

# Vanderbilt University School of Engineering

## Biomedical Engineering Undergraduate Curriculum Guide

This guide is a supplement to the Official University Catalog. The University Catalog is the official guiding document. The roster of faculty, basic curriculum and descriptions of all classes are found in the Undergraduate Catalog published annually by the University online at <https://registrar.vanderbilt.edu/catalogs/>. If there is a discrepancy between this curriculum guide and the catalog, the catalog wording take precedence and will be used to determine if requirements have been met. This includes requirements for enrollment and graduation.



**VANDERBILT**  
School *of* Engineering  
Biomedical Engineering

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**W**elcome to the study of biomedical engineering at Vanderbilt University. The mission of our department encompasses that of the Vanderbilt School of Engineering, which is to provide a high-quality education in selected areas of engineering, balanced with broad learning opportunities from other fields, and integrated to provide intellectual richness and flexibility. It is the mission of the Vanderbilt Department of Biomedical Engineering to

- Enlighten our students with the engineering, mathematics and basic sciences that advance health care and biotechnology;
- Develop the reasoning faculties of our students, enlarge their mindsets and instill in them precepts of accuracy, ethics and enterprise; and
- Form the engineers, physicians, scientists and industrialists upon whose leadership continued progress in scientific understanding, health and industry depend.

The objectives of the Vanderbilt undergraduate program in biomedical engineering are that within a few years of graduation, graduates will

1. Continue to expand their knowledge, for example by pursuing advanced degrees at top-tier institutions in engineering, medicine, business, or law.
2. Contribute to society while upholding the highest professional and ethical standards.
3. Become leaders and succeed in their careers as engineers, scientists, health professionals, entrepreneurs, and other professionals.

To achieve these objectives, the BME faculty has designed the curriculum described in this guide. If you follow this curriculum, the objectives above will be met for you specifically and you will be prepared for the next stage of your life as a biomedical engineer. In particular, this curriculum is designed to provide you with the following outcomes:

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 global, cultural, social, environmental, and economic factors.
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.

As is the case for most things worth learning, biomedical engineering as a field is too broad to cover in its entirety in an undergraduate curriculum. Vanderbilt BME spans a wide range of particular interests from devices that allow us to see inside the body without entering to systems of equations that provide insight on how the circulatory system responds to changes in cardiac function; from the observation and determination of how microscopic cells and groups of cells control macroscopic events to the management of information flow in a medical center. While you may focus on a particular part of BME, a working knowledge of other material is essential. Consequently, our curriculum will provide you the broad fundamentals of biomedical engineering and then allow you the flexibility to concentrate on your particular area of interest in your junior



and senior years. Rather than being forced to choose from fixed specialty tracks, the curriculum gives you the opportunity to build on required core knowledge and explore and define your own area(s) of specialization for higher level study.

The University Catalog is the official guiding document. The roster of faculty, basic curriculum and descriptions of all classes are found in the Undergraduate Catalog published annually by the University online at <https://registrar.vanderbilt.edu/catalogs/> If there is a discrepancy between this curriculum guide and the catalog, the catalog wording take precedence and will be used to determine if requirements have been met. This includes requirements for enrollment and graduation.

**Please note that our curriculum is not static. Consult with your academic adviser regarding changes to the curriculum and how they apply to you. For any other questions, please reach out to the Director of Undergraduate Studies for biomedical engineering and/or their student assistant.**

## General Guidelines

1. **Student Responsibility.** The student, not his or her adviser, is responsible for seeing that he or she has fulfilled all the requirements for graduation. The adviser's role is as a co-conspirator in the success of the student.
2. The **Undergraduate Catalog** (also known as “The Bulletin of Vanderbilt University”) contains all official information related to degree requirements. It is available online at <https://registrar.vanderbilt.edu/catalogs/>. In case of any conflict between the Catalog and this guide, the Undergraduate Catalog shall prevail.
3. **Credit Hours.** BME majors need credit hours as allocated in the table below to graduate.

	<b>Credit Hours</b>
Mathematics	15
Basic Sciences	20
Engineering Fundamentals	6
Electrical engineering	3
BME core	38
BME electives	12
Technical (science, engineering, math) electives	9
Liberal Arts Core	18
Open electives	6
<b>Total hours</b>	<b>127</b>

4. **Core Curriculum.** The required courses that comprise the core curriculum are shown as explicitly listed courses in the detailed curricula on Page 14 and, for premed and double majors (BME/ChBE and BME/EE), on Pages 18 and 19, respectively. While there is some flexibility, the course sequence is laid out to ensure that students will have the necessary prerequisites for each course and will not encounter scheduling conflicts for required courses. Should you, by choice or by necessity, find yourself using a different sequence for completing these courses, pay careful attention to prerequisites, corequisites, and feasibility of scheduling.
5. **Basic Sciences.** The core curriculum includes a basic science requirement (20 hours) consisting of Chemistry 1601-1602, 1601L-1602L, Physics 1601-1602, 1601L-1602L, and Biological Sciences 1510/1510L.
6. **Electives.** 27 hours of electives are required. Of these, at least 12 hours must be BME electives with no more than a total of 6 credit hours from BME 3860-3861. The remaining 15 hours may be selected from either Open (6 hours) or Technical electives (9 hours) listed on page 15. Both semesters of organic chemistry count as Technical electives. Courses taken to fulfill the program elective requirement may not be taken pass/fail.
7. **Liberal Arts Core.** Students must take 18 credit hours of liberal arts electives to satisfy the Liberal Arts Core (LAC) requirement.
  1. At least 3 hours selected from courses classified in the AXLE Curriculum Course Distribution of the College of Arts and Science as Humanities and Creative Arts (HCA) with the exception of CMST 1500, 2100, 2110, and 2120, and

