

Curriculum Changes

Green indicates insertions

~~Red indicates deletions~~

The degree program requires **124 hours**.

Students who are admitted to the program may take courses at N.C. State. Classes designated BM(M)E ### are offered as BMME ### on the UNC campus and BME ### on the NC State campus. N.C. State course numbers for non-BME courses are designated in parenthesis.

Code	Title	Hours
Core Requirements		
Students should take the following courses, preferably in their second year:		
BM(M)E 201 or COMP 116	MATLAB for Scientists and Engineers -Computer Methods in Biomedical Engineering (BME 201 or CSC 113) Introduction to Scientific Programming	3
BM(M)E 205 or <u>BMME 160</u> and BM(M)E 215	Introduction to Biomedical Mechanics Statics (CE 214 or MAE 206) and <u>Biomedical Mechanics Lab</u>	4 <u>3</u>
BM(M)E 207 or <u>BMME 350</u>	Electronics for Biomedical Engineers -Electronics (BME 210) Electronics for Biomedical Engineers (BME 210)	4
BM(M)E 209 or (<u>BMME 150</u> and BM(M)E 219)	Introduction to the Materials Science of Biomaterials Introduction to Materials Science and Materials Science of Biomaterials Lab (MSE/BME 203 and <u>BM(M)E 219</u>)	4 <u>3</u>
BM(M)E 298 or <u>BMME 210</u>	BME Design and Manufacturing I (BME 252 and BME 299) BME Design and Manufacturing I	2
Students should take the following courses, preferably in their third year:		
BM(M)E 398 or <u>BMME 310</u>	BME Design and Manufacturing II (BME 352) BME Design and Manufacturing II	2
Choose one of the following (additional courses taken count as a BME specialty elective):-		3
BMME 341	Thermodynamics and Kinetics Applied to Solids (MAE 201 or MSE 301)	
BMME 405	Biomechanics of Movement	
BMME 455	Biofluid Mechanics (CE 382 or MAE 308)	
BMME 475	Transport Processes	

Code	Title	Hours
BMME 505	Skeletal Biomechanics	
BM(M)E 301 OR <u>BMME 351</u>	Human Physiology: Electrical Analysis Human Physiology and Biological Measurements for Engineers	4
BM(M)E 302	Human Physiology: Mechanical Analysis	4
Take three gateway electives to prepare for specialty electives in two areas		9
BM(M)E 315 or <u>BMME 475</u>	Biotransport Transport Processes	
<u>BM(M)E 325</u>	Biochemistry for Biomedical Engineers	
BM(M)E 335 or <u>BMME 510</u>	Biomaterials Biomaterials	
<u>BM(M)E 345</u>	Biomedical Solid Mechanics (BME 342)	
<u>BM(M)E 355</u>	Biocontrols	
BM(M)E 365 OR <u>BMME 410</u>	Linear Systems in Biomedical Engineering Systems and Signals (BME 311)	3
BM(M)E 375 or <u>BMME 580</u>	Biomedical Microcontroller Applications Microcontroller Applications I (BME 480)	
BM(M)E 385 or <u>BMME 465</u>	Bioinstrumentation Biomedical Instrumentation I	
Students should take the following courses, preferably in their final year:		
<u>BMME 697</u>	Biomedical Engineering Senior Design- Project I (BME 451)	3
<u>BMME 698</u>	Biomedical Engineering Senior Design- Project II (BME 452)	3
Students should take four electives from no more than two specialization areas		12
Engineering Elective – an upper level (300 or greater) engineering course		3
BIOL 202	Molecular Biology and Genetics (GN 311)-^H	4
BIOL 252 & 252L	Fundamentals of Human Anatomy and Physiology and Fundamentals of Human Anatomy and Physiology Laboratory (BIO 212)	4
MATH 528	Mathematical Methods for the Physical Sciences I (MA 501)	3
Choose one statistics class from:		3

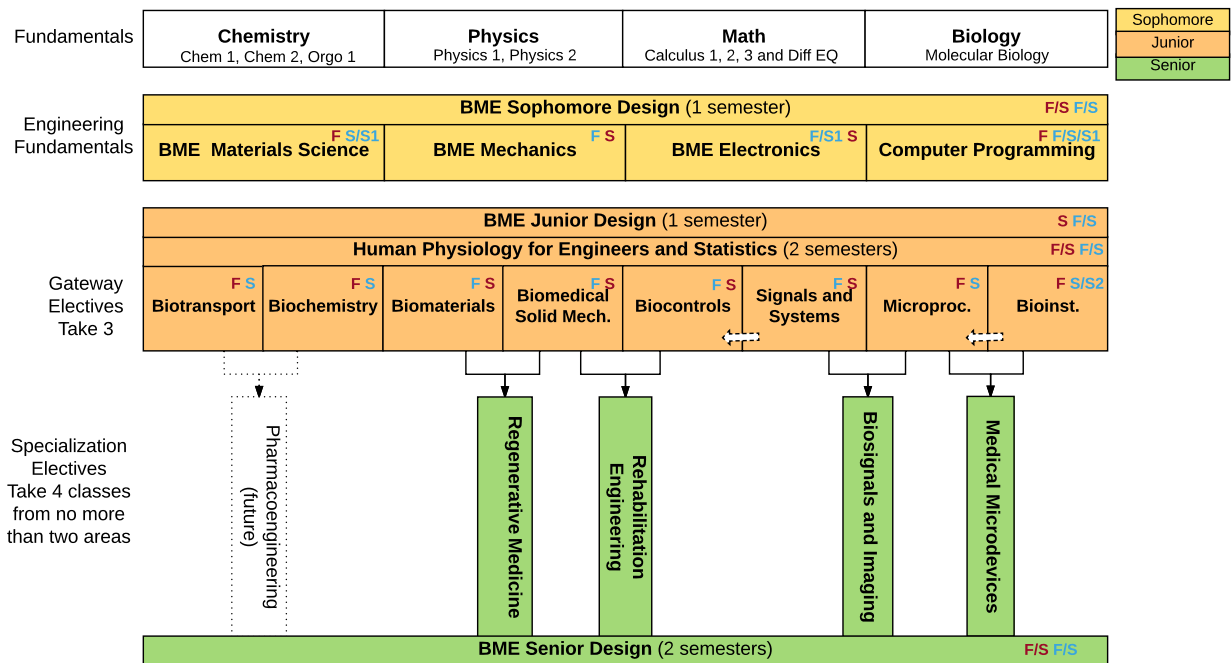
Code	Title	Hours
STOR 435	Introduction to Probability (ST 370)	
or STOR 455	Statistical Methods I	
Additional Requirements		
A choice of four biomedical specialty electives (any BMME course above 400 excluding BMME 691H and BMME 692H)		12
Students should take the following courses, preferably in their first two years:		
BIOL 101 & 101L	Principles of Biology and Introductory Biology Laboratory (BIO 183) ^H	4
CHEM 101 & 101L	General Descriptive Chemistry I and Quantitative Chemistry Laboratory I (CH 101 + 102)	4
CHEM 102 & 102L	General Descriptive Chemistry II and Quantitative Chemistry Laboratory II (CH 201 + 202) ^H	4
CHEM 261	Introduction to Organic Chemistry I (CH 221 + CH 222)	3
MATH 231	Calculus of Functions of One Variable I (MA 141)	4
MATH 232	Calculus of Functions of One Variable II (MA 241)	4
MATH 233	Calculus of Functions of Several Variables (MA 242) ^H	4
MATH 383 & 383L	First Course in Differential Equations and First Course in Differential Equations Laboratory ^H	4
PHYS 116	Mechanics (PY 205 + 206) ^H	4
or PHYS 118	Introductory Calculus-based Mechanics and Relativity	
PHYS 117	Electromagnetism and Optics (PY 208 + 209) ^H	4
or PHYS 119	Introductory Calculus-based Electromagnetism and Quanta	
Remaining General Education courses and electives to reach 124 hours		28
Total Hours		124

^H Honors version available. An honors course fulfills the same requirements as the nonhonors version of that course. Enrollment and GPA restrictions may apply.

Students must satisfy all Foundations, Approaches, and Connections requirements, as outlined elsewhere in this catalog. Some General Education requirements should be met with specific courses as listed above.

Curriculum Layout

The figure below illustrates the organization of the curriculum (not all courses shown). F=fall semester; S=spring semester; S1=1st summer term; S2=2nd summer term. Red letters indicate terms when the course is offered on the NC state campus and blue letters indicate terms when the course is offered on the UNC campus.



Specialization Electives

Specialization electives may change as new courses are developed. Check the BME website for the most recent lists of specialization electives. BMME courses are offered on the UNC campus and BME courses are offered on the NC State campus. Courses in blue are offered on the UNC campus and courses in red are offered on the NC State campus.

Biosignals and Imaging		
BME 412	Biomedical Signal Processing	3
BMME 461	Introduction to Medical Imaging	3
BMME 576	Mathematics for Image Computing	3
BMME 581	Biomedical Microcontroller Applications II	3
ECE 455	Computer Control of Robots	3
ECE 461	Embedded Systems	3
ECE 456	Mechatronics	3
MATH 528	Mathematical Methods for Physical Scientists	3
Medical Microdevices		
BME 412	Biomedical Signal Processing	3
BME 522	Medical Instrumentation	3
BME 536	Digital Control Systems	3
BMME 581	Biomedical Microcontroller Applications II	3
BME 418	Wearable Biosensors	3
ECE 505	Neural Interface Engineering	3
E 304	Intro to Nano Science and Technology	3
BMME 455	Biofluid Mechanics	3
Or MAE 308	Fluid Mechanics	3
Or CE 382	Hydraulics	3
BMME 441	Thermal Physics	3
Or MAE 201	Engineering Thermodynamics I	3
Or MSE 301	Intro to Thermodynamics of Materials	3
Regenerative Medicine		
BME 426	Biomaterials Characterization	3
BME 484	Fundamentals of Tissue Engineering	3
BMME 441	Thermal Physics	3
Or MAE 201	Engineering Thermodynamics I	3
Or MSE 301	Intro to Thermodynamics of Materials	3
BMME 420	Introduction to Synthetic Biology	3
BIT 466	Animal Cell Culture	2
and BME 483	Tissue Engineering Technologies	2
BMME 470	Analysis of Tissue Engineering Technologies	3
TE 463	Polymer Engineering	3
BMME 455	Biofluid Mechanics	3
Or MAE 308	Fluid Mechanics	3
Or CE 382	Hydraulics	3
PHYS 405	Biological Physics	3
Rehabilitation Engineering		
BME 443	Orthopedic Biomechanics	3
BMME 405	Biomechanics of Movement	3
BME 418	Wearable Biosensors	3

BME 425	Bioelectricity	3
BMME 445	Systems Neuroscience	3
BMME 447	Neural Basis of Rehabilitation Engineering	3
BME 467	Mechanics of Tissues and Implants Requirements	3
BMME 505	Skeletal Biomechanics	3

Sample Plan of Study

Sample plans can be used as a guide to identify the courses required to complete the major and other requirements needed for degree completion within the expected eight semesters. The actual degree plan may differ depending on the course of study selected (second major, minor, etc.). Students should meet with their academic advisor to create a degree plan that is specific and unique to their interests. The sample plans represented in this catalog are intended for first-year students entering UNC–Chapel Hill in the fall term. Some courses may not be offered every term.

First Year		Hours
BMME 101	Frontiers of Biomedical Engineering ¹	1
MATH 231	Calculus of Functions of One Variable I ²	4
MATH 232	Calculus of Functions of One Variable II ²	4
PHYS 116 or PHYS 118	Mechanics ^{2, H} or Introductory Calculus-based Mechanics and Relativity	4
CHEM 101 & 101L	General Descriptive Chemistry I and Quantitative Chemistry Laboratory I ²	4
CHEM 102 & 102L	General Descriptive Chemistry II and Quantitative Chemistry Laboratory II ^H	4
BIOL 101 & 101L	Principles of Biology and Introductory Biology Laboratory	4
ENGL 105	English Composition and Rhetoric ³	3
Foreign Language level 3		3
Approaches and Connections (12 courses)		36
Lifetime Fitness		1
Hours		314
Sophomore Year		
MATH 233	Calculus of Functions of Several Variables ^H	4

MATH 383 & 383L	First Course in Differential Equations and First Course in Differential Equations Laboratory "	4
PHYS 117 or PHYS 119	Electromagnetism and Optics " or Introductory Calculus-based Electromagnetism and Quanta	4
BIOL 101 & 101L	Principles of Biology and Introductory Biology Laboratory "	4
CHEM 102 & 102L	General Descriptive Chemistry II and Quantitative Chemistry Laboratory II	4
CHEM 261	Introduction to Organic Chemistry I	3
BMME 298 10	BME Design and Manufacturing I	2
BIOL 202	Molecular Biology and Genetics "	4
COMP 116 or BMME 201	Introduction to Scientific Programming or MATLAB for Scientists and Engineers	3
BMME 205160	Statics-Introduction to Biomedical Mechanics (Fall only)	4 3
BMME 150	Introduction to Materials Science (Spring-only)	3
BMME 209	Introduction to the Materials Science of Biomaterials (Spring only)	4
Approaches and Connections (1 course)		3
Hours		324
Junior Year		
BMME 39810	BME Design and Manufacturing II	2
BIOL 252 & 252L	Fundamentals of Human Anatomy and Physiology and Fundamentals of Human Anatomy and Physiology Laboratory	4
MATH 528	Mathematical Methods for the Physical Sciences I (lab section is optional)	3
STOR 435 or STOR 455	Introduction to Probability or Statistical Methods I	3
BME Specialty Elective I		3
BMME 207350	Electronics for Biomedical Engineers-Biomedical Electronics (Fall only)	4
BMME 3051	Human Physiology and Biological Measurements for Engineers: Electrical Analysis -(Spring only)	4
BMME 302	Human Physiology: Mechanical Analysis (Fall only)	4
BMME 465	Biomedical Instrumentation I (Spring-only)	4
BMME 410	Systems and Signals (Spring-only)	3
BMME 3*5	Gateway Elective 1	3

<u>BMME 3*5</u>	Gateway Elective 2	3
<u>BMME 3*5</u>	Gateway Elective 3	3
	Engineering Elective	3
	Approaches 2	3
	Approaches 3	3
Hours		320
Senior Year		
	BME Specialty Elective 1	3
	BME Specialty Elective 2	3
	BME Specialty Elective 3	3
	BME Specialty Elective 4	3
	Choose one of the following (additional courses taken count as a BME Specialty Elective)	3
<u>BMME 341</u>	Thermodynamics and Kinetics Applied to Solids (Fall only)	3
<u>BMME 405</u>	Biomechanics of Movement (Spring only)	
<u>BMME 455</u>	Biofluid Mechanics (Fall only)	-
<u>BMME 475</u>	Transport Processes (Spring only)	-
<u>BMME 505</u>	Skeletal Biomechanics (Fall only)	-
<u>BMME 697</u>	Biomedical Engineering Senior Design Project I (Fall only)	3
<u>BMME 698</u>	Biomedical Engineering Senior Design Project II (Spring only)	3
	Remaining <u>General Education</u> courses and electives to reach 124 credits	128
Hours		3026
Total Hours		125

^H Honors version available. An honors course fulfills the same requirements as the nonhonors version of that course. Enrollment and GPA restrictions may apply.

¹ Strongly recommended, but not required.

² With a grade of C or better. AP, IB, or transfer credit will be accepted according to university policies.

³ With a grade of C- or better. Transfer credit will be accepted according to university policies.

New Curriculum

The degree program requires **124 hours**.

Students who are admitted to the program may take courses at N.C. State. Classes designated BM(M)E ### are offered as BMME ### on the UNC campus and BME ### on the NC State campus. N.C. State course numbers for non-BME courses are designated in parenthesis.

Code	Title	Hours
Core Requirements		
Students should take the following courses, preferably in their second year:		
<u>BM(M)E 201</u> or <u>COMP 116</u>	Computer Methods in Biomedical Engineering (CSC 113) Introduction to Scientific Programming	3
<u>BM(M)E 205</u> or <u>BMME 160</u> and <u>BM(M)E 215</u>	Introduction to Biomedical Mechanics Statics (CE 214 or MAE 206) and Biomedical Mechanics Lab	4
<u>BM(M)E 207</u> or <u>BMME 350</u>	Biomedical Electronics (BME 210) Electronics for Biomedical Engineers	4
<u>BM(M)E 209</u> or <u>(BMME 150)</u> and <u>BM(M)E 219)</u>	Introduction to the Materials Science of Biomaterials Introduction to Materials Science and Materials Science of Biomaterials Lab (MSE/BME 203 and BM(M)E 219)	4
<u>BM(M)E 298</u> or <u>BMME 210</u>	BME Design and Manufacturing I (BME 252 and BME 299) BME Design and Manufacturing I	2
Students should take the following courses, preferably in their third year:		
<u>BM(M)E 398</u> or <u>BMME 310</u>	BME Design and Manufacturing II (BME 352) BME Design and Manufacturing II	2
<u>BM(M)E 301</u> <u>OR</u> <u>BMME 351</u>	Human Physiology: Electrical Analysis Human Physiology and Biological Measurements for Engineers	4
<u>BM(M)E 302</u>	Human Physiology: Mechanical Analysis	4
Take three gateway electives to prepare for specialty electives in two areas		
<u>BM(M)E 315</u> or <u>BMME 475</u>	Biotransport Transport Processes	
<u>BM(M)E 325</u>	Biochemistry for Biomedical Engineers	
<u>BM(M)E 335</u> or <u>BMME 510</u>	Biomaterials Biomaterials	
<u>BM(M)E 345</u>	Biomedical Solid Mechanics (BME 342)	

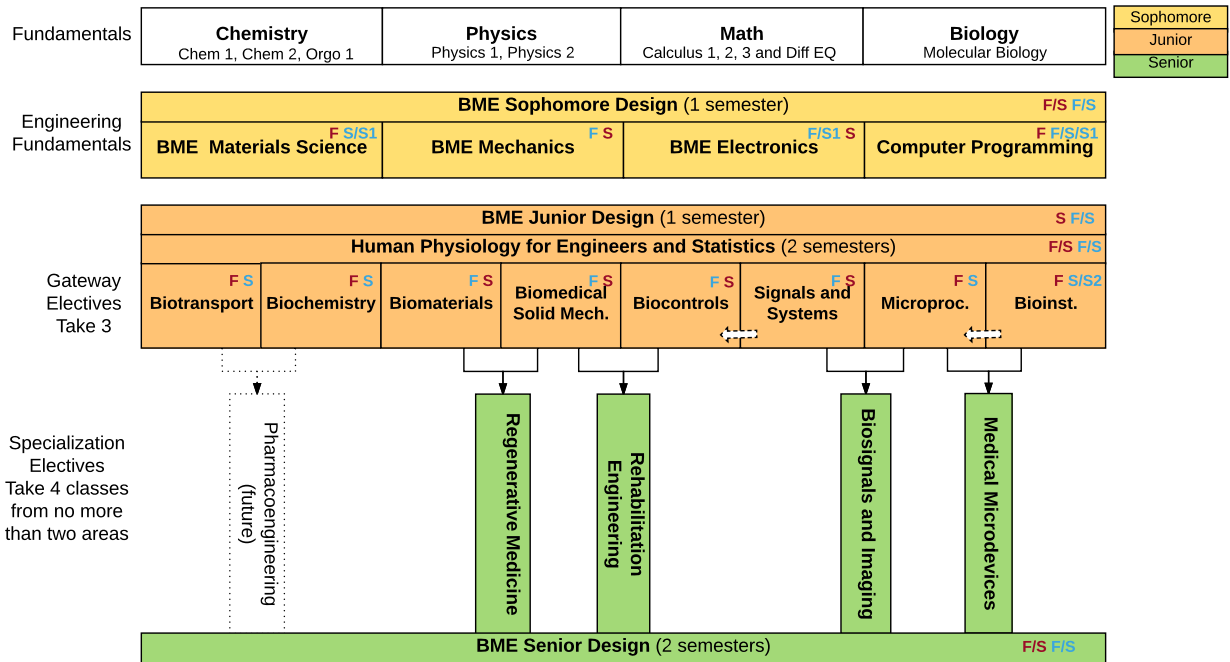
<u>BM(M)E 355</u>	Biocontrols	
<u>BM(M)E 365</u> OR <u>BMME 410</u>	Linear Systems in Biomedical Engineering Systems and Signals (BME 311)	3
<u>BM(M)E 375</u> or <u>BMME 580</u>	Biomedical Microcontroller Applications Microcontroller Applications I (BME 480)	
<u>BM(M)E 385</u> or <u>BMME 465</u>	Bioinstrumentation Biomedical Instrumentation I	
Students should take the following courses, preferably in their final year:		
<u>BMME 697</u>	Biomedical Engineering Senior Design I (BME 451)	3
<u>BMME 698</u>	Biomedical Engineering Senior Design II (BME 452)	3
Students should take four electives from no more than two specialization areas		12
Engineering Elective – an upper level (300 or greater) engineering course		3
Additional Requirements		
Students should take the following courses, preferably in their first two years:		
<u>BIOL 101</u> & <u>101L</u>	Principles of Biology and Introductory Biology Laboratory (BIO 183) ^H	4
<u>CHEM 101</u> & <u>101L</u>	General Descriptive Chemistry I and Quantitative Chemistry Laboratory I (CH 101 + 102)	4
<u>CHEM 102</u> & <u>102L</u>	General Descriptive Chemistry II and Quantitative Chemistry Laboratory II (CH 201 + 202) ^H	4
<u>CHEM 261</u>	Introduction to Organic Chemistry I (CH 221 + CH 222)	3
<u>MATH 231</u>	Calculus of Functions of One Variable I (MA 141)	4
<u>MATH 232</u>	Calculus of Functions of One Variable II (MA 241)	4
<u>MATH 233</u>	Calculus of Functions of Several Variables (MA 242) ^H	4
<u>MATH 383</u> & <u>383L</u>	First Course in Differential Equations and First Course in Differential Equations Laboratory ^H	4
<u>PHYS 116</u>	Mechanics (PY 205 + 206) ^H	4
or <u>PHYS 118</u>	Introductory Calculus-based Mechanics and Relativity	
<u>PHYS 117</u>	Electromagnetism and Optics (PY 208 + 209) ^H	4
or <u>PHYS 119</u>	Introductory Calculus-based Electromagnetism and Quanta	
Remaining <u>General Education</u> courses and electives to reach 124 hours		28
Total Hours		124

^H Honors version available. An honors course fulfills the same requirements as the nonhonors version of that course. Enrollment and GPA restrictions may apply.

Students must satisfy all Foundations, Approaches, and Connections requirements, as outlined elsewhere in this catalog. Some General Education requirements should be met with specific courses as listed above.

Curriculum Layout

The figure below illustrates the organization of the curriculum (not all courses shown). F=fall semester; S=spring semester; S1=1st summer term; S2=2nd summer term. Red letters indicate terms when the course is offered on the NC state campus and blue letters indicate terms when the course is offered on the UNC campus.



Specialization Electives

Specialization electives may change as new courses are developed. Check the BME website for the most recent lists of specialization electives. BMME courses are offered on the UNC campus and BME courses are offered on the NC State campus.

Courses in blue are offered on the UNC campus and courses in red are offered on the NC State campus.

Biosignals and Imaging		
BME 412	Biomedical Signal Processing	3
BMME 461	Introduction to Medical Imaging	3
BMME 576	Mathematics for Image Computing	3
BMME 581	Biomedical Microcontroller Applications II	3
ECE 455	Computer Control of Robots	3
ECE 461	Embedded Systems	3
ECE 456	Mechatronics	3
MATH 528	Mathematical Methods for Physical Scientists	3
Medical Microdevices		
BME 412	Biomedical Signal Processing	3
BME 522	Medical Instrumentation	3
BME 536	Digital Control Systems	3
BMME 581	Biomedical Microcontroller Applications II	3
BME 418	Wearable Biosensors	3
ECE 505	Neural Interface Engineering	3
E 304	Intro to Nano Science and Technology	3
BMME 455	Biofluid Mechanics	3
Or MAE 308	Fluid Mechanics	3
Or CE 382	Hydraulics	3
BMME 441	Thermal Physics	3
Or MAE 201	Engineering Thermodynamics I	3
Or MSE 301	Intro to Thermodynamics of Materials	3
Regenerative Medicine		
BME 426	Biomaterials Characterization	3
BME 484	Fundamentals of Tissue Engineering	3
BMME 441	Thermal Physics	3
Or MAE 201	Engineering Thermodynamics I	3
Or MSE 301	Intro to Thermodynamics of Materials	3
BMME 420	Introduction to Synthetic Biology	3
BIT 466	Animal Cell Culture	2
and BME 483	Tissue Engineering Technologies	2
BMME 470	Analysis of Tissue Engineering Technologies	3
TE 463	Polymer Engineering	3
BMME 455	Biofluid Mechanics	3
Or MAE 308	Fluid Mechanics	3
Or CE 382	Hydraulics	3
PHYS 405	Biological Physics	3

Rehabilitation Engineering		
BME 443	Orthopedic Biomechanics	3
BMME 405	Biomechanics of Movement	3
BME 418	Wearable Biosensors	3
BME 425	Bioelectricity	3
BMME 445	Systems Neuroscience	3
BMME 447	Neural Basis of Rehabilitation Engineering	3
BME 467	Mechanics of Tissues and Implants Requirements	3
BMME 505	Skeletal Biomechanics	3

Sample Plan of Study

Sample plans can be used as a guide to identify the courses required to complete the major and other requirements needed for degree completion within the expected eight semesters. The actual degree plan may differ depending on the course of study selected (second major, minor, etc.). Students should meet with their academic advisor to create a degree plan that is specific and unique to their interests. The sample plans represented in this catalog are intended for first-year students entering UNC–Chapel Hill in the fall term. Some courses may not be offered every term.

First Year		Hours
BMME 101	Frontiers of Biomedical Engineering ¹	1
MATH 231	Calculus of Functions of One Variable I ²	4
MATH 232	Calculus of Functions of One Variable II ²	4
PHYS 116 or PHYS 118	Mechanics ^{2, H} or Introductory Calculus-based Mechanics and Relativity	4
CHEM 101 & 101L	General Descriptive Chemistry I and Quantitative Chemistry Laboratory I ²	4
BIOL 101 & 101L	Principles of Biology and Introductory Biology Laboratory	4
ENGL 105	English Composition and Rhetoric ³	3
Foreign Language level 3		3
Approaches and Connections (1 course)		3
Lifetime Fitness		1
Hours		31

Sophomore Year		
MATH 233	Calculus of Functions of Several Variables ^H	4
MATH 383 & 383L	First Course in Differential Equations and First Course in Differential Equations Laboratory ^H	4
PHYS 117 or PHYS 119	Electromagnetism and Optics ^H or Introductory Calculus-based Electromagnetism and Quanta	4
CHEM 102 & 102L	General Descriptive Chemistry II and Quantitative Chemistry Laboratory II	4
CHEM 261	Introduction to Organic Chemistry I	3
BMME 298	BME Design and Manufacturing I	2
COMP 116 or BMME 201	Introduction to Scientific Programming or MATLAB for Scientists and Engineers	3
BMME 205	Introduction to Biomedical Mechanics (Fall only)	4
BMME 209	Introduction to the Materials Science of Biomaterials (Spring only)	4
Hours		32
Junior Year		
BMME 398	BME Design and Manufacturing II	2
BMME 207	Biomedical Electronics (Fall only)	4
BMME 301	Human Physiology: Electrical Analysis (Spring only)	4
BMME 302	Human Physiology: Mechanical Analysis (Fall only)	4
BMME 3*5	Gateway Elