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UnderGraduate Program Administration

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UNDERGRADUATE ADMINISTRATOR

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CLASS ADVISING

| All Classes | Your Assigned Faculty Advisor | Email List see page 6 | Email for Appointment |

Special Permission Number/Pre-req Override

Please email Undergraduate Administrator or Director with your:

~FULL NAME, RUID#, Class of XXX and COURSE NAME (not Index #)~

Please inform me of any messages during registration such as course is closed, do not have pre-reqs, etc.

Please wait patiently for a response.
Introduction to Biomedical Engineering

The Biomedical Engineering program at Rutgers University was initially established in 1965 as a track within Electrical Engineering, offering M.S. degrees with a Biomedical Engineering emphasis. In 1986, the State of New Jersey formally chartered the Rutgers Department of Biomedical Engineering as an independent entity within the School of Engineering with exclusive responsibility for granting M.S. and Ph.D. degrees in biomedical engineering. The Department developed its graduate programs in collaboration with the University of Medicine and Dentistry of New Jersey (UMDNJ) to provide a strong foundation in the basic biomedical and clinical sciences along with rigorous training in engineering fundamentals. The undergraduate program in Biomedical Engineering was inaugurated in 1991 under the “Applied Sciences’ option within the School of Engineering; a formal undergraduate B.S. degree in BME was approved by the University in 1997 and by the State in 1999.

The achievements of biomedical engineering constantly touch our daily lives. Past and current breakthroughs that were pioneered at Rutgers include: techniques for online analysis and operating room lesioning of brain tissue for Parkinson’s disease; an artificial hand with finger dexterity; the use of virtual reality in the rehabilitation of limbs; revolutionary techniques for making large numbers of new biopolymers for implants; and rapid NMR analysis of protein structure, balloon catheters, and pacemakers.

The BME program currently offers three main curriculum options: 1) biomedical computing, imaging, and instrumentation, 2) biomechanics and rehabilitation engineering, and 3) tissue engineering and molecular bioengineering. The biomedical computing, imaging, and instrumentation provides training in computational approaches, various imaging modalities, bioelectronic device design, and in theoretical modeling related to microscopic and macroscopic biomedical phenomena.

A focus in biomechanics and rehabilitation engineering offers instruction on development of devices for improved human performance. In the tissue engineering and molecular bioengineering, students apply principles of materials science, biochemistry, cell and molecular biology and engineering to design engineered tissues, biomaterials, and molecular medicine, through the pursuit of problems on the cellular, molecular, and nano scale. The broad education provided by these areas allows students to choose from a wide variety of careers. Many graduates work in large corporations and smaller companies as practicing biomedical engineers. Increasing numbers of graduates are finding rewarding jobs in state and federal institutions, including the Patent and Trademark Office and many of the National Laboratories of Advanced Research. The degree program also prepares qualified students for graduate study leading to the M.S. or Ph.D. degrees in biomedical engineering. In addition, students are prepared to meet the graduate entrance requirements for medical and law schools, business administration, and other professional disciplines.

There are several exciting opportunities for conducting research at the Undergraduate level. The Department has recently established a Research Scholars Academy in Biomedical Engineering. Additionally, the department participates in the School of Engineering’s James J. Slade Scholars Research Program. Both selective programs can serve as springboards for highly qualified students to commence work toward the M.S. or Ph.D. degree in the senior year of the undergraduate curriculum.
Biomedical Engineering Mission, Goals, Educational Objectives and Educational Outcomes

Biomedical Engineering Mission Statement
The mission of the BME undergraduate program is to provide students with a broad and flexible education in engineering and biological science as well as medically related subjects. The students are prepared to analyze, synthesize, and link knowledge in the multi-disciplinary fields, with the emphasis on quantitative approaches and methods. The students will be integral part of the society to improve the understanding and control of biological processes towards improving human health. Our curriculum guides our students toward skill in creating new knowledge and technologies as well as applying current knowledge.

Rutgers Mission & Vision Statements are published at http://studentaffairs.rutgers.edu/about/us/mission-statement

Mission of the School of Engineering:
The School of Engineering Mission Statement was revised and ratified by the faculty on October 7, 2011. The mission statement is as follows.

- To educate and train the future engineers of a complex, diverse, and global workplace
- Provide high quality, relevant education programs to undergraduate and graduate students using the latest technology and education techniques
- To conduct state-of-the-art research that embraces technology to address societal challenges of a multifaceted United States and a globally connected world
- Create an environment to encourage and assist faculty to become leaders in their fields, and to further gain national and international recognition
- Conduct cutting-edge research in strategically important engineering areas
- To serve as a resource to local, New Jersey, and regional stakeholders in advancing the public’s interest
- Promote economic development through technology, entrepreneurship, and innovation

The mission statement is published at: http://www.soec.rutgers.edu/administration

Program Educational Objectives (PEOs)
The BME program educational objectives (PEO) are consistent with the mission of Rutgers University and with the overall mission of the School of Engineering stated above. These objectives were modified and ratified by the faculty on April 12, 2012. The University mission and aims of the school are printed in the Undergraduate Catalog for the School of Engineering, read by prospective students, and entering freshmen. The educational objectives of the Biomedical Engineering Program are to educate students to attain the following:

1. To establish themselves as practicing professionals in biomedical or biotechnology industries or engage themselves in advance study in biomedical engineering or a related field.
2. To make positive contributions in biomedical industries and/or other sectors.
3. To demonstrate their ability to work successfully as a member of a professional team and function effectively as responsible professionals.

The BME mission statement and PEOs are available to the public at the departmental Web page, http://www.bme.rutgers.edu/content/educationABET.php. Also, note that one change has been made to the educational objectives since the last ABET visit. The change was a rewording of the objectives to make them consistent with the most recent ABET definition of Program Educational Objectives, although the sense of the objectives is unchanged.

Student Outcomes (SOs)
The student outcomes were adapted in the according to ABET guidelines. Therefore, each Biomedical Engineering student will demonstrate the following attributes by the time they graduate:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The student outcomes were established with the goal that they must be compatible with the program educational objectives and the mission of the School and University. Furthermore, the outcomes should be measurable, in the sense that our success in achieving them can be quantified. The BME student outcomes are available to the public at the departmental Web page, http://www.bme.rutgers.edu/content/educationABET.php.
# BME Faculty/Staff Locator

**Phone:** 848-445-4500  *  Fax: 732-445-3753

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Phone</th>
<th>Room</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Androulakis, Ioannis</td>
<td>848 445 6561</td>
<td>212</td>
<td><a href="mailto:yannis@soe.rutgers.edu">yannis@soe.rutgers.edu</a></td>
</tr>
<tr>
<td>Berthiaume, Francois</td>
<td>848 445 6566</td>
<td>217</td>
<td><a href="mailto:fberthia@soe.rutgers.edu">fberthia@soe.rutgers.edu</a></td>
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<tr>
<td>Boustany, Nada</td>
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<td><a href="mailto:nboustan@soe.rutgers.edu">nboustan@soe.rutgers.edu</a></td>
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<tr>
<td>Buettner, Helen</td>
<td>848 445 6597</td>
<td>318</td>
<td><a href="mailto:buettner@soe.rutgers.edu">buettner@soe.rutgers.edu</a></td>
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<tr>
<td>Cai, Li</td>
<td>848 445 6559</td>
<td>208</td>
<td><a href="mailto:lcai@soe.rutgers.edu">lcai@soe.rutgers.edu</a></td>
</tr>
<tr>
<td>Drzewiecki, Gary</td>
<td>848 445 6688</td>
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<td><a href="mailto:garydrz@soe.rutgers.edu">garydrz@soe.rutgers.edu</a></td>
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<td>Freeman, Joseph</td>
<td>848 445 6595</td>
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<tr>
<td>Gormley, Adam</td>
<td>848 445 6569</td>
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<td><a href="mailto:adam.gormley@rutgers.edu">adam.gormley@rutgers.edu</a></td>
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<tr>
<td>Labazzo, Kristen - UGD</td>
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<td><a href="mailto:sakala@soe.rutgers.edu">sakala@soe.rutgers.edu</a></td>
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<tr>
<td>Li, John K-J</td>
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<tr>
<td>Moghe, Prabhas</td>
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<td>315</td>
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<td>Parekkadan, Biju</td>
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<tr>
<td>Pierce, Mark</td>
<td>848 445 6570</td>
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<td>Roth, Charles</td>
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<tr>
<td>Schloss, Rene</td>
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<tr>
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<td><a href="mailto:shinbrot@soemail.rutgers.edu">shinbrot@soemail.rutgers.edu</a></td>
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<td>Shoane, George</td>
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<td>Shreiber, David</td>
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<td>Sy, Jay</td>
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<td><a href="mailto:js2191@soe.rutgers.edu">js2191@soe.rutgers.edu</a></td>
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<td>Yarmush, Martin</td>
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## Staff

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<td>Johnson, Linda L.</td>
<td>848 445 6869</td>
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## Basic Curriculum

### Department of Biomedical Engineering

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Total 15

Minimum number of credits required ..... BME Degree Credits: 129

- Organic Chemistry is required for the Pre-medical School option. (Organic Chemistry I + Organic Chemistry II + Lab)
- ONLY Pre-med students are required to take all three of the following courses: 119:115 (Biology I) and 119:116 (Biology II) and 119:117 (Biology Lab).
- Rule I: without both intro courses (Intro to BME + Sys. Phys.) NO 300-level courses – You MUST see UGD for Approval.
- Rule II: for anyone to register in Senior Design they need to have passed 6 out the 8 core BME courses Passed courses MUST include 309, 310, & 315
- Total of 12 credits of Technical Electives is Required.
- 14/650:388 Computer-Aided Design in Mechanical Engineering (3 cr. TE) is strongly recommended for the Biomechanics and Rehab.
- 125:309/310 Devices Lec/Lab and 125:401/421 Senior Design I Lec/Proj are only offered in the Fall.
- 125:315 Measurements Lab and 125:402/422 Senior Design II Lec/Proj are only offered in the Spring.
- Allowed to use an additional Technical Elective 3 cr. (TE) to replace Life Science Elective 3 cr. (LSE).
- BME permanent Summer Courses are 201 and 255.
- BME CORE Courses offered both, Fall and Spring, semesters.
- Sophomore courses 2XX, Junior courses 3XX (except RSA course), and Senior courses 4XX

You must successfully pass ALL the courses on the curriculum to obtain your .................... Biomedical Engineering Degree!
Departmental Guidelines

∞ Organic Chemistry is required for the Pre-Medical School option.

Organic Chemistry I + Organic Chemistry II + Lab

∞ ONLY Pre-med students are required to take all three of the following courses:

119:115 (Biology I) and 119:116 (Biology II) and 119:117 (Lab).

∞ Total of 12 credits of Technical Electives is Required!

∞ 14:650:388 Computer-Aided Design in Mechanical Engineering (3 cr TE) is strongly recommended for the Biomechanics and Rehab.

∞ Rule I: Without 200-level courses (Intro to BME [125:201] + Sys. Phys. [125:255]) NO BME 300-level courses – You MUST see UGD for Approval.

∞ Rule II: For anyone registering for Senior Design they need to have passed 6 out the 8 core BME courses (Must complete 309, 310, and 315 PLUS at least THREE out of 303, 304, 305, 306, and 308). So basically, we will allow you to take Senior Design if you fail AT MOST TWO COURSES (without counting for the labs). While we allow students to register for SD with only 6/8 core, we do not encourage this as it may impact senior year electives. Also, the grad program is going to make a new rule that students who do not complete all of the junior core cannot apply to the CDP.

∞ Rule III: The rule for CO-OP is (assuming you are on track)

--> Depending on when you do your co-op (fall or spring) you will be allowed to take either 315, or 309/310 as co-reqs in the senior year.

--> You must have successfully completed everything else.

So, basically CO-OP students are allowed one extra course (315) in the senior year.

This is a fair resolution. It requires that you move to Senior Design after having successfully completed a significant fraction of the course work (6/8) and still we give you the benefit to recover from mishaps without penalizing you with an extra year. If you are 3 or more courses behind, including the labs, YOU should not be in Senior Design.

TRANSFER STUDENTS:
∞ Your curriculum will be determined by the number of credits that are transferred to Rutgers and the remaining courses needed to complete program. The rules above may or may not apply to you. You will find out after your evaluation by the Office of Academic Affairs (OAA).

The OAA handles Transfer Orientation Sessions, please contact that office for more information (848-445-2212).

SCHOOL OF ENGINEERING / ACADEMIC AFFAIRS OFFICE:
∞ You may review the School of Engineering website addressing several concerns: soe.rutgers.edu

There are links to other websites to assist you with most issues you are trying to resolve.
Department Core Course Requirements

The following is a description of the Required core courses that are currently offered by the Biomedical Engineering Department to the School of Engineering undergraduates. Please check with Schedule of Courses online to see which courses will be offered. Although they may appear on list, does not mean they are offered.

14:125:201 Introduction to Biomedical Engineering (3)
Prerequisites: 01:640:152 and (750:124 or 750:203)

Overview of applications of engineering in medicine and healthcare. Introduction to biological and biomedical problems using fundamental concepts and tools from electrical, mechanical, and chemical engineering.

14:125:255 Biomedical Engineering System Physiology (3)
Prerequisites: (640:152 or 640:192) and (750:124 or 750:203)

Introduction to quantitative modeling of physiological systems geared towards the Biomedical Engineering student. It will cover fundamental topics in physiology ranging from cell membrane models and chemical messengers to neuronal signaling and control of body movement. In addition, specific physiological systems are discussed in detail, including the cardiovascular, pulmonary, and visual systems. Furthermore, pharmacokinetic models provide quantitative assessment of the dynamics of drug distribution and compartmental interactions.

14:125:303 Biomedical Transport Phenomena (3)
Prerequisites: 01:640:244 and 14:125:201 and (14:125:255 or 14:125:355)

Biomedical mass transport processes involving diffusion, diffusion-convection, and diffusion-reaction schemes; Introduction to biofluid dynamics; Transport processes in the cardiovascular system, hemorheology, extracorporeal mass transport devices and tissue engineering.

14:125:304 Biomaterials (3)

This course is designed to introduce the subjects of material properties, testing, biomaterial requirements and device design. It is the intention of the instructor to convey the basic knowledge of this large volume of information and to give an elementary understanding of the terminology used in the academic and commercial settings. This will provide the student with rudimentary skills that will allow them to succeed in grasping the ideas and theories of biomaterial science for future work.

14:125:305 Numerical Modeling in Biomedical Systems (3)
Prerequisites: 01:640:244 and 14:125:201 and 14:125:255 and 14:440:127

Introduction to modeling and simulation techniques in the analysis of biomedical systems. Application of numerical methods for the solution of complex biomedical process problems. Development and use of PC computer software for the analysis and solution of engineering problems.
14:125:306  Kinetics and Thermodynamics of Biological Systems (3)
Prerequisites: 01:119:115 and 01:640:244 and 14:125:201 and 14:125:255

Fundamentals of thermodynamics and kinetic analysis as applied to biomedical systems and technologies. Essential principles in thermodynamics will be introduced, including First Law, Second Law, and interrelationships among thermodynamic variables. Fundamental tools in kinetic analysis are also covered, including interpretation of rate data, enzyme kinetics, and pharmacokinetics. Application to biological systems and biomedical technologies are provided.

14:125:308  Biomechanics (3)

This course emphasizes the relationship between applied and resultant forces and stresses acting on the musculoskeletal system. Students are exposed to the basic concepts of vectors, internal and external forces, functional anatomy, trusses and equilibria of spatial force systems, moments and work and energy concepts. In addition, students learn about stress and strain tensors, principal forces, viscoelasticity, and failure analysis from classical mechanics.

14:125:309  Biomedical Devices and Systems (3)
Prerequisites: 01:640:251 and 01:750:227 and 14:125:201 and 14:125:255
Co-requisite: 14:125:310

Time and frequency domain analysis of electrical networks; hydrodynamic, mechanical, and thermal analogs; basic medical electronics, and energy conversion systems. Design of biological sensors.

14:125:310  Biomedical Devices & Systems Lab (1)
Prerequisites: 01:640:251 and 01:750:227 and 14:125:201 and 14:125:255
Co-requisite: 14:125:309

Experiments and demonstrations dealing with basic medical electronics and signal analysis. Provides an overview of current biomedical technology and its uses.

14:125:315  BME Measurement and Analysis Lab (2)

Experiments and demonstrations dealing with the measurement and analysis of various physiological quantities of cardiovascular and respiratory systems, and the measurement of cellular viability, metabolism, morphogenesis, and protein and nucleic acid composition.

14:125:401/402 and 421/422 Biomedical Senior Design I/II and Projects I/II (1, 2)
Prerequisites: Senior Standing (Passed 6 out of 8 junior level courses)

The purpose of this course is to give the student a comprehensive design experience in the biomedical engineering field. The student will complete a design project under the supervision of a faculty member. The project will typically involve the experimental or computational study of a design-oriented problem in biomedical engineering.
ELECTIVES

Departmental Electives

Please check with Schedule of Courses online to see which courses will be offered. Although they may appear on list, does not mean they are offered.

14:125:403 Cardiovascular Engineering (3)
Prerequisites: 14:125:303 and (14:125:208 or 14:125:308) and 14:125:315

Introduction to modeling and measurement methods for the cardiovascular system, analysis of blood flow dynamics, the function of the heart, and noninvasive approaches. Applications to cardiovascular instrumentation, basic cardiovascular system research, assist devices, and disease processes.

14:125:411 Bioelectric Systems (3)
Prerequisites: 14:125:309 and 14:125:310

Introduction to the understanding of bioelectric phenomena that occur in physiological systems. This includes the origin of biopotentials, the use of biopotential electrodes in their measurements and subsequent amplification, signal processing and analysis of their physiological relevance. Applications of physical principles and basic electric engineering techniques are emphasized.

14:125:417 Introduction to Musculoskeletal Mechanics (3)
Prerequisite: 14:125:208 or 14:125:308

Introduction to motion-actuation, force-generation, and load- support mechanisms in musculoskeletal system, as explained from basic engineering principles. Experimental and analytical approaches to solve realistic orthopaedic and recreational activities problems.
14:125:424  Biomedical Instrumentation Laboratory (3)
Prerequisite: 14:125:315 or 14:332:221 or 14:332:373

Practical hands-on designs of biomedical instrumentation including biopotential and physiological signal processing amplifiers, electrodes, biosensor and transducers, electro-optical, acoustic, and ultrasonic devices.

14:125:431  Introduction to Optical Imaging (3)
Prerequisite: 14:125:303 and 14:125:309

Introductory overview of optical phenomena and the optical properties of biological tissue. The course is specifically focused on optical imaging applications in biology and medicine. Topics will include reflection, refraction, interference, diffraction, polarization, light scattering, fluorescence and Raman techniques, and their application in biomedical imaging and microscopy.

14:125:433  Fundamentals and Tools of Tissue Engineering (3)
Prerequisite: 14:125:303

Fundamentals of polymer scaffolds and their use in artificial tissues. Regulation of cell responses in the rational design and development of engineered replacement tissue. Understanding the biological, chemical, and mechanical components of intra and intercellular communication. Preliminary discussions on real-life clinical experiences.

14:125:434  Tissue Eng II, Biomed and Biotechnological Applications (3)
Prerequisites: 14:125:433

This course will cover the applications of tissue engineering and builds upon the prior course fundamentals and tools. Emphasis is placed on applying the fundamental principles and concepts to problems in clinical medicine and large-scale industrial manufacturing. Topics: skin replacement, cartilage tissue repair, bone tissue engineering, nerve regeneration, corneal and retinal transplants, ligaments and tendons, blood substitutes, artificial pancreas, artificial liver, tissue integration with prosthetics, vascular grafts, cell encapsulation and angiogenesis.
14:125:437  Computational Systems Biology (3)

The course will provide an introductory overview of some of the key issues in computational systems biology. The course is designed in a way that will define the systems component and the biology component independently to give the students the opportunity to appreciate the special features of both elements. A novelty of the course is the introduction of medical informatics concepts.

14:125:445  Principles of Drug Delivery (3)
Prerequisites: 14:125:303

Fundamental concepts in drug delivery from an engineering perspective. Biological organisms are viewed as highly interconnected networks where the surfaces/interfaces can be activated or altered ‘chemically’ and ‘physically/mechanically’. The importance of intermolecular and interfacial interactions on drug delivery carriers is the focal point of this course. Topics include: drug delivery mechanisms (passive, targeted); therapeutic modalities and mechanisms of action; engineering principles of controlled release and quantitative understanding of drug transport (diffusion, convection); effects of electrostatics, macromolecular conformation, and molecular dynamics on interfacial interactions; thermodynamic principles of self-assembly; chemical and physical characteristics of delivery molecules and assemblies (polymer based, lipid based); significance of biodistributions and pharmacokinetic models; toxicity issues and immune responses.

14:125:455  BME Global Health (3)
Prerequisites: 14:125:401

This course provides an overview of how biomedical technologies are developed and translated into clinical practice. The course identifies the major diseases facing industrialized and developing countries alongside the technological advances which can be used to tackle these problems. Throughout the course, particular attention will be paid to the economic, ethical, social, and regulatory constraints which often determine the true impact of new technologies.
14:125:465 BME Microfluidics (3)

Prerequisites: 14:125:303 or 14:650:312

Microfluidics is the study of flow phenomena at small length scales with characteristic channel dimensions typically less than the diameter of a human hair. Small length scale effects become important as surface forces such as viscous drag and surface tension govern flow behavior rather than body forces (inertia) as seen in macroscale fluid mechanics. Miniaturization of fluid handling systems also allows the development of cell handling and manipulation devices, or microTotal Analysis Systems (TAS) also called “lab on a chip”, which combines biological sample preparation, separation, and analysis in a single device. Topics explored in this class include fundamental understanding and derivation of constitutive balances in fluid mechanics (i.e., Navier Stokes equation), exploration of electrokinetic flow phenomena for electrophoresis, fabrication techniques for microfluidics, overview of (TAS) systems especially capillary electrophoresis and miniaturized polymerase chain reaction for biochips, and exploration of integrated microfluidics for personalized medicine and drug delivery.

14:125:470 Advanced Biomedical Devices Lab- 3 credits

Prerequisites: 14:125:309, 310, and 315

The course applies the background obtained from the Biomedical Systems and Devices Laboratory and Lecture courses (125:309 and 310) that are restricted to linear systems and devices. This proposed course introduces advanced nonlinear electronics and devices. The Advanced Biomedical Devices lab also covers device standards and precision laboratory test methods; introduction to medical device interface systems; biomedical device power sources; wireless data transmission, basic radio systems; the blue tooth standard. Lastly, students will learn how to apply nonlinear data reduction methods to process long duration wireless data records that they will obtain during lab exercises.

14:125:475 Design and Advanced Fabrication of Biomedical Devices- 3 credits

Prerequisites: 14:125:304

The purpose of this course is to provide an overview of fabrication techniques and bioconjugate chemistry, as applied in the biomedical field. The course will cover topics covering to macro- to molecular-scale considerations for medical devices and implants. Students that complete the course will gain an understanding of the factors that go into the design and fabrication of medical devices as well as the tradeoffs between biomaterials theory and device implementation. They will also have hands-on exposure to digital design tools used in fabrication and observe traditional and cutting-edge fabrication instruments in use.
14:125:493/494  BME Research Scholars Academy (3,3)
Prerequisite: Biomedical Engineering Research Scholars Academy Senior Students Only*

These courses provide advanced research immersion activity and the supporting educational tools for members of the BME Research Scholars Academy that participate within a formalized two-year research experience. Students work independently with faculty members on a research project of relevance to biomedical engineering. In addition, students meet monthly for roundtable discussions of a wide range of scientific ethical and professional issues.

14:125:498/499  Topics in BME (3,3)
Prerequisite: Varies based on Topics

16:125:5XX  All BME 3-credit Graduate courses, except 587/588, will count as a Departmental Elective.

Criteria for eligibility/Rules to take Graduate Courses APPLIES:
P/NC options, grading policy, participation expectations, etc.
See Graduate Handbook/Administrator/Director for assistance via bme.rutgers.edu
Technical & Life Science Electives

(Most of the courses listed below have multiple prerequisites. Please check with the Rutgers Schedule of Classes or contact the Department offering these courses regarding updated information about the prerequisites.)

Biomedical Engineering

14:125:4xx Any of the BME departmental elective courses can be counted toward technical electives.
14:125:490 BME Research Scholars Academy (Prereq: RSA Juniors Only) (Contact RSA Advisor[s] for permission)
14:125:491/2 Independent Study Research (6 credits max towards TE) (Only by approval of the Faculty research advisor)
14:125:493/4 BME Research Scholars Academy (Prereq: RSA Seniors Only) (Contact RSA Advisor[s] for permission)
14:125:495 BME Internship (By Permission of Undergraduate Director Only) [Form in the handbook]
14:125:496/7 BME Co-op Internship (By Permission of Undergraduate Director Only) [Form in the handbook]

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<td>30:718:304</td>
<td>Pathophysiology (NB)</td>
</tr>
<tr>
<td>30:721:301</td>
<td>Introduction to Pharmaceutics (NB)</td>
</tr>
<tr>
<td>30:721:320</td>
<td>Drug Delivery I and Laboratory (NB)</td>
</tr>
<tr>
<td>30:721:430</td>
<td>Introduction to Biopharmaceutics and Pharmacokinetics (NB)</td>
</tr>
<tr>
<td>TR:125:TE1</td>
<td>Biomedical Engineering Technical Elective Transfer Equivalent (NB)</td>
</tr>
<tr>
<td>TR:125:TE2</td>
<td>Biomedical Engineering Technical Elective Transfer Equivalent (NB)</td>
</tr>
<tr>
<td>TR:125:TE3</td>
<td>Biomedical Engineering Technical Elective Transfer Equivalent (NB)</td>
</tr>
<tr>
<td>TR:125:TE4</td>
<td>Biomedical Engineering Technical Elective Transfer Equivalent (NB)</td>
</tr>
<tr>
<td>TR:125:TEC</td>
<td>Biomedical Engineering Technical Elective Transfer Equivalent (NB)</td>
</tr>
</tbody>
</table>

**If a class you wish to take is not listed and you believe it meets the qualifications of a technical elective, please contact the undergraduate director.**
Acceptable Humanities/Social Science & General Electives

Please refer to:

http://www.soe.rutgers.edu/oas/electives

for list of Humanities/Social Science & General Electives

Office of Academic Affairs (B100) maintains & approves this list.

** BME supports and approves these listings **
Areas of Interest in BME

Modern applications of Biomedical Engineering encompass a wide range of technical areas. The goal of the Rutgers Biomedical Engineering Department is to educate its students with a broad base in core biomedical engineering and provide depth in the frontier areas of biomedical engineering profession through exposure to key areas of specialization. Based on area of interest, the student can then design the appropriate technical elective, life-science elective, and departmental elective. In the event there are specific questions related to each area, general faculty advisors should be contacted.

Your degree will say: “Biomedical Engineering”

* Please check with the Track Advisors for updates to recommended electives.

Track Advisors

<table>
<thead>
<tr>
<th>Your Interests In:</th>
<th>Advisors</th>
<th>Advising</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical Computing, Imaging, and Instrumentation (BCII)</td>
<td>M. Pierce <a href="mailto:mark.pierce@rutgers.edu">mark.pierce@rutgers.edu</a></td>
<td>Email for Appointment</td>
</tr>
<tr>
<td>Biomechanics and Rehabilitation Engineering (BRE)</td>
<td>J. Zahn <a href="mailto:jdzahn@soe.rutgers.edu">jdzahn@soe.rutgers.edu</a></td>
<td>Email for Appointment</td>
</tr>
<tr>
<td>Tissue Engineering and Molecular Bioengineering (TEMB)</td>
<td>Li Cai <a href="mailto:lcai@soe.rutgers.edu">lcai@soe.rutgers.edu</a></td>
<td>Email for Appointment</td>
</tr>
<tr>
<td></td>
<td>T. Shinbrot <a href="mailto:shinbrot@soe.rutgers.edu">shinbrot@soe.rutgers.edu</a></td>
<td></td>
</tr>
</tbody>
</table>
**Biomedical Computing, Imaging & Instrumentation (BCII)**

**Target Audience:**

These course recommendations are designed to train students who are interested in academic or industrial careers that involve the measuring and modeling of physiological systems, medical imaging, medical image processing and analysis and the graphics and visualization industries. Emphasis is placed both on understanding the physiological system as well as the engineering and development of new sensors and measurement devices. Specialists in Medical Imaging and Medical Image Analysis find careers in small and large industries as well as research centers and universities. They will also prepare students with a solid background for graduate study.

**BME Department Electives for BCII**

14:125:403   Cardiovascular Engineering  
14:125:411   Bioelectric Systems  
14:125:424   Biomedical Instrumentation Lab  
14:125:431   Introduction to Optical Imaging  
14:125:437   Computational Systems Biology  
14:125:455   BME Global Health  
14:125:465   BME Microfluidics

**Recommended Life Science Electives for BCII** *(see complete list of Life Sciences in Handbook)*

01:146:245   Fundamentals of Neurobiology  
01:146:270   Fundamentals of Cell and Developmental Biology  
01:146:295   Essentials of Cell Biology & Neuroscience

**Recommended Technical Science Electives for BCII** *(see complete list of TE in Handbook)*

01:198:424   Modeling and Simulation of Continuous Systems  
14:332:346   Digital Signal Processing  
14:332:361   Electronic Devices  
14:332:376   Virtual Reality  
14:332:417   Control Systems Design  
14:332:448   Image Processing-Design  
14:332:466   Opto-Electronic Devices  
14:332:471   Robotics and Computer Vision  
01:640:350   Linear Algebra  
01:640:421   Advanced Calculus for Engineering  
01:750:305   Modern Optics
Biomechanics and Rehabilitation Engineering (BRE)

Target Audience:

The biomechanics “option” has added emphasis on tissue and fluid mechanics, whereas the rehabilitation engineering option has an emphasis on prosthetics and assisted devices. These recommendations electives have been identified as more appropriate for an emphasis on rehabilitation engineering (R) and/or biomechanics (B). Students undertaking this curriculum will be well prepared for employment in the medical device industry (orthopedic, imaging, cardiovascular), and positions involving direct contact with health care, rehabilitation, and human performance. Also, an excellent background for students seeking advanced degrees in engineering, medicine, and physical/occupational therapy.

BME Department Electives for BRE

14:125:417 Musculoskeletal Mechanics
14:125:433 Tissue Engineering I: Fundamentals and Tools (B)
14:125:434 Tissue Engineering II: Biomedical and Biotechnological Applications (B)
14:125:455 BME Global Health
14:125:460 Motor Control & Motion Analysis
14:125:465 BME Microfluidics

Recommended Life Science Electives for BRE (see complete list of Life Sciences in Handbook)

01:146:270 Fundamentals of Cell and Developmental Biology (B)

Recommended Technical Science Electives for BRE (see complete list of TE in Handbook)

14:155:551 Polymer Science and Engineering I
14:155:552 Polymer Science and Engineering II
14:332:376 Virtual Reality
14:332:471 Robotics and Computer Vision
14:440:222 Dynamics
14:540:461 Engineering Law
14:635:320 Introduction to Nanomaterials
14:635:407 Mechanical Properties of Materials
01:640:421 Advanced Calculus for Engineering
14:650:342 Design of Mechanical Components
14:650:388 Computer-Aided Design
14:650:401 Control Systems
14:650:455 Design of Mechanisms
14:650:472 Biofluid Mechanics (B)
01:960:384 Intermediate Statistical Analysis
**Tissue Engineering and Molecular Bioengineering (TEMB)**

**Target Audience:**

These course recommendations are designed for students who desire to apply engineering principles to the development of biomedical technologies underlying tissue engineering, biomaterials design and applications, and molecular medicine. An emphasis is placed on biochemistry and on molecular and cell biology in the life sciences arena and on thermodynamics, kinetics, and transport and materials sciences within the engineering sciences. Students undertaking this curriculum will be well prepared for employment in the tissue engineering, pharmaceutical and biotechnology industries, for medical school, or for graduate study in Biomedical Engineering.

**BME Department electives appropriate for TEMB**

14:125:433 Tissue Engineering I: Fundamentals and Tools  
14:125:434 Tissue Engineering II: Biomedical and Biotechnological Applications  
14:125:437 Computational Systems Biology  
14:125:445 Principles of Drug Delivery  
14:125:455 BME Global Health  
14:125:465 BME Microfluidics

**Recommended Life Science Electives** (see complete list of Life Sciences in Handbook)

01:694:301 Intro. to Biochemistry & Molecular Biology  
01:694:407 Molecular Biology & Biochemistry I  
01:694:408 Molecular Biology & Biochemistry II  
01:146:270 Fundamentals of Cell and Developmental Biology

**Recommended Technical Science Electives** (see complete list of TE in Handbook)

01:146:474 Immunology  
01:146:470 Advanced Cell Biology I  
14:155:411 Introduction to Biochemical Engineering  
14:155:551 Polymer Science and Engineering I  
14:155:552 Polymer Science and Engineering II  
01:160:409 Organic Chemistry of High Polymers  
01:447:380 Genetics  
14:635:320 Introduction to Nanomaterials  
14:635:323 Bio. Applications of Nanomaterials  
01:640:250 Introduction to Linear Algebra  
01:640:421 Advanced Calculus for Engineering  
01:694:411 Molecular Pathways and Signaling  
01:960:379 Basic Probability and Statistics  
01:960:384 Intermediate Statistical Analysis
Special Programs

Declaring a Minor
There are no official minors in any engineering subject. It is possible for students to pursue 2 engineering BS degrees, simultaneously or sequentially. In this case only 1 set of humanities/social science electives need to be completed.

Declaring a Different Major within Engineering
Careful thought should precede any change of curriculum. Students should consult the executive officers or appropriate faculty advisors in the two majors.

Double Major vs. Dual Degree
A Double Major means that you must fulfill the ‘major requirements’ as described for that department (refer to the Undergraduate catalog for details). Generally, a second major is around 30 credits. You would remain a School 14 student, but you would have the second major denoted on your transcript.

A Dual Degree means that you apply to the other college and be accepted. After you are accepted, you must fulfill all requirements for the BA for that college (like Rutgers College or Cook College). This is a more involved process and includes additional work on top of the ~30 credits for the major. For example, if you declare a technical major like Mathematics or Physics, Rutgers College requires that you take additional non-western humanity courses as well as completing a minor in a H/SS area. Consult the specific college for more details.

You would receive two separate degrees, one from each school. If you do not complete both degrees concurrently (example, you have a few classes left for your BA, and you decide to graduate with just your BS from Engineering), you may not come back to finish your remaining classes and obtain the second degree.

For either option, refer to the department in which you want to get the major/degree for advice on course selection, and check the RU catalog and departmental websites. Fill out the form and bring it to EN B100 (Academic Affairs).

B.S./M.B.A. Program
Qualified candidates for the Bachelor of Science (BS) degree in the School of Engineering are given the opportunity to obtain the Master of Business Administration (MBA) degree from the Rutgers Graduate School of Management in one year of academic work following the completion of the requirements for the BS degree.

If accepted into the program, during the fourth year, BME students will take graduate courses towards the MBA degree which will be offered at Rutgers Business School: Graduate Program — Newark and New Brunswick's campuses. The fourth year is declared as the senior year of undergraduate school. The student, consequently, receives the benefit of undergraduate tuition rates. At the end of the fourth year, students should have successfully completed all undergraduate requirements for the BS Degree. During the fifth year, the students will complete graduate studies and receive the MBA degree.

A 3.0 grade point average is required. The GMAT should be taken during the junior year. The application to the MBA program should be pursued during the spring semester of the junior year. Please contact the Business School for more information.

B.S./M.D. Program
BME students either are not eligible to do the BS/MD program or that they will be expected to take the full 4 years to complete the program. Please contact the Health Professions Office for more information at hpo.rutgers.edu.
Bachelor's/Master's Combined Degree Program

The goal of the BME Bachelor’s/Master’s Combined Degree Program (BME-CDP) is to allow academically qualified students to receive the B.S and M.S. /M.Eng degrees in a shortened time frame. This highly intensive academic program gives students more research experience and better prepares them for research and development careers or further graduate study. Completing the BME-CDP is possible in as little as 5 years if the candidate takes graduate-level courses in the senior year in addition to completing all the undergraduate degree requirements. (Courses cannot double-count for both UG requirements and graduate credit)

Information can be found at https://bme.rutgers.edu/resources-and-forms

Including: Eligibility, Curriculum, and Application.

Email Graduate Administrator with questions.

James J. Slade Scholars Program

Administered through Office of Academic Affairs

www.soe.rutgers.edu/oaas

Application & Completion forms for James J. Slade Scholar can be found on the above link

Please complete forms in its entirety.

NOTE: James J. Slade Program does not count toward the Undergraduate BS Degree!

However, you can earn credit toward the Graduate Degrees.
Register for courses 16:125:587/588.

Directed Research in Biomedical Engineering

These courses (291,292) provide opportunity to students (with 3.25 or higher GPA) to participate in research project earlier within biomedical engineering environment. The underclass students are provided with appropriate facilities and other professional development opportunities.

Note: The credits earned are extra and does not count towards the graduation requirements of BME Degree.

Prerequisite: Permission of department.

*Extra Special Problem courses (491-492) credits or other technical courses may be used to replace up to four required technical courses (including those in the major) with the approval of research advisor and executive officer.
Industrial Interactions

The Office of Career Exploration and Success will be assisting you with career development and employment opportunities. They have a variety of resources (CareerKnight, Online Career Self-Assessment and Planning, On-Campus Interviewing Program), various clinics (Mock Interview Clinic, Drop-in Resume Clinic, Networking Clinic, Internship Clinic) and the staff (Liaisons for Engineering: Joe Scott, Tamara Peters, and Mindy O’Mealia) to provide you with the guidance you will need and the career opportunities you are seeking.

Your next step should be to access the CareerKnight system at http://careers.rutgers.edu. All students automatically have a CareerKnight account. This system will allow you to begin your career development plan from scheduling an appointment with a career counselor to applying for internships. You can also contact The Office of Career Exploration and Success at 848-932-7997, if you have any questions.

Once you have received an Internship offer, complete the Application for Internship in this handbook and submit to the Undergraduate Administrator who will provide you access to register.

Please ensure that you are aware of the following:

**Regulations:**
1. Internship credits counts as a **Technical Electives ONLY. No Exceptions!**
2. Graded on a Pass/No Credit scale.
3. Final report (1-2 pages) MUST be submitted to *UG Director* at end of Internship summarizing work.
   • Report should include what the job duties were, what skills were learned, and anything else about the industry experience that you wish to share, bad or good.
4. Supervisor(s) MUST submit evaluation to *UG Director* at the end of the Internship.
   • This can simply be an email but MUST be sent DIRECTLY to the Undergraduate Director from the supervisor! Evaluation should confirm employment, list the duties performed, and contributions made to the project. If appropriate, supervisor can also include information about your performance. If an internal evaluation is performed and supervisor is comfortable/allowed to share that, that will also suffice.
5. Register during open registration period.
6. **Limit is TWO** Internship 3cr. Courses will count towards degree.

**Co-op Program**

The Co-op program is a formal mechanism where students earn course credits by working for a local company for six months (one semester plus a summer). This provides the students with a capstone experience to the undergraduate curriculum by integrating prior coursework into a working engineering environment. Previous Co-op students have worked at companies such as Johnson & Johnson Ethicon, Johnson & Johnson McNeil, Howmedica Osteonics, and Boston Scientific. **Please see the Undergraduate Director for approval.**

If you have any questions, please feel free to send an email to Kristen Labazzo at sakala@soc.rutgers.edu or stop by her office in the Biomedical Engineering Building, Office 328C.
Faculty Research Expertise

Ioannis P. Androulakis  Ph.D., Purdue University
Novel computational algorithms, microarray experiment and molecular dynamics simulations, combustion phenomena

Francois Berthiaume  Ph.D., Pennsylvania State University
Wound Healing, Tissue Engineering & Regenerative Medicine, Metabolic Engineering

Nada Boustany  Ph.D., Massachusetts Institute of Technology
Biomedical Imaging, Cellular Biophysics, Optical Microscopy

Helen Buettner  Ph.D., University of Pennsylvania
Nerve growth and regeneration, cellular engineering, modeling of biological processes, computer graphics and simulation, video microscopy

Li Cai  Ph.D., Dana Farber Cancer Institute
Nerve growth and regeneration, cellular engineering, modeling of biological processes, computer graphics and simulation, video microscopy

Gary Drzewiecki  Ph.D., University of Pennsylvania
The cardiovascular system, new methods of blood pressure determination, mathematical models of the normal and diseased heart, study of flow in circulation, application of chaos and fractals

Joseph Freeman  Ph.D., Rutgers University
Tissue engineering, Biomechanics, Biomaterials, and Musculoskeletal regeneration

Adam Gormley  Ph.D., University of Utah
Biomaterials, nanomedicine, self-assembly, biosensing and diagnostics

Kristen Labazzo  Ph.D., Rutgers University
Biomaterials, mesenchymal stem cells, medical devices, assistive technologies

Noshir Langrana  Ph.D., Cornell University
Orthopedic biomechanics, biomechanical design, finite element methods and tissue engineering

John K-J. Li  Ph.D., University of Pennsylvania
Cardiovascular mechanics, biosensors and transducers, cardiac arrhythmias and assist devices, controlled drug delivery systems, ultrasound, and electro-optics

Adrian Mann  D. Phil., Oxford University
Biomaterial fabrication and characterization, Nanomechanics and Nanoprobe Microscopy
Prabhas Moghe  
Ph.D., University of Minnesota  
*Cell and tissue engineering, Cell-interactive Biomaterials, Micro/Nanobiotechnology*

Biju Parekkadan  
Ph.D., Harvard-MIT Division of Health Sciences and Technology  
*Cell & Genetic Engineering, Bioreactor engineering, Regenerative Medicine & Immunotherapy*

Mark Pierce  
Ph.D., University of Manchester  
*Cell & Genetic Engineering, Bioreactor engineering, Regenerative Medicine & Immunotherapy*

Charles Roth  
Ph.D., University of Delaware  
*Molecular bioengineering; nucleic acid biotechnology; liver systems engineering; cancer therapeutics*

Troy Shinbrot  
Ph.D., University of Maryland  
*Nerve regeneration; structure from noise; pharmaceutical engineering*

George Shoane  
Ph.D., University of California, Berkeley  
*Biomedical optics, Microscopy, Contrast agents, Cancer imaging*

David Shreiber  
Ph.D., University of Pennsylvania  
*Tissue engineering, injury biomechanics, and nerve regeneration*

Jay Sy  
PhD, Georgia Institute of Technology & Emory University  
*Drug delivery, Biomaterials, Medical Devices*

Valerie Tutwiler  
Ph.D., Drexel University  
*Hemostasis/Thrombosis, Biomechanics, Biomaterials, Inflammation*

Maribel Vazquez  
Sc.D., Massachusetts Institute of Technology  
*Microfluidics-based biosystems, neural cell migration and retinal regeneration*

Martin Yarmush  
Ph.D. Rockefeller University  
M.D. Yale University School of Medicine  
*Tissue engineering, molecular bioengineering, bioseparations and biothermodynamics, and metabolic engineering*

Jeffrey Zahn  
Ph.D., University of California, Berkeley  
*Microfabrications and microfluidics*
Forms: Research Guidelines

Internship in Biomedical Engineering:

Courses graded as Pass/No Credit can be counted as 3 credit technical electives.

The UAB has agreed to accept up to 6 credits in experiential-based learning toward the Engineering degree in addition to the capstone design. Exceptions can be made by the UGDs to accept up to 9 credits max. We had an implicit rule for making such an exception:
- We accept 9 credits max for students who have completed both the Internship (125:495; 3 credits) and a co-op (125:496/497; 6 credits)
- We accept 6 credits max for students who have not completed a co-op, which means two 3-credit Internship courses can be counted.

Some additional notes:
- For any given semester, students can only take up to 6 credits of experiential based learning, so students are not allowed to register co-op and internship together.
- By default, departmental Independent Study courses are also considered as experiential based learning, so they are part of the mix as well. UGDs can override this default if an independent study is offered in a classroom setting.
- The max number of research credits includes research done in other departments not managed by BME.

Time/Hours Expected Weekly-Minimum:

For Research, Co-op, or Internship; there is a standard 5 hours per credit minimum required. (Example. 3 credits = 15 hours minimum; 2 credits = 10 hours minimum; 1 credit = 5 hours minimum)

*However, student and PI may reach alternate (more or less) arrangements based on research needs.

Due to COVID19:

The following forms must be sent directly to Advisors/Faculty/PIs and UnderGraduate Director to obtain their signature and ultimately sent to UnderGraduate Administrator for registration purposes.
Application for Directed Research 14:125:291/292

DEPARTMENT OF BIOMEDICAL ENGINEERING

** FRESHMAN AND SOPHOMORE STUDENTS **

Instructions:
1) MUST be a BME Student with GPA of 3.25 or higher.
2) Complete this form and obtain all required signatures.
3) Submit it to the Undergraduate Program Administrator in BME-110 for the Special Permission Number to register during registration period.
4) Use the Special Permission number given to register for 3 credits! to be a full-time student only
5) CREDITS Do Not count toward BS DEGREE. No Exceptions!
6) Advisor(s) must submit grade via email to Undergraduate Director promptly during grading period. (Grades of A, B, and C correspond to Pass)

Student’s Name (Print) ___________________________, __________________________ # ____________

(Last) (First) (RUID)

E-Mail: ____________________________ Avg. GPA: _________________

Semester: ____________________________ Class of: ____________________________

Are you on academic probation? Yes _____ No _____

*Print PI’s name(s) Lab: ____________________________

Project Title:

________________________________________

________________________________________

________________________________________

Approval Signature(s) of PI’s:

________________________________________

Department Chair or Undergraduate Director’s Signature:

________________________________________ Date: _________________

Signature of Student: __________________________ Date: _________________

Index Number: ________________ Special Permission Number: ________________
Independent Study 14:125:491/492 (3cr.)

DEPARTMENT OF BIOMEDICAL ENGINEERING
** JUNIOR AND SENIOR STUDENTS **

Instructions:
1) Complete this form and have it signed by the research advisor you will be working under.
2) Submit it to the Undergraduate Program Administrator in BME-110 for the Special Permission Number to register during registration period.
3) Use the Special Permission number given to register for 3 credits!
4) TECHNICAL ELECTIVE credit only. No Exceptions!
5) You must have completed or currently registered for Devices Lecture and Lab to be eligible.
6) Advisor(s) must submit grade via email to Undergraduate Director promptly during grading period.

Student’s Name (Print) ______________________ #________________ (Last) (First) (RUID)

E-Mail: ______________________ Avg. GPA: ______________________

Semester: ______________________ Class of: ______________________

Are you on academic probation? Yes _____ No _____
If yes, you cannot receive credit for Independent Study in Biomedical Engineering.

(Maximum number of credits students can earn for Independent Study in Biomedical Engineering is six, but no more than three in any semester.)

*Print PI’s name(s): ________________________________

Project Title:

________________________________________________________________________

If you are not a BME student,
Please give your department name: ________________________________

Approval Signature(s) of PI’s and Email Address(es):

PI’s Signature: ______________________ Email: ______________________

[PI NOTE: Student must complete all assignments/reports you require, and you must send UG Director Grade.]

Signature of Student: ______________________ Date: ______________________

Index Number: ______________ Special Permission Number: ____________
BME Research Scholars Academy

**MUST BE A RISING JUNIOR IN ORDER TO APPLY**

The APPLICATION PROCESS - Rising Juniors will be informed how to apply!

The BME Research Scholars Academy is designed for a highly selective group of biomedical engineering undergraduates, who, based on their demonstrated academic record and/or research potential, are given the opportunity to immerse themselves in an accelerated research program at Rutgers. It is anticipated that most Research Scholars Academy members will go on to further graduate and/or professional training after graduation.

- Applications are submitted online by Aug. 31st (junior year). We adhere to a minimum 3.5 GPA. Student must have planned with the prospective mentors prior to filling out the application.
- Selected candidates are provisionally admitted to the RSA and are assigned to mentors by the end of September (junior year).
- Students are evaluated by their mentors during the remaining of the fall semester and a final decision for accepting a student into the RSA is made by the mentor by the end of the semester and is communicated to the faculty responsible for the RSA program. We will establish general guidelines regarding what constitutes an evaluation. The process needs to be clear and transparent, and students need to be aware of what is required of them. Students who fail during the probation period cannot re-apply and/or be assigned to a different faculty member. The final decision is not negotiable. The fall semester of the junior year is a trial period for which students do not receive credit for.
- Students admitted to the RSA register for the upcoming 3 consecutive semesters (490 spring junior, 493 fall senior, 494 spring senior) and receive 9 credits and policies are the same. No co-op is allowed unless it is the result of prior coordination between the mentor and the industrial partner, and it involves work related to a student's HA project.
- Grading Policy:
  a. active participation of research in mentor's lab
  b. presentation on RSA student's research project (RSA project and Senior Design project should be different, if they are the same, significant amount of efforts should be put into the project)
  c. a short project report (includes Abstract, Intro, Methods, Results, and Discussions) to both the mentor and the RSA coordinator.
  d. participation of RSA activities (e.g., seminars on poster preparation, preparation for Graduate/ Medical school applications, Graduate/Medical student lives, etc.)
- The Academy members are nominated for the Rutgers University Research Fellowship (RURF) and other appropriate fellowship opportunities.
- In appropriate cases, the Academy members will be supported by faculty research grants through Research Experiences for Undergraduate Supplements or other federal and industrial grants.

REGISTRATION FOR CREDITS: The Research Scholars Academy members can count to six credits of Advanced BME Research (125:493 or 494) toward their BME technical electives or BME departmental electives. (In addition, Academy members can count a maximum of three credits of Independent Study in Biomedical Engineering (125:491, 492) electives toward their technical electives.

Note: Students that do not belong to the Research Scholars Academy and perform individual research with a BME faculty can count to six credits of Independent Study in Biomedical Engineering in Research (125:491, 492) toward their technical electives, but they will not be allowed to register for 125:493 or 125:494, nor count any of their research toward departmental elective requirements.

For further information on the Research Scholars Academy, including application procedure, please contact Dr. Ioannis (Yannis) Androulakis at Yannis@soc.rutgers.edu.
Application for Internship 14:125:495 (3 cr.)

DEPARTMENT OF BIOMEDICAL ENGINEERING

*This form MUST be completed BEFORE registering and starting Internship. UPD needs to approve the internship prior to its start to ensure that it meets the requirements of a technical elective. Then given to Undergraduate Administrator, who will assign a special permission number. *

I. PERSONAL INFORMATION

REGISTRATION for: ___ Summer (OR) ___ Fall/Spring

Student's Name ________________________________ ________________________________ (Last) (First)

Phone: __________________________ Class of: __________________________

Email: __________________________ RUID# __________________________

First Day of Work: ______________ Last Day of Work: ______________

II. EMPLOYER INFORMATION

Employing Institution: __________________________

Supervisor/Contact Name(s):

1. __________________________ 2. __________________________

Phone/Fax: __________________________ Phone/Fax: __________________________

Email: __________________________ Email: __________________________

Job Description: __________________________

________________________

________________________

Regulations:

1. Internship credits counts as a Technical Electives ONLY. No Exceptions!

2. Graded on a Pass/No Credit scale.

3. Final report (1-2 pages) MUST be submitted to *UG Director* at end of Internship summarizing work.
   • Report should include what the job duties were, what skills were learned, and anything else about the industry experience that you wish to share, bad or good.

4. Supervisor(s) MUST submit evaluation to *UG Director* at the end of the Internship.
   • This can simply be an email but MUST be sent DIRECTLY to the Undergraduate Director from the supervisor! Evaluation should confirm employment, list the duties performed, and contributions made to the project. If appropriate, supervisor can also include information about your performance. If an internal evaluation is performed and supervisor is comfortable/allowed to share that, that will also suffice.

5. Register during open registration period.

6. Limit is TWO Internship 3cr. Courses will count towards degree.

III. Signatures:

I have read the above regulations and understand the rules for my internship assignment

Student’s Signature: __________________________ Date: __________________________

UG Director Signature: __________________________ Date: __________________________

Index Number: __________________________ Special Permission Number: __________________________
Application for Co-Op 14:125:496/497 (6 cr.)

DEPARTMENT OF BIOMEDICAL ENGINEERING

*This form MUST be completed BEFORE registering for Co-op. It must be approved by the Undergraduate Director. Then given to Undergraduate Administrator, who will assign a special permission number. *

I. PERSONAL INFORMATION

Student's Name (Print)_________________________,____________________#__________________________

(Last) (First) (RUID)

Phone: ____________________________ Class of: ____________________________

Email: ____________________________ Course: 125:496___ or 125:497____

First day of Work:__________________________ Last day of Work:__________________________

II. EMPLOYER INFORMATION

Employing Institution: ________________________________________________________________

Supervisor/Contact Name(s):

1. ____________________________ 2. ____________________________

Phone/Fax: ____________________________ Phone/Fax: ____________________________

Email: ____________________________ Email: ____________________________

Job Description:

________________________________________________________________________________

________________________________________________________________________________

III. Regulations:

a. Co-op credits counts as a Technical Electives ONLY. No Exceptions!

b. Graded on a Pass/No Credit scale.

c. Final report (1-2 pages) MUST be submitted to *UG Director* at end of Co-op summarizing work.

d. Supervisor(s) MUST submit evaluation to *UG Director* at the end of the Co-op.

e. Up to 6 additional credits may be taken while on Co-op. Only ONE course during the day.

f. work *continuously* for 6 months (Semester + Summer [not negotiable]).

g. *Full-time* job assignment required.

h. Register during open registration period.

i. Non-compliant with all above – NOT ELIGIBLE FOR CO-OP…see Internship in BME.

j. Limited to ONE Co-Op 6 cr.

IV. Signatures:

I have read the above regulations and understand the rules for my co-op assignment

Student’s Signature:__________________________ Date: ____________________________

UG Director Signature:__________________________ Date: ____________________________

Index Number: ____________________________Special Permission Number: ____________________________
Bachelor’s/Master’s Combined Degree Program

Department of Biomedical Engineering

Objectives
The goal of the BME Bachelor’s/Master’s Combined Degree Program (BME-CDP) is to allow academically qualified students to receive the B.S. and M.S. or M.Eng degrees in a compressed time frame. This highly intensive academic program gives students more research experience and better prepares them for research and development careers or further graduate study. Completing the BME-CDP is possible in as little as 5 years if the candidate takes graduate-level courses in the senior year in addition to completing all the undergraduate degree requirements. (Courses cannot double-count for both UG requirements and graduate credit)

Eligibility/Application

To be considered for the BME-CDP, candidates must:

See Graduate Handbook for rules/regulations for eligibility and application

*There is no GRE requirement for the BME-CDP although the GRE’s may be required to apply for any PhD program or for future funding or fellowships.

Curriculum

The BME-CDP requires the candidate to take the remaining undergraduate credits during the Senior Year and 33 Graduate level credits during Senior and Graduate Years (Years 5+). The general timeline for the BME-CDP is as follows:

**Senior Year:** Candidates will take 6-18 graduate (500+ level) credits along with the remaining BME undergraduate courses needed for the B.S. degree (Senior Design, DE, TE, etc.).

**Fifth Year (1st graduate year):** Remainder of master’s courses and work on the M.S. thesis or M.Eng project. Candidates can take fewer graduate courses, but this could lengthen the duration of the master’s degree.

**Summer following the Fifth Year:** If necessary, students will complete the M.S. thesis and defend it or present the M.Eng project.

Please Note:
1) Candidates need to graduate with the BME B.S. degree at the end of the spring semester of the 4th year to continue (officially) in the master’s program, as a full-fledged graduate student, starting either in the summer or fall following the 4th year.

2) Graduate courses in the senior year will be billed at the lower undergraduate tuition rate.

3) The J.J. Slade Scholar Program can be, and is recommended to be, pursued along with the BME-CDP. If applying to the J.J. Slade Scholar Program in conjunction with the BME-CDP, that program requires a separate application form: https://soe.rutgers.edu/slade. At least ONE of your recommendation letters should be from your intended J.J. Slade Research Advisor. Contact Lawrence Stromberg (lev42@soe.rutgers.edu) for questions on this additional option.

4) Continuation in the BME-CDP is contingent on receiving no more than one “C” grade in any of the BME graduate courses during the Senior Year.
## Sample Curriculum for the BME Bachelor’s/Master’s Combined Degree Program (BME-CDP)

### Fall of Senior Year
- 14:125:401/421 Senior Design I 3 Credits
- xx:125:xxx Departmental Elective 3 Credits
- xx:125:xxx Departmental Elective 3 Credits
- xx:xxxx:xxx Technical Elective 3 Credits
- 16:125:605 BME Seminar (zero credit) and/or
- 16:125:xxx Graduate Core Course(s) and/or
- 16:125:xxx Graduate Elective Course(s)
- 1-9 Credits (1-3 courses)

### Spring of Senior Year
- 14:125:402/422 Senior Design II 3 Credits
- xx:125:xxx Departmental Elective 3 Credits
- xx:125:xxx Departmental Elective 3 Credits
- xx:xxxx:xxx Technical Elective 3 Credits
- 16:125:605 BME Seminar (zero credit) and/or
- 16:125:xxx Graduate Core Course(s) and/or
- 16:125:xxx Graduate Elective Course(s)
- 1-9 Credits (1-3 courses)

### Fall of 1st Master’s Year (Official Graduate Student in the School of Graduate Studies)
- 16:125:501 BME Math Modeling Course 3 Credits
- 16:125:601 Engineering Ethics and Seminar 1 Credit
- 16:125:xxx Graduate Core or Electives (as needed) 3-9 Credits (1-3 courses)
- 16:125:701 Research (MS Only) 3 Credits

### Spring of 1st Master’s Year
- 16:125:586 BME Cell Biology Course 3 Credits
- 16:125:602 Engineering Writing and Seminar 1 Credit
- 16:125:628 Clinical Practicum 1 Credit
- 16:125:xxx Graduate Core or Electives (as needed) 3-9 Credits (1-3 courses)
- 16:125:699 Non-Thesis Study (M.Eng Only) or 3 Credits (OR)
- 16:125:702 Research (MS Only) 3 Credits

### Late Spring-Summer of 1st Master’s Year (or 6th year depending on progress)
Finish up writing M.S. Thesis to defend or finishing the M.Eng project for presentation

## Summary:

### Senior Year Bachelor's Curriculum
- Senior Design I & II
- Departmental Electives
- Technical Electives
- Other courses as needed for the B.S.

### Master's Curriculum
- 3 Core Courses (out of 5) 9 credits
- 1 BME Math Methods Course 3 credits
- 1 BME Adult and Stem Cell Biology Course 3 credits
- 3 One-Credit Professional Developmental Courses 3 credits
- 3 Electives 9 credits
- 2 Seminar Courses (when not taking 601/602) 0 credit
- If pursuing MS: 6 Research Credits 6 credits (MS Only)
- If pursuing M.Eng: 3 Non-Thesis Study Credits 3 credits (M.Eng Only)
- If pursuing M.Eng: 4th Elective Course 3 credits (M.Eng Only)

33 Total Master’s Credits