2. At least 3 hours selected from courses classified in the AXLE Curriculum Course Distribution of the College of Arts and Science as Social and Behavioral Sciences (SBS)
3. Remaining hours are to be selected from:
  - a. Courses classified in the AXLE Curriculum Course Distribution of the College of Arts and Science as Humanities and Creative Arts (HCA), International Cultures (INT), History and Culture of the United States (US), Social and Behavioral Sciences (SBS), and Perspectives (P)
  - b. CS 1151 and ENGM 2440
  - c. Arabic 1101, Chinese 1011, 1012, 1101, English 1100, French 1101, German 1101, Greek 1101, Hebrew 1101, Italian 1101, Japanese 1011, 1012, 1101, Latin 1101, Portuguese 1101, Russian 1101, and Spanish 1100, 1101
  - d. Peabody College courses in Psychology and Human Development numbered 1205, 1207, 1250, 2200, 2250, 2300, 2400, 2500, 2550, 2600, and 3150, and in Human and Organizational Development numbered 1250, 1300, 2100, 2260, 2400, 2500, 2700, and 3232
  - e. All MUSC, MUSE, MUSO, COMP, MREP, MUTH, and performance courses in the Blair School of Music, **except** MUSO 1001
  
8. **Open Electives.** These credit hours allow students to explore an area of interest that may or may not be related to BME. All BME students should take **BME 1015**, which can be counted as 1 credit hour for Open or Technical electives. **Freshmen engineering seminars** carry 1 hour of Open elective credit and are recommended. Courses excluded from the liberal arts core listings may be counted as Open electives. All officer education courses designated as eligible for credit (see the Undergraduate Catalog, Special Programs for Undergraduates) may be taken as Open electives. In addition, officer education courses in history and political science carry AXLE designations and may be taken as part of the Liberal Arts Core. AFROTC students may count 6 hours of military courses as Open electives.
  
9. **Study Abroad.** Students interested in study abroad during the academic year (rather than a summer program) should begin planning early to deal with the challenges presented by sequences of courses that are not offered every semester. For more information, go to the School of Engineering Study Abroad website (<https://engineering.vanderbilt.edu/academics/undergraduate/study-abroad/>), the Global Education Office website (<http://www.vanderbilt.edu/geo/>), or contact Associate Dean Cynthia Paschal ([cynthia.paschal@vanderbilt.edu](mailto:cynthia.paschal@vanderbilt.edu)). To better plan your Study Abroad experience, contact your adviser and setup a meeting.
  
10. **AP, IB, and Transfer Credits.** Advanced Placement, International Baccalaureate, and transfer credits can be applied toward certain requirements for your BME degree if the specific credits are determined to be acceptable in the transfer credit process embedded in YES. Potential study abroad credits can also be seen in YES.
  
11. **Graduate School Preparation / Professional Preparation.** The BME curriculum should prepare you for graduate school or professional practice. Consult with your adviser to plan your electives to suit your career goals. Students planning to take the Graduate Record Examination (GRE) in anticipation of applying to graduate school are encouraged to strengthen

verbal skills by taking courses with significant non-technical reading, by reading for pleasure and by studying vocabulary frequently.

**12. Medical School Preparation.** If you are considering medical school, note the following:

- a) Premeds take organic chemistry with lab (Chem 2221-2222/2221L-2222L) as eight of their Technical Elective hours.
- b) Premeds planning to take the medical college admission test (MCAT) need to take biochemistry (BSCI 2520) as 3 of their Technical Elective hours.
- c) We recommend that premeds consider deferring Physiological Transport (BME 3000) until their senior year if taking biochemistry (BSCI 2520) in their junior year.
- d) We strongly recommend that premeds not pursue a double major.
- e) Premeds should take English courses as two of their six LAC courses. Writing (“W”) courses are encouraged. On some medical school applications, it may be possible to count BME 2900W, 3900W and 4901W as 3 credit hours of the “English” courses.
- f) Premeds should also include courses in Psychology and Sociology as two of their six LAC courses.
- g) Premeds should plan to take one year (8 credit hours) of Biology. BSCI 1510/1510L is required for the BME major, leaving students to select four more credit hours of Biology among their electives. Some medical schools require a year of Biology and lab, in which case BSCI 1511/1511L can be used to satisfy this requirement. These courses can be taken as Technical or Open electives.
- h) The Health Professions Advising Office (HPAO) offers additional guidance and support to students preparing for medical school and should be contacted early in the degree program.
- i) While AP credits are generally accepted toward the undergraduate degree, many medical schools do not accept AP credits when evaluating applicants’ credentials. So, while for example you may have four hours of AP credit for Chem 1601/1601L, you may need to take four additional credit hours of Vanderbilt chemistry in order to be considered for a particular medical school. Check said medical school’s website to be sure this is required.
- j) Our curriculum will prepare students to apply to nearly all medical schools. However, students should be aware that some medical schools have additional requirements. Check with the HPAO (<https://www.vanderbilt.edu/hpao/>) regarding any unique requirements.

**13. Honors.** With approval of the Honors Program Director, Dr. Amanda Lowery, juniors and seniors in biomedical engineering who have achieved a **minimum GPA of 3.5** may be accepted into the undergraduate honors program. Honors students take at least six credit hours of 5000-level or higher BME courses, which can be counted toward the undergraduate degree requirements as BME electives or can be taken for graduate school credit. Honors students must make a GPA of 3.0 in these classes and maintain an overall 3.5 GPA to be designated with honors upon graduation. The diploma designation is Honors in Biomedical Engineering. Students in the honors program must also complete a two semester-long research project and present a research report; this can be accomplished through the BME 3860 and 3861 Undergraduate Research elective courses. The report is due in manuscript form to the Honors Program Director the same day as it is due to the research course director and project preceptor.

To apply, fill out the [Honors Program Application Form](#) detailing how you plan to meet the requirements for the honors program, complete you’re Four Year Curriculum Spreadsheet, and meet with your academic advisor to obtain their approval before the start of your senior year. Once these steps have been completed, your advisor will fill out an online approval form

which will be sent to the Honors Program Director ([amanda.r.lowery@vanderbilt.edu](mailto:amanda.r.lowery@vanderbilt.edu)) for approval.

14. **Internships.** The experience of working as an intern in a biomedical engineering firm or research laboratory can be an invaluable component of your education and preparation for future employment. Such an experience strengthens the understanding of concepts learned in the classroom, teaches valuable workplace skills, and provides insight into future career options. Summer internships are strongly encouraged, especially for rising juniors and seniors. Please meet with your academic adviser and the Center for Student Professional Development for guidance **no later than November** prior to the summer in which you wish to participate in an internship.
  
15. **Double majors.** At present, there are two formal double majors within the School of Engineering, one with chemical engineering/BME and another with electrical engineering/BME. The term ‘double major’ in this context identifies a pre-defined program that has been agreed to by both departments in such a way to meet the expectations of both majors in a reasonable number of total credit hours.

Students interested in the BME/ChBE double major should consult with Dr. Craig Duvall ([craig.duvall@vanderbilt.edu](mailto:craig.duvall@vanderbilt.edu)) regarding requirements and details of scheduling—a sample curriculum is given on page 18 of this guide. The double major with electrical engineering is detailed on page 19; students considering the BME/EE double major are urged to consult with the BME/EE double major adviser, Prof. Benoit Dawant ([benoit.dawant@vanderbilt.edu](mailto:benoit.dawant@vanderbilt.edu)). Students **must declare** their intention to double major by completing the appropriate form available in the School of Engineering Office of Academic Services.
  
16. **Second Majors.** Occasionally students choose to obtain two majors outside those offered through the double major programs. Students pursuing two majors should note that there are no pre-approved exceptions between the two departments, and thus, in such cases, **students must meet all of the individual requirements of both majors**, which generally requires advanced placement credits, summer study, higher semester course loads, and/or extra semester(s). Students choosing this track must manage their requirements and will typically be assigned two academic advisers, one for each program. For any further questions or advice on planning, students are encouraged to consult both majors’ advisers and/or the Assistant to the Director of Undergraduate Studies for Biomedical Engineering. In cases where two majors are unattainable but the areas of study are still of interest, students are encouraged to pursue a Minor in one of the subject areas. For further information and sample curricula, see page 20.
  
17. **Minors.** There are ten official minors in the School of Engineering: computer science, digital fabrication, electrical and computer engineering, energy and environmental systems, engineering management, environmental engineering, materials science and engineering, nanoscience and nanotechnology, quantum information science and engineering, scientific computing. Students wishing to pursue these minors can spend their allotted hours of Technical and Open electives towards these minors. Please see the Undergraduate Catalog for sequences. **Other minors outside the School of Engineering are possible** and students are encouraged to consult the Undergraduate Catalog and faculty in the program of interest for minor requirements. Students must declare their intention to add a minor by completing the appropriate form available online at the School of Engineering Office of Academic Services website (<https://engineering.vanderbilt.edu/academics/undergraduate/academic-services/>).

18. **Focus Areas.** VUSE offers seven focus areas in Human Computer Interaction, Microelectronics, Nanotechnology, Strategic and Technical Consulting, Engineering Communications, Technology Entrepreneurship, and Product Development. Students can declare a maximum of three focus areas. Courses taken for completion of a focus area may be applied toward undergraduate degree requirement, as appropriate; however, a qualifying course cannot be applied to more than one focus area. Students interested in declaring a focus area must do so before the start of their final semester at Vanderbilt. Successful completion of a declared focus area will be designated on a student's transcript upon graduation.

Focus areas provide guidance to students wishing to concentrate on a specialized topic within engineering. Focus areas are typically nine credit hours (about half the course load of a minor), and [qualifying courses](#) are listed in the catalog. These seven focus areas will earn a designation on your transcript but you may also chose to focus your electives in a different area and not receive the transcript designation. Focusing your electives, even when not designated on your transcript may be valuable for future employment opportunities.

19. **Accelerated Graduate Program in Engineering.** Students with a significant number of class credits (**20 to 30 hours**), earned either through Advanced Placement tests or in college courses taken during high school, may be eligible for the Accelerated Graduate Program in Engineering. Through this program, a student is able to earn both a bachelor's degree and a master of science in about the same time required for the bachelor's degree. To be eligible for the program, a student must complete **86 hours** (senior standing) by the end of the sophomore year with a **minimum GPA of 3.5**.

To enroll, students must meet with and be approved by their current academic adviser, the Director of Graduate Studies in their department ([craig.duvall@vanderbilt.edu](mailto:craig.duvall@vanderbilt.edu) for BME), the Senior Associate Dean of Engineering ([cynthia.paschal@vanderbilt.edu](mailto:cynthia.paschal@vanderbilt.edu)), and the Senior Associate Dean of Graduate Education ([florence.sanchez@vanderbilt.edu](mailto:florence.sanchez@vanderbilt.edu)) **in the specified order**. Upon admission to this program, a second "career" will be set up for the student which will allow the student to start taking graduate courses (course numbers > 5000) during the junior and senior years. These courses will be credited toward the Master of Science. Note that no double counting of courses is allowed (i.e., the student must meet the degree requirements for each degree independent of the other degree). The student receives the bachelor's degree at the end of the fourth year and typically spends the summer finishing a master's thesis to complete the Master of Science. Further information can be obtained from the director of graduate studies of the student's major department.

**Disclaimer: This Sample Curriculum is only an example of a 4-year schedule. All BME core classes (except senior design courses) are offered during both Fall and Spring semesters, and there is flexibility as to the order in which courses are taken. However, students are responsible for checking and meeting course pre- and co-requisites prior to enrollment. For example, it may be beneficial to start the Quantitative Methods and Instrumentation series earlier, if possible, to enable further flexibility. BME 3000 Transport does not serve as a prerequisite or corequisite, making it a good candidate to take later if necessary. Courses may be interchanged to promote flexibility, provided fulfillment of all listed prerequisites (see table of co- and pre-requisites after the sections on electives). Consult with your academic advisor or contact the DUS or DUS assistant for any specific questions about your course enrollment or scheduling plans.**

### Biomedical Engineering Sample Curriculum

First Year - Fall		Cr Hrs	First Year - Spring		Cr Hrs
Chem 1601/1601L	General Chem + Lab	4	Chem 1602/1602L	General Chem + Lab	4
ES 1401-1403*	Intro to Engineering	3	CS 1103/1101/1100**	Programming	3
Math 1300	Calculus	4	Math 1301	Calculus	4
LAC Elective		3	Physics 1601/1601L	General Physics + Lab	4
	Vanderbilt Visions	0	BME 1015 (Open Elective)	Innovations & Careers	1
<b>Total Hours</b>		<b>14</b>	<b>Total Hours</b>		<b>16</b>
Second Year – Fall			Second Year - Spring		
BME 2301***	Systems Physiology 1	3	BME 2302	Systems Physiology 2	3
BSCI	Intro Bio + Lab	4	BME 2100	Biomechanics	3
1510/1510L*****			Math 2400****	Diff Eqns/Linear Alg	4
Math 2300	Multivariable Calc.	3	ECE 2112	Circuits	3
Physics 1602/1602L	General Phys. + Lab	4	BME 2900W	Engineering Lab 1	1
LAC Elective		3	BME 2400	Quantitative Methods 1	3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>17</b>
Third Year - Fall			Third Year - Spring		
BME 3000	Physiological Transp.	3	BME 3302	Instrumentation 2	4
BME 3301	Instrumentation 1	4	BME 3500	Biomaterials	3
BME 3400	Quantitative Methods 2	3	BME Elective*****		3
BME 3900W	Engineering Lab 2	1	BME Elective		3
LAC Elective		3	LAC Elective		3
Tech Elective*****		3			
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>16</b>
Fourth Year - Fall			Fourth Year - Spring		
BME 4901W	Engineering Lab 3	1	BME 4951	BME Design	3
BME 4950	BME Design	2	BME Elective		3
BME 4959	Design Seminar	1	Tech Elective		3
BME Elective		3	LAC Elective		3
Tech Elective		3	Open Elective		3
LAC Elective		3			
Open Elective		2			
<b>Total Hours</b>		<b>15</b>	<b>Total Hours</b>		<b>15</b>

Hours required to graduate = 127



## Notes:

\*For transfer students, ES 1401-1403 can be replaced with any course(s) in the School of Engineering **except:**

- 1) CS 1151 and ENGM 2440,
- 2) ES 2700, 2900, 3884,
- 3) ENGM 3350, and
- 4) courses that is(are) restricted to open elective credit toward a degree in the school, such as BME 1015, 2201, 2860, CS 1000, ENGM 4800, ES 1001.
- 5) The substituting course(s) cannot simultaneously be counted toward other requirements in the primary degree nor can it(they) be taken pass/fail.
- 6) Accepted substitutions include UG research courses (BME 3860, BME 3861) and ES 2100W Technical Communications.

\*\*Students with an interest in advanced computer science should consider taking CS 1101(Java) or 1100 (Python) rather than CS 1103 (MATLAB). However, these students will be responsible for learning the MATLAB skills (taught in CS 1103) needed in later BME courses.

\*\*\*BME 2301 does not have to be the first BME class taken in fall of sophomore year. Other examples on how to launch into initial BME courses are to enroll in BME 2100 or BME 2400 (provided completion of the MATH 2300 prerequisite). The first requirement for BME 2301 is that it is a co-requisite for junior BME lab (BME 3900W).

\*\*\*\*Math 2400 is the required course, though a combination of BOTH Math 2420 and either Math 2410 or 2600 may be substituted, with the extra math hours counting as Technical electives.

\*\*\*\*\*BME students take at least 12 credit hours of BME program electives and 9 credit hours of Technical (science, engineering, or math) electives. See following sections on electives.

\*\*\*\*\* AP Biology credit (BSCI 1100/1100L) will NOT fulfill this requirement. BSCI 1510/1510L is a required course.

## Program Electives

### BME ELECTIVES

A total of 12 BME elective hours must be taken. BME Electives are elective courses taught within the BME department and carrying a “BME” course code at the 2000-level and higher (e.g., BME 4100).

- Up to 6 credit hours of Undergraduate Research, BME 3860/3861, generally taken junior spring semester or senior year, may count as a BME elective.
- BME students may count **only one of the following** VUSE courses as BME electives: ChBE 4810, 4500, 4870; EECE 3214, 4353, 4354; ENVE 4610; and ME 2220. This option does not apply to BME/EE double majors.
- BME freshman seminars, BME 2201 Biomedical Ethics, and BME 3890: Pathology and Pathophysiology (Counts as Technical/Open Elective) cannot count as BME electives.



- BME graduate courses, with the exception of BME 8991-8994, may be taken as electives provided the student has a 3.5 GPA and appropriate permissions.

### TECHNICAL ELECTIVES

A total of 9 hours of Technical (Science, Engineering, or Math) electives must be taken. Technical electives include the following:

- Courses in the School of Engineering **except** BME 2201, 2860, CHBE 3300, CE 2200, CS 1000, 1151, ENGM 2160, 2440, 3100, 3350, ME 2171, and listings in Engineering Science.
- Up to 3 hours of independent study courses in the School of Engineering may be taken as technical electives.
- Courses numbered 2000 or higher in the mathematics and natural sciences (MNS) AXLE category in the College of Arts and Science **except** MATH 2600, 2610, 2810, and 3000.
- Biological Sciences BSCI 1511/1511L and Nursing NURS 1500, 1600.

### CORE PREREQUISITES

Course Number; Title	Preferred Semester	Prerequisites	Corequisites
BSCI 1510/L; Intro Bio with Lab	Sophomore Fall	CHEM 1601	CHEM 1601
BME 2301; Sys Physiology I	Sophomore Fall, Spring	CS 1101/1103	BSCI 1510, PHYS 1602
BME 2302; Sys Physiology II	Sophomore Fall, Spring	CS 1101/1103, PHYS 1601	BSCI 1510, PHYS 1602
BME 2100; Biomechanics	Sophomore Spring	PHYS 1601, MATH 1301, CS 1101/1103	
BME 2400; Quant. Mthds. I: Stat. Analysis	Sophomore Spring	MATH 2300	CS 1101/1103
BME 2900W; BME Laboratory	Sophomore Spring	CS 1101/1103	BME 2301
ECE 2112; Circuits I	Sophomore Spring		PHYS 1602, MATH 2300
MATH 2300; Multivariable Calculus	Sophomore Fall	MATH 1301 or MATH 2200	
Math 2400; Diff. Eqtns. with Linear Algebra	Sophomore Spring	MATH 2300	MATH 2300
PHYS 1602/L; General Physics II with Lab	Sophomore Fall		
BME 3000; Phys. Transport Phenomena	Junior Fall	BME 2100, MATH 2400/2420	
BME 3301; Biomed. Instr. I	Junior Fall, Spring	ECE 2112	BME 3400

BME 3302; Biomed Instr. II	Junior Fall, Spring	BME 3301 or ECE 2213/L or ECE 2214/L	
BME 3400; Quant. Mthds. II: Sgnls. & Mdlng.	Junior Fall	CS 1101/1103, MATH 2400	BME 2400
BME 3500; Biomedical Materials	Junior Fall	CHEM 1602, PHYS 1601	
BME 3900W; BME Laboratory	Junior Fall	BME 2900W	BME 2302, 2100
BME 4901W; BME Laboratory III	Senior Fall	BME 2400, BME 3900W	
BME 4950, 4951; Design. of Biomed Eng. Sys I, II	Senior Fall, Spring		BME 3302
BME 4959; Snr Eng. Design Seminar	Senior Fall	Senior Standing*	BME 4950

\*Senior standing may also be awarded to students pursuing accelerated degrees, if eligible. See page 13 for more information.

**Note:** The curriculum for all first-year engineering disciplines is the same, and thus those courses are not listed here but can be found online in the Undergraduate Catalog.

## BME Premed Sample Curriculum

<b>First Year - Fall</b>		<b>Cr Hrs</b>	<b>First Year - Spring</b>		<b>Cr Hrs</b>
Chem 1601/1601L	General Chem + Lab	4	Chem 1602/1602L	General Chem + Lab	4
ES 1401-1403	Intro to Engineering	3	CS 1103/1101/1100	Programming	3
Math 1300	Calculus	4	Math 1301	Calculus	4
LAC Elective		3	Physics 1601/1601L	General Physics + Lab	4
PSY 1200	General Psychology	3	BME 1015 (Open ele.)	Innovations & Careers	1
	Vanderbilt Visions	0			
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>16</b>
<b>Second Year – Fall</b>			<b>Second Year - Spring</b>		
BME 2301	Systems Physiology 1	3	BME 2302	Systems Physiology 2	3
BSCI 1510/1510L	Intro Bio + Lab	4	Math 2400	Diff Eqns/Linear Alg	4
Math 2300	Multivariable Calc.	3	BSCI 1511/1511L	Intro Bio + Lab	4
Physics 1602/1602L	General Phys. + Lab	4	BME 2900W	Engineering Lab 1	1
Chem 2221/2221L	Organic Chem + Lab	4	Chem 2222/2222L	Organic Chem + Lab	4
<b>Total Hours</b>		<b>18</b>	<b>Total Hours</b>		<b>16</b>
<b>Third Year - Fall</b>			<b>Third Year - Spring</b>		
BME 2100	Biomechanics	3	BME 3301	Instrumentation 1	4
ECE 2112	Circuits 1	3	BME 3500	Biomaterials	3
BME 2400	Quantitative Methods 1	3	BME 3400	Quantitative Methods 2	3
BME 3900W	Engineering Lab 2	1	BME Elective		3
SOC 1010	Sociology	3	BSCI 2520	Biochemistry	3
BME Elective		3			
<b>Total Hours</b>		<b>16</b>	<b>Total Hours</b>		<b>16</b>
<b>Fourth Year - Fall</b>			<b>Fourth Year - Spring</b>		
BME 4901W	Engineering Lab 3	1	BME 4951	BME Design	3
BME 4950	BME Design	2	LAC Elective		3
BME 4959	Design Seminar	1	BME Elective		3
BME 3000	Physiological Transp.	3	LAC Elective		3
BME 3302	Instrumentation 2	4			
BME Elective		3			
LAC Elective		3			
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>12</b>

Hours required to graduate = 128

### Notes

Students with advanced placement in math may wish to omit a math class in the third semester.

## BME/ChBE Double Major Sample Curriculum

First Year - Fall		Cr Hrs	First Year - Spring		Cr Hrs
Chem 1601/1601L	General Chem. + Lab	4	Chem 1602/1602L	General Chem. + Lab	4
ES 1401-1403	Intro to Engineering	3	CS 1103/1101/1100	Programming	3
Math 1300	Calculus	4	Math 1301	Calculus	4
LAC Elective	Vanderbilt Visions	0	Physics 1601/1601L	General Physics + Lab	4
<b>Total Hours</b>		<b>14</b>	<b>Total Hours</b>		<b>15</b>
Second Year – Fall			Second Year - Spring		
CHBE 2100	Chem. Proc. Principles	3	BME 2301	Systems Physiology 1	3
BSCI 1510/1510L	Intro Bio + Lab	4	CHBE 2200	Thermodynamics	3
Math 2300	Multivariable Calc.	3	Math 2400	Diff Eqns/Linear Alg	4
Physics 1602/1602L	General Phys. + Lab	4	ECE 2112	Circuits	3
Chem 2221/2221L	Organic Chem. + Lab	4	BME 2900W	Engineering Lab 1	1
			Chem 2222/2222L	Organic Chem. + Lab	4
<b>Total Hours</b>		<b>18</b>	<b>Total Hours</b>		<b>18</b>
Third Year - Fall			Third Year - Spring		
BME 2302	Systems Physiology 2	3	BME 3301	Instrumentation 1	4
BME 2100	Biomechanics	3	BME 3400	Quantitative Methods 2	3
BME 2400	Quantitative Methods 1	3	BME 3500	Biomaterials	3
CHBE 3300	Fluid Mech. & Ht. Trns	3	BME 3900W	Engineering Lab 2	1
CHBE 3200	Phase Equil. & Sep.	3	CHBE 3250	Chem Reaction Eng.	3
LAC Elective		3	CHBE 3350	Mass Trns. & Sep.	3
<b>Total Hours</b>		<b>18</b>	<b>Total Hours</b>		<b>17</b>
Fourth Year - Fall			Fourth Year – Spring		
BME 4959	Design Seminar	1	ChBE 4951W	ChE Design	3
BME 3302	Instrumentation 2	4	BME/CHBE		3
CHBE 4900W	Chem. Lab 2	3	Elective <sup>1</sup>		
CHBE 4950W	Chem Eng. & Design	4	LAC Elective		3
CHBE 4959	Safety in ChE Design	1	LAC Elective		3
LAC Elective		3	LAC Elective		3
<b>Total Hours</b>		<b>16</b>	<b>Total Hours</b>		<b>15</b>

Hours required to graduate = 131

\*All double majors should have Dr. Paul Laibinis (ChE) or Dr. Craig Duvall (BME) assigned as their academic advisor

\*For double majors, students must pursue a senior design project that incorporates key concepts from both fields of study.

### Notes

1. ChBE/BME Elective: 3 hours selected from CHBE 4500, 4800, 4805, 4810, 4820. This major elective can also be satisfied by any BME course numbered 4000 or higher except BME 6110. Other BME courses below 4000 (for example, BME 3890 special topics courses) will be considered as exceptions that must be approved by your BME/ChE double major advisor (Craig Duvall and/or Paul Laibinis).

## BME/ECE Double Major Sample Curriculum

First Year - Fall		Cr Hrs	First Year - Spring		Cr Hrs
Chem 1601/1601L	General Chem. + Lab	4	Chem 1602/1602L	General Chem. + Lab	4
ES 1401-1403	Intro to Engineering	3	CS 1101	Programming	3
Math 1300	Calculus	4	Math 1301	Calculus	4
LAC Elective	Vanderbilt Visions	0	Physics 1601/1601L	General Physics + Lab	4
			BME 1015		1
<b>Total Hours</b>		<b>14</b>	<b>Total Hours</b>		<b>16</b>
Second Year – Fall			Second Year - Spring		
BME 2301	Systems Physiology 1	3	BME 2302	Systems Physiology 2	3
BSCI 1510/1510L	Intro Bio + Lab	4	BME 2100	Biomechanics	3
Math 2300	Multivariable Calc.	3	Math 2400	Diff Eqns/Linear Alg	4
Physics 1602/1602L	General Phys. + Lab	4	ECE 2123/2123L	Digital Systems + Lab	4
ECE 2112/2112L	Circuits 1 + Lab	4	ECE 2214	Analog Circuits and Systems	3
<b>Total Hours</b>		<b>18</b>	<b>Total Hours</b>		<b>17</b>
Third Year - Fall			Third Year - Spring		
CS 2201/2203	Program Design and Data Structures	3	BME 3302	Instrumentation 2	4
BME 2900W	Engineering Lab 1	3	BME 3500	Biomaterials	3
BME 2400	Quantitative Methods 1	4	BME 3900W	Engineering Lab 2	1
ECE 3235/3235L	Electronics 1	3	ECE Elective		3
LAC Elective		3	ECE Elective		3
LAC Elective		3	LAC Elective		3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>17</b>
Fourth Year - Fall			Fourth Year – Spring		
BME 4901W	Engineering Lab 3	1	BME 4951*	BME Design	3
BME 4950*	BME Design	2	BME Elective		3
BME 4959	Design Seminar	1	ECE Elective		3
BME 3000	Physiological Trans.	3	ECE Elective		3
ECE Elective		3	LAC Elective		3
ECE Elective		3			
LAC Elective		3			
<b>Total Hours</b>		<b>16</b>	<b>Total Hours</b>		<b>15</b>

Hours required to graduate = 130

\*For double majors, students must pursue a senior design project that incorporates key concepts from both fields of study.

### Notes

Within the 18 hours of ECE electives, students must complete **at least 9 hours** in one and at least **at least 6 hours** in another of the Areas of Concentration listed under Electrical and Computer Engineering in the Undergraduate Catalog. BME 3302 may be included toward satisfying the Area of Concentration requirement but cannot be counted as an Electrical and Computer Engineering elective. Also, at least one of the elective courses must be an approved Design Domain Expertise (“DE”) course.

## BME/CS Second Major Sample Curriculum Assuming AP Credits Described Below

First Year - Fall		Cr Hrs	First Year - Spring		Cr Hrs
MATH 2300	Multivariable Calculus	3	MATH 2410/2600	Linear Algebra	3
LAC Elective		3	LAC Elective		3
ES 1401-3	Intro to Engineering	3	EECE 2112	Circuits 1	3
CS 1101**	Intro to Java/Python	3	CS 2201	Data Structures	3
CS 1151	Computers and Ethics	3	CS 2212	Discrete Structures	3
			BME 1015 (opt.)		1
<b>Total Hours</b>		<b>15</b>	<b>Total Hours</b>		<b>16</b>
Second Year – Fall			Second Year - Spring		
BME 2301	Systems Physiology 1	3	BME 2302	Systems Physiology 2	3
EECE 2123/L	Digital Systems	4	BME 2100	Biomechanics	3
LAC Elective		3	CS 3250	Algorithms	3
MATH 2400	Dif. Eqtns. w/ Lin. Alg.	4	LAC Elective		3
CS 3251	Intrmed. Software Dsg.	3	BME Elective		3
			BME 2400	Quantitative Methods 1	3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>18</b>
Third Year - Fall			Third Year - Spring		
CS 3270	Programming Lang.'s	3	BME 3302	Instrumentation 2	4
BME 2900W	Engineering Lab 1	1	BME 3500	Biomaterials	3
CS 3281	Prin. Of Op. Sys.'s	3	BME 3900W	Engineering Lab 2	1
BME Elective		3	CS 3250	Algorithms	3
BME 3301	Instrumentation 1	4	CS Depth		3
BME 3400	Quantitative Methods 2	3	BME 3000	Physiological Transport	3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>17</b>
Fourth Year - Fall			Fourth Year – Spring		
BME 4901W	Engineering Lab 3	1	BME 4951	BME Design	3
BME 4950	BME Design	2	BME Elective		3
BME 4959	Design Seminar	1	CS Depth		3
CS Depth		3	CS Project		3
CS Depth		3			
BME Elective		3			
<b>Total Hours</b>		<b>13</b>	<b>Total Hours</b>		<b>12</b>

Hours required to graduate assuming AP credits described below = 125\*

\*\*CS 1101 counts towards both BME and CS majors, as well as a CS minor

### Notes

Completing CS as a second major requires a large number of credit hours, and BME students interested in depth of CS study are recommended to first consider pursuit of a CS minor. The sample curriculum above is based on the assumption that a student pursuing a second major in CS would bring 30 hours of AP credit, including 1 English (3 hours LAC), 1 History (3 hours LAC), 2 Biology (6 hours), 2 Chemistry (6 hours), 2 Physics (6 hours), and 2 Math (6 hours). A student would not have to have these exact AP credits to pursue this second major, but a similar number of overall AP credits would be ideal. Math classes in the first and second years can be delayed and/or rearranged to accommodate any extra classes. The above Sample Curriculum is only intended as a starting point for each student's unique situation.

**BME/CSET (Communication of Science, Engineering, and Technology) Second Major Sample Curriculum**

<b>First Year - Fall</b>		<b>Cr Hrs</b>	<b>First Year - Spring</b>		<b>Cr Hrs</b>
CHEM 1601/L	General Chem + Lab	4	CHEM 1602/L	General Chem + Lab	4
ES 1401-3	Intro to Engineering	3	CS 1103/1101	Programming	3
MATH 1300	Calculus	4	MATH 1301	Calculus	4
LAC Elective		3	PHYS 1601/L	General Physics + Lab	4
			BME 1015	Innovations & Careers	1
<b>Total Hours</b>		<b>14</b>	<b>Total Hours</b>		<b>16</b>
<b>Second Year – Fall</b>			<b>Second Year - Spring</b>		
BME 2301	Systems Physiology 1	3	BME 2302	Systems Physiology 2	3
BSCI 1510/L	Intro Bio + Lab	4	BME 2100	Biomechanics	3
MATH 2300	Multivariable Calc.	3	MATH 2400	Dif. Eqtns. w/ Lin. Alg.	4
PHYS 1602/L	General Physics + Lab	4	EECE 2112	Circuits	3
LAC Elective		3	BME 2900W	Engineering Lab 1	1
			BME 2400	Quantitative Methods 1	3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>17</b>
<b>Third Year – Fall</b>			<b>Third Year – Spring</b>		
BME 3000	Physiological Transp.	3	BME 3302	Instrumentation 2	4
BME 3301	Instrumentation 1	4	BME 3500	Biomaterials	3
BME 3400	Quantitative Methods 2	3	BME Elective		3
BME 3900W	Engineering Lab 2	1	BME Elective		3
CSET 2100	Science Comm.	3	CMST 1501, 2100,	Public Speaking	3
Tech Elective		3	2110, 2120		3
<b>Total Hours</b>		<b>17</b>	<b>Total Hours</b>		<b>16</b>
<b>Fourth Year - Fall</b>			<b>Fourth Year – Spring</b>		
BME 4901W	Engineering Lab 3	1	BME 4951	BME Design	3
BME 4950	BME Design	2	BME Elective		3
BME 4959	Design Seminar	1	Tech Elective		3
Tech Elective		3	Open Elective		3
BME Elective		3	Open Elective		3
ENGL 3215*	Art of Blogging	3			
ECON 2350**	Health Care Policy	3			
<b>Total Hours</b>		<b>15</b>	<b>Total Hours</b>		<b>15</b>

\*or any course specified in the [UCG](#) (pg. 93) as a CSET Non-science Writing Course

\*\*or any course specified in the [UCG](#) (pg. 94) as a CSET Bridging Course AND a LAC SBS (social and behavioral sciences) course

Hours required to graduate = 127

**Notes**

It is possible to complete all CSET requirements without exceeding the number of credit hours required for the normal BME degree (126). The requirements for the second major in CSET can typically be accomplished by appropriate choice of courses to fulfill elective requirements. To pursue this path, students will typically need to declare the CSET second major before the Fall Semester of their junior year. For concerns and help with course selection for the CSET Non-Science Writing Course and/or Bridging Course, students are encouraged to contact the CSET Program Chair Dr. David Weintraub (david.weintraub@vanderbilt.edu).

**List of other Common Second Majors**

Blair, Music Performance  
Data Science