Biomedical Engineering Undergraduate Advising Manual *(updated August, 2013)*

The Discipline of Biomedical Engineering

This department is recognized as a world leader in preparing students for careers in industry and business and for graduate education in engineering, medicine, and science. Biomedical engineering utilizes knowledge from traditional engineering disciplines to solve problems in living systems. The undergraduate program contains a set of "core knowledge," defined and taught by the faculty, that future biomedical engineers should possess. The core includes courses in molecular and cellular biology, linear systems, biological control systems, modeling and simulation, thermodynamic principles in biology, and engineering analysis of systems level biology and physiology. Building on these core subjects, each student then takes a cohesive sequence of advanced engineering courses appropriate to one of five focus areas: Biological Systems Engineering; Cellular/Tissue Engineering and Biomaterials; Computational Biology; Imaging; and Sensors, Instrumentation and Micro/Nanotechnology. The curriculum challenges students to analyze problems from both an engineering and a biological perspective. Students work side by side with faculty in research labs on both the Homewood and E. Baltimore campuses and can also be found working in multidisciplinary teams to develop innovative design solutions to clinical problems. Beginning in the freshman year, the department strives to empower students to explore and define their own frontiers in this very broad and exciting discipline.

Career Opportunities in Biomedical Engineering

1. **Basic and applied research in engineering, biology, or medicine.** Graduates from these programs conduct basic and applied research at universities, government laboratories, and large industries in an area of biomedical science or engineering.

2. **Medical practice or research.** These are graduates who have gone to medical or other professional schools. After completion, graduates practice medicine and/or perform

research. Biomedical engineering has advantages as a premedical major due to the increasing technological complexity in medicine.

3. **Professional engineering practice.** Working in industrial settings, hospitals or other biomedical institutions, these graduates use multiple facets of science to pursue industrial jobs in biomedical engineering. This includes engineering research and development, engineering design and product development, and business aspects of engineering, such as sales, customer engineering, and technical management.

Degree Programs

- **Bachelor of Science in Biomedical Engineering** Students graduating with a B.S. must be able to function competently in an engineering role and therefore must devote a major portion of their undergraduate education to engineering course work. The B.S. in Biomedical Engineering degree program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

  Those students who intend to work as engineers or pursue graduate programs in engineering must graduate with a B.S. degree. The requirements described in this guide are intended to ensure an excellent foundation in science, humanities and social sciences, engineering sciences and engineering design methods.

- **Bachelor of Arts in Biomedical Engineering** This program is designed for students who want more flexibility and diversity in their education than is possible within the B.S. program. The amount of required engineering is less than in the B.S. program leaving more time for electives. This program is suitable for a student who wants a general background in engineering but plans to continue his or her education at the graduate level in some field outside of engineering.

- **Combined B.S.-M.S.E. in Biomedical Engineering** The master's degree program in biomedical engineering can be integrated with the undergraduate B.S. program into a single 5-6 year program (since the MSE Program requires a research thesis, students may need 4 semesters to satisfy their requirements). The B.S. is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. The combined program allows the student to extend his or her studies into advanced areas of engineering and gain practical experience through a laboratory research or a design project. Students apply for and are admitted to the BS/MSE during their junior year. The M.S.E. program is designed to provide advanced study in any area of research interest of the BME department. If an integrated B.S./M.S.E. program is chosen, the student should plan accordingly so the requirements of both programs can be completed in five years. A requirement of the program is completion of a thesis project. Students should begin work on this project during their senior year. Information about the M.S.E. program can be obtained from Samuel Bourne (318 Clark Hall) or Dr. Kevin Yarema.

Bachelor of Science – Degree Requirements

The mission of the BS degree program of the Department of Biomedical Engineering is to provide state-of-the-art biomedical engineering education to students. Our Program Objectives have guided the development of the undergraduate degree curriculum so that:

1. Students will be successful in attaining entry into graduate (MS or PhD Degree Programs) or professional schools (Medical, Dental, Veterinarian, Business, Public Health, Law), or
2. Students will be successful in attaining employment in positions that utilize biomedical engineering or a related field.

To this end, our responsibility is as much to the future as it is to the present. Through a strong research and educational environment, we strive to empower our students to explore and define their own frontiers as well as instill the ethical principals that will foster rewarding professional endeavors. Upon completion of the B.S. in Biomedical Engineering, students will demonstrate the ability to:

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering. They will learn to:

- Apply knowledge of advanced mathematics (calculus, differential equations, linear algebra, statistics) to problems at the interface of engineering, biology and medicine
- Apply knowledge of life sciences (biology, physiology and medicine) to problems at the interface of engineering, biology and medicine
- Apply knowledge of natural sciences (chemistry and physics) to problems at the interface of engineering, biology and medicine
- Apply principles of engineering to problems at the interface of engineering, biology and medicine
- Mathematically model and simulate biological systems using computers

Outcome (b): an ability to design and conduct experiments, as well as to analyze and interpret data. They will learn to:

- Formulate hypotheses for experiments, including those on living systems
- Devise procedures for experiments, including those on living systems
- Collect and validate data using appropriate equipment
- Display, describe, summarize and interpret experimental results in a lab report
- Relate the experimental results to previous work, recognizing the interaction between living and non-living materials and systems
- Practice lab safety

Outcome (c): an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. They will learn to:

- Identify a desired need and define the biomedical engineering problem to be solved
- Determine the multiple, realistic constraints to the problem and assess the likelihood for success for different approaches
- Undergo the design process of creation, synthesis and integration
- Evaluate success of design to meet the desired need

Outcome (d): an ability to function on multidisciplinary teams. They will learn to:

- Communicate opinions, viewpoints and expertise with other team members
- Understand team goals and assume and fulfill individual responsibilities within the team

Outcome (e): an ability to identify, formulate, and solve engineering problems. They will learn to:

Conceptualize the engineering problem

- Formulate a solution to the problem
- Solve problem using experimental, mathematical and/or computational tools

Outcome (f): an understanding of professional and ethical responsibility. They will learn to:

- Understand the guidelines for ethical and responsible use of human subjects and data for research
- Understand the guidelines for ethical and responsible use of animals for research
- Understand professional and ethical standards in the workplace
- Properly acknowledge the work of others

Outcome (g): an ability to communicate effectively. They will learn to:

- Synthesize, summarize and explain technical content in a written report
- Synthesize, summarize and explain technical content in an oral presentation

Outcome (h): the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. They will learn to:

- Understand the contributions that biomedical engineers can make in academia, industry and government
- Understand how biomedical engineering solutions are of benefit inside and outside the U.S.

Outcome (i): a recognition of the need for, and an ability to engage in life-long learning. They will learn to:

- Use library resources, professional journals and Internet effectively
- Update technical literacy to understand contemporary issues
- Recognize need for self-assessment

Outcome (j): a knowledge of contemporary issues. They will learn to:

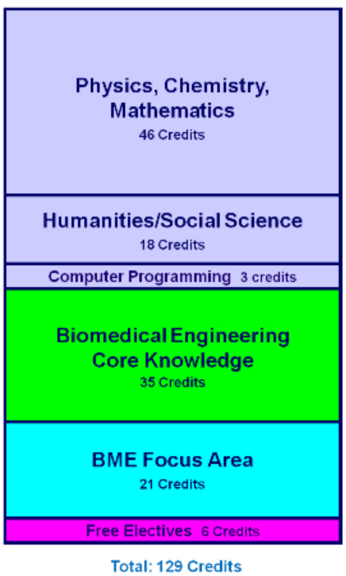
- Understand recent developments in biomedical engineering
- Understand differing viewpoints in academia, government, industry and business
- Gain ability to search and critically evaluate scientific literature

Outcome (k): an ability to use the techniques, skills and modern engineering tools necessary for engineering practice. They will learn to:

- Gain proficiency in computer simulations and mathematical analysis tools
- Create mathematical models
- Develop laboratory skills applied to living systems
- Utilize data acquisition systems

Structure of the Bachelor of Science Curriculum

The curriculum has been divided into 6 main areas: Basic Science and Mathematics, Biomedical Engineering Core, Biomedical Engineering Focus Area, Computer Programming, Humanities/Social Sciences, and Other Electives. No course may be counted in more than 1 of these areas. Within 1 area, a course can fill multiple requirements (i.e. H&S and Writing Intensive or Upper Level Engineering and Design). At least 129 credits must be taken. All general University requirements, as listed in the catalog and the undergraduate manual, must be met.



Physics, Chemistry and Mathematics (46 credits)

At least 22 credits* of basic science courses must be taken (29 if pre-med). The following courses must be taken for a letter grade and passed or completed by advanced placement examination. (*Note: AP labs are counted even though no credit is awarded)

Physics

(4) Physics for Physical Science & Engineering Majors I (171.101)
(4) Physics for Physical Science Engineering Majors II (171.102)
(1) Physics Lab I (173.111)
(1) Physics Lab II (173.112)

Chemistry

(3) Introductory Chemistry I (030.101)
(1) Introductory Chemistry Lab I (030.105)
(3) Introductory Chemistry II (030.102)
(1) Introductory Chemistry Lab II (030.106)
(4) Introduction to Organic Chemistry (030.205)

Premedical students only: Intermediate Organic Chemistry (030.206) and Lab (030.225)

Mathematics

At least 24 credits (23 credits if a 3-credit advanced statistics course is taken) of mathematics courses must be taken. The following courses must be taken for a letter grade and passed or completed by advanced placement examination.

(4) Calculus I for Physical Science and Engineering Majors (110.108)*
(4) Calculus II for Physical Science and Engineering Majors (110.109)
(4) Calculus III (110.202)

Either Option A or Option B

Option A: (recommended)
(4) Linear Algebra (110.201)
(4) Differential Equations (110.302)

Option B:
(4) Linear Algebra and Differential Equations (550.291)
One additional 3-400 level course from the Mathematics or Mathematical Sciences Department.

One of the following Statistics courses:

(4) Prob/Stats for Physical and Information Science and Eng (550.310)
(4) Prob/Stats for Biological Sciences and Eng (550.311)
(4) Applied Statistics and Data Analysis (550.413)
(4) Introduction to Statistics (550.430)
(3) Linear Statistical Models (550.432)
(3) Monte Carlo Simulation and Reliability (550.433)
(3) Nonparametric and Robust Methods (550.434)
(3) Bioinformatics and Genetics (550.435)

(3) Information, Statistics and Perception (550.437)
(3) Probability and Statistics in Civil Engineering (560.435)

*If Calculus I is waived without credit, then either Number Theory (110.114), Discrete Mathematics (550.171), or an additional 300 level math course must be taken.

Biomedical Engineering Core (35 credits)

At least 35 credits of core requirements must be taken. The following courses must be taken for a letter grade and passed.

(2) Biomedical Engineering Modeling and Design (580.111)
(1) BME in the Real World (580.202/302)
(4) Molecules and Cells (580.221
(4) Biomedical Systems and Control (580.222)
(4) Biomedical Modeling Simulations (580.223)
(4) Statistical Mechanics and Thermodynamics (580.321)
(4) Systems Bioengineering I (580.421)
(4) Systems Bioengineering II (580.422)
(2) Systems Bioengineering Lab I (580.423)
(2) Systems Bioengineering Lab II (580.424)
(4) Systems Bioengineering III (580.429)

Biomedical Engineering Focus Areas (21 credits)

Students will choose 21 credits from the appropriate focus area couse sheet. At least 18 credits must be higher-level engineering courses (5xx.3xx or 6xx.3xx level or above, but not research or Design Team). 3 or fewer credits can be a non-upper-level engineering focus area course, research, Design Team or 580.580/581. These courses must be taken for a letter grade and passed.

For additional information regarding the engineering focus areas, click the appropriate link:

Cell, Tissue and Biomaterials

Computational Biology

Imaging

Sensors, Instrumentation and MicroNano Technology

Systems Bioengineering

Guidelines for Specialty Focus Areas

Although the five focus areas in the undergraduate curriculum are broadly defined by the focus area lists (and contain much overlap), certain areas of biomedical engineering still may not be entirely encompassed within a single area. One example is neuroengineering, which may draw upon instrumentation and systems biology. Another is biomechanics, which may draw upon computational biology and tissue engineering. To allow additional flexibility in the choice of focus areas, students may opt to focus in a specialty area. However, because the four predefined focus areas are already quite broad, it is envisioned that the specialty focus area will be the exception and not the norm. The rules for this option are as follows.

1. Students must submit a written petition for a specialty focus area to the undergraduate program coordinator prior to their graduating year.
2. The petition should give a name to the specialty area (such as neuroengineering or biomechanics) and clearly articulate the definition of this area. In general, the area must be an accepted specialty of biomedical engineering.
3. The proposed combination of courses for the specialty area must be drawn from the focus area lists, consistent with the definition of the specialty area. For each different list that is used, a minimum of 2 courses (that do not jointly appear on the lists that are chosen) must be selected. The requirements for total number of credits and distribution of credits is otherwise the same as for the four predefined focus areas.
4. The petition will be reviewed by the program coordinator and program director, and either approved or disapproved. Please email Cathy Jancuk cjancuk@jhu.edu to request a sample specialty focus area petition.

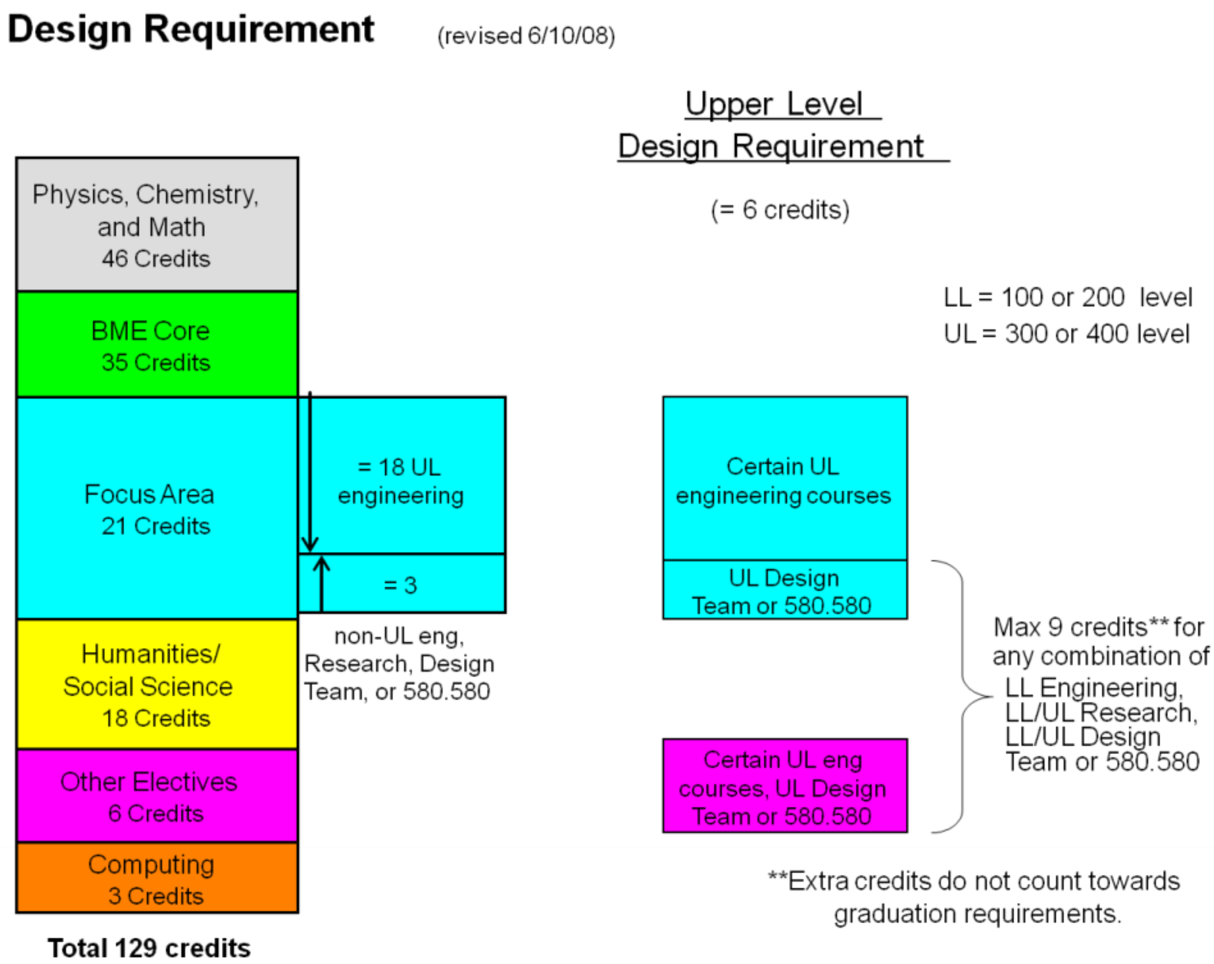
Design Requirement

At least two courses for a minimum of 6 credits must be taken. All design experiences must have some biological component. The design experience can be a structured 300-level or higher approved design course (see list below), or a research experience (course 580.580 & 580.581) for which a student would construct a twenty-page research report or submit a copy of a publication. Students who choose to complete the independent research experience must submit a proposal outlining the project as well as document the experience in a substantial research paper.

Approved year-long design courses: may be counted as ULE (upper level engineering) if that course is listed on the appropriate Focus Area Sheet or approved as part of a hybrid focus area.

One semester of design team (580.311, 411 or 413) or one semester of 580.580: may count in the 3 credit, non-ULE (upper-level engineering) portion of the focus area requirement. The other semester (580.312, 412, 414 or 580.581) may count in the Other Elective category.

The following diagram shows how design relates to the program requirements.



Approved Design Courses

Courses that are **bolded** are a two-semester sequence that must be taken in its entirety. Courses in *italic font* are one-semester courses that must be augmented by one semester of 580.580*.

(6) 510.433-434	**Senior Design in Materials Science & Engineering I & II**
(3) 520.448	*Advanced Electronics Laboratory*
(3) 520.454	*Control Systems Design*
(4) 520.495	*Microfabrication Lab*
(6) 520.498-499	**Senior Design Project**
(3) 530.421	*Mechatronic*
(3) 530.495	*Microfabrication Lab*
(3) 540.400 and 540.421	**Project in Design: Modeling Pharmcokinetics and Project in**

Design: Pharmacodynamics

(6) 580.311-312	**BME Design Team Junior (see additional information below)**
(6) 580.411-412	**BME Design Team Senior (see additional information below)**
(8) 580.413-414	**BME Design Team Leader (see additional information below)**
(6) 580.471-580.571	**Biomedical Instrumentation with Honors**
(4) 580.495	*Microfabrication Lab*
(6) 580.580-581	**BME Upper Level Design (see additional information below)**
(3) 600.321	*Object Oriented Software Engineering*
(7) 600.445-446	**Computer Integrated Surgery I & II**

580.580/580.581 Design Project

The objective of 580.580 and 580.581 is to conceive and carry out a research-based design project. These projects will be carried out in laboratories throughout Johns Hopkins University (as research projects) and will require a substantial design component in accordance with the following ABET (Accreditation Board for Engineering and Technology) definition:

"The process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. The engineering design component of a curriculum must include at least some of the following features: development of student creativity, use of open-ended problems, development and use of design methodology, formulation of design problem statements and quantitative specifications, consideration of alternative solutions, feasibility considerations, and detailed system descriptions."

The requirement for 580.580-581 is that you write a design proposal before registering, prepare a project paper upon completion, and attend design lectures once a week. The proposal **must** be approved by your design advisor, as well as by Dr. Robert Allen. Students are not required to register for 580.580 and 580.581 in consecutive semesters (ex: a student could register for 580.580 in their junior year spring semester and 580.581 in their senior year spring semester), however, registering consecutive semesters provides continuity to the project.

If 580.580 will be used to augment a one-semester design course, students will register for one semester only – all other policies and procedures apply.

Registering for the class is not nearly as important as having a proposal approved; this should be done as soon as possible. The course can be added any time before the end of the 6-week semester deadline.

Step 1 - submit project proposal to your advisor and BME Office (in electronic format)
Step 2 - receive notification to begin project or to revise proposal

Step 3 - register for the class
Step 4 - submit a final report to your advisor and the BME office.

There are no formal guidelines for a design proposal. Common items within a proposal should be the following:

1) title page,
2) abstract (what you will do, how, & what your MEASURABLE GOALS (quantify) are,
3) introduction and background,
4) statement of proposed work and how will you do it.
5) expected outcomes and how they are to be measured, and
6) time line and bibliography.

Not including 1) and 2), five pages or so should be sufficient. For a sample project, a reasonable title could start, "Evaluating and Characterizing Sensing Technology to Measure Hand Applied Forces." and your first abstract sentence could read, "We propose to explore sensing technology to ...” Attached is the remainder of the abstract. Note that it **does not** descibe the clinical problem; that should be reserved for background. An example of a well-written proposal can be requested from the BME Office in 318 Clark Hall.

BME Design Team

BME Design Team (580.211-212, 580.311-312, 580.411-412 and 580.413-414) is a full year course. Applications for Team Leaders and Upperclassmen (sophomore, junior and senior) are solicited via email in April each year. Team Leaders are interviewed and announced prior to May 1. Once selections are made, upperclassmen are contacted by the newly installed team leaders. Registering for the class is not nearly as important as getting your application submitted and being contacted by a team leader. The course can be added in the fall semester before the end of the 6-week semester deadline. Please remember that you are making a commitment to be part of a team for the entire year. BME students must complete the entire year to receive credit.

Students will receive the following credits for BME Design Team:

Year	Fall	Spring
Upperclassman	3	3
Team Leader	4	4

*Note, not all of these credits will be counted toward fulfillment of graduation requirements. The limits are described below. Any excess credits a student receives will be listed on his/her transcript and factored into his/her GPA.

Freshman Year - Students who take design team as a freshman can count 3 credits toward their focus area credits (non-ULE) or other elective credits.

Sophomore-Senior Year - Students may count a maximum of 9 credits: focus area (3) or other elective (6). For juniors and seniors, one year of Design Team fulfills your upper level design requirement.

Computer Programming

At least 3 credits computer programming must be taken. The course must be taken for a letter grade and passed or completed by advanced placement examination.

(3) 500.200 Computing for Engineers and Scientists
(3) 510.202 Computation and Programming for Materials Science and Engineering
(4) 550.385 Scientific Computing: Linear Algebra
(4) 550.386 Scientific Computing: Differential Equations
(3) 570.210 Computation and Math Modeling (added 2/2009)
(3) 580.200 Intro. to Scientific Computing in BME Using Python, Matlab and R
(3) 600.107 Intro. to Programming in Java (students without prior exposure are advised co-register for 600.108 Intro to Programming Lab)
(3) 600.111 Python Scripting
(3) 600.112 Introduction to Programming for Scientists and Engineers

Humanities and Social Sciences (18 credits)

At least 6 courses for a minimum of 18 credits should be taken. This must include at least two semesters of coursework in which substantial attention is paid to developing written communication skills; these courses are considered writing-intensive and are marked with by a (W) in the course catalog. The H & S courses should form a coherent program relevant to the student's goals and must include at least one course at the 300 level. A course in which economic, ethical, political, or social issues related to technology are discussed is recommended.

Many times, student use these credits as an opportunity to pursue a minor or to look at science from a humanistic view through courses in the department of Science, Medicine, and Technology.

Writing Requirement

All undergraduates are required to fulfill the University writing requirement before graduation. "W" courses, which require a number of written papers, are found throughout the curriculum. Any course taken to satisfy the writing requirement cannot be taken on a satisfactory/unsatisfactory basis. Students pursuing a BS must complete 2 "W" courses.

Courses without H/S Designation (limited applicability)

Introductory Language Courses: Note that the Whiting School (and the BME Department) allow the first two semesters of any elementary course in a foreign language to count toward the fulfillment of the H/S requirement, as long as both semesters are successfully completed.

Music Theory Courses: Music Theory I, II and III may be counted toward the H/S requirement ONLY if the student will COMPLETE a music minor.

Other Electives (6 credits)

Students may place any course (art, music, engineering, math, internship credit, etc.) in this category. (Note: AP Biology and Statistics cannot be used.) Some suggestions for efficient use of these 6 credits include:

- Intermediate Organic Chemistry and Lab (premed students)
- Research credit over the 3-credit limit from the focus area (non-ULE)
- Design Team credit over the 3-credit limit from the focus area (non-ULE
- 580.581 credit (a 3-credit 580.580 would be used in the focus area (non-ULE)

Bachelor of Arts – Degree Requirements

This program is designed for students who want more flexibility and diversity in their education than is possible with the BS program. The amount of required engineering coursework is considerably less – leaving more time for electives. This program is suitable for a student who is interested in a general background in engineering but plans to pursue graduate level work or a career in a field outside of engineering.

Structure of the Bachelor of Arts Curriculum

The curriculum has been divided into 4 main areas: Basic Science and Mathematics, Biomedical Engineering Core, Humanities/Social Sciences, and Other Electives. No course may be counted in more than 1 of these areas. Within 1 area, a course can fill multiple requirements (i.e. H&S and Writing Intensive). At least 120 credits must be taken. All general University requirements, as listed in the catalog and the undergraduate manual, must be met.

Physics, Chemistry and Mathematics (42 credits)

At least 22 credits* of basic science courses must be taken (29 if pre-med). The following courses must be taken for a letter grade and passed or completed by advanced placement examination. (*Note: AP labs are counted even though no credit is awarded)

Physics

(4) Physics for Physical Science & Engineering Majors I (171.101)
(4) Physics for Physical Science Engineering Majors II (171.102)
(1) Physics Lab I (173.111)
(1) Physics Lab II (173.112)

Chemistry

(3) Introductory Chemistry I (030.101)
(1) Introductory Chemistry Lab I (030.105)
(3) Introductory Chemistry II (030.102)
(1) Introductory Chemistry Lab II (030.106)
(4) Introduction to Organic Chemistry (030.205)
Premedical students only: Intermediate Organic Chemistry (030.206) and Lab (030.225)

Mathematics

At least 20 credits of mathematics courses must be taken. The following courses must be taken for a letter grade and passed or completed by advanced placement examination.

(4) Calculus I for Physical Science and Engineering Majors (110.108)*
(4) Calculus II for Physical Science and Engineering Majors (110.109)
(4) Calculus III (110.202)

(4) Linear Algebra (110.201)
(4) Differential Equations (110.302)

Biomedical Engineering Core (35 credits)

At least 35 credits of core requirements must be taken. The following courses must be taken for a letter grade and passed.

(2) Biomedical Engineering Modeling and Design (580.111)
(1) BME in the Real World (580.202/302)
(4) Molecules and Cells (580.221
(4) Biomedical Systems and Control (580.222)
(4) Biomedical Modeling Simulations (580.223)
(4) Statistical Mechanics and Thermodynamics (580.321)
(4) Systems Bioengineering I (580.421)
(4) Systems Bioengineering II (580.422)
(2) Systems Bioengineering Lab I (580.423)
(2) Systems Bioengineering Lab II (580.424)
(2) Systems Bioengineering III (580.429)

Humanities and Social Sciences (24 credits)

At least 8 courses for a minimum of 24 credits should be taken. At least two semesters of a modern foreign language must be taken. Student must also include at least 12 credits of coursework in which substantial attention is paid to developing written communication skills; these courses are considered writing-intensive and are marked with by a (W) in the course catalog. The H & S courses should form a coherent program and include at least 9 credits chosen from one department, including at least one course at the 300-level. A course in which economic, ethical, political, or social issues related to technology are discussed is recommended.

Many times, student use these credits as an opportunity to pursue a minor or to look at science from a humanistic view through courses in the department of Science, Medicine, and Technology.

Writing Requirement

All undergraduates are required to fulfill the University writing requirement before graduation. "W" courses, which require a number of written papers, are found throughout the curriculum.

Any course taken to satisfy the writing requirement cannot be taken on a satisfactory/unsatisfactory basis. Students pursuing a BA must complete 4 "W" courses.

Courses without H/S Designation (limited applicability)

Introductory Language Courses: Note that the Whiting School (and the BME Department) allow the first two semesters of any elementary course in a foreign language to count toward the fulfillment of the H/S requirement, as long as both semesters are successfully completed.

Music Theory Courses: Music Theory I, II and III may be counted toward the H/S requirement ONLY if the student will COMPLETE a music minor.

Other Electives (19 credits)

At least 19 additional credits (12 credits for premedical students counting Intermediate Organic Chemistry and Lab) are needed to complete the 120 credit requirement for the BA Degree. A course in computer programming is highly recommended.

Information for All Degree Programs

Advanced Placement Credit

Please consult the Arts and Science/Engineering Catalog. All current University policy is posted there. If you do not see a course/test listed, then Johns Hopkins does not accept credit for it. Please note that while the University does accept AP credit for Biology and Statistics, these courses cannot be counted toward the 129 credits required for the BS, nor the 120 credit requirement for the BA.

Advising Procedures

The director of the undergraduate program is Dr. Leslie Tung (ltung@jhu.edu). The program manager for the undergraduate program is Ms. Cathy M. Jancuk (cjancuk@jhu.edu). Freshmen will be assigned advisors through the Biomedical Engineering Office, Room 318 Clark Hall. Students keep the same advisor from year to year unless a change is requested or their advisor is unavailable for an extended period of time. To change advisors, students must meet with Ms. Jancuk.

Students are required to make appointments with their advisors during spring and fall advising when they are planning their course of study. It is imperative that the advisee bring a copy of his/her checklist to the meeting. The coordinator will not sign registration forms for students who have not met with their advisor. Approximately one week prior to the start of the advising period, electronic sign-up lists will be sent out to all students (usually done via a scheduling website like Doodle). Students must also consult their advisors when making changes to their classes. This may be accomplished by sending an e-mail to the advisor.

D Credit/Poor Grades

No more than 6 credits (or two courses) of **courses in which a grade of D was received** may be applied to engineering, science and mathematics requirements. Students may absolve any grade that is a C+ or below by repeating a course. Repeated courses must be taken at Johns Hopkins (see Undergraduate Academic Manual).

Research/Independent Study

Up to 9 credits of **Undergraduate Research** (580.50X, 580.53X) may be applied toward the requirements for graduation (up to 3 credits toward non-ULE focus area) with approved write-up, and up to 6 toward other elective credit). Credits received for **Independent Study** may only be applied toward "Other Electives". Students should use research and independent study to augment their classroom experiences, not replace them.

The following policies and procedures apply to research and independent study. Note also that the University has a number of policies that apply to research and independent study which are detailed in the Undergraduate Advising Manual.

<u>Independent Study</u> (580.51X, 580.54X) should be used for reading courses, literature reviews, etc. A pass/fail grade will be given unless the student produces written work (a paper, homework problems, etc.) which can be objectively graded. An oral presentation or exam may be substituted if appropriate.

<u>Research</u> (580.50X, 580.53X) should be used for laboratory work, computer programming, design and construction of equipment, or other practical work or bench work. Only a pass/fail grade should be given for research unless there is an objective basis for a grade (a paper or report).

- Freshmen and sophomores may register for 580.50X (research) or 580.51X (independent study).
- Upperclassmen may take 580.53X (research) or 580.54X (independent study) if, in the preceptor's opinion, the student's project qualifies as 300 level (advanced undergraduate) work.
- Students registering for intersession research should use 580.547.
- Students registering for summer research should use 580.597.

For student using 3 credits of research toward the non-ULE category in the Focus Area: students must submit a 1-2 page write-up summarizing the work done, justification for focus area credit, and the basis for grading. This should be emailed to Cathy Jancuk cjancuk@jhu.edu no later than the semester prior to graduation. THIS APPLIES TO RESEARCH DONE IN THE BME DEPARTMENT AND TO RESEARCH DONE ELSEWHERE.

Satisfactory/Unsatisfactory

Engineering courses beyond the required engineering credits for the B.S. (or B.A.), 24 mathematics, and 22 basic science courses may be taken **S/U.** This only applies for classes taken after first semester freshman year since ALL students take first semester freshman year S/U. A limited number of H/S courses may be taken S/U – no writing intensive courses (W) may be taken S/U. Please consult the Undergraduate Academic Manual for guidelines regarding S/U credits.

Study Abroad

It is possible for all BME majors to study abroad with appropriate planning. Please consult the JHU Study Abroad website (**http://www.jhu.edu/~advising/StAbd.htm**) for more information on specific protocol and programs. Dr. Lori Citti**jhuabroad@jhu.edu** is the person with whom one should speak about specifics of the study abroad programs.

The Vredenburg Scholarship is open to all current sophomores and juniors. It provides the opportunity for School of Engineering students to have summer exploration opportunities including academic experiences (research and study abroad) and internships with a private company, nonprofit organization or NGO (paid or unpaid). There are both early decision and regular decision deadlines. Please consult the Vredenburg web site (**http://engineering.jhu.edu/academicaffairs/vredenburg/**) or the Office of Engineering Academic Affairs in Shaffer 102 for more information.

Transfer Courses

Summer school courses (up to 12 credits) taken at other institutions may be included in the student's program, but only with prior approval from the student's advisor and the Office of Academic Advising. This limit does not apply to AP courses. Such courses may be used to fulfill requirements if a similar course taught at Hopkins would be appropriate.