering, at least one faculty member from a partnering School or College, and at least one additional faculty member from outside the Department of Bioengineering.

Preliminary Examination
The PhD Preliminary Examination will be offered once per year and is to be taken by students upon completion of Core courses (with the exception of Bioengineering Seminar credits) and Concentration Area courses. The Preliminary Examination includes written and oral components. The written portion of the exam gauges student competency in fundamental bioengineering topics covered in their courses. ISSTBE affiliated faculty will submit and grade questions in their respective areas of expertise for the written portion of the Preliminary Examination. The oral portion of the examination is a formal presentation comprised of the student’s critique of a peer-reviewed journal paper selected from the student’s area of concentration, delivered to the ISSTBE Program Director and a subset of faculty with expertise in the respective concentration having Graduate Faculty status. Students are allowed no more than two opportunities to take the Preliminary Examination (oral or written components).

Comprehensive Examination
To qualify for candidacy, students must pass the Preliminary Examination, maintain a minimum GPA of 3.0 and pass the Comprehensive Examination. The Comprehensive Examination requires the student to prepare a written dissertation research proposal (following an external funding agency format) that is presented, defended and approved by their Dissertation Committee. The Dissertation Committee approval constitutes passing both the written and oral portions of the Comprehensive Examination. The written portion is comprised of the student’s dissertation proposal document and the oral portion consists of the student’s presentation and defense of their dissertation proposal, including response to questions posed by their Dissertation Committee. The Dissertation Committee will evaluate written and oral performance on the Comprehensive Examination separately as a Pass, Conditional Pass, or Fail. Students receiving a Conditional Pass must satisfactorily meet conditions set forth by the Dissertation Committee in order to Pass. Students failing either or both portions of the Comprehensive Examination will be permitted to repeat the respective portion(s) once.

Students must meet with their Dissertation Committee at least once per year during the remainder of their PhD program, culminating in the Dissertation Defense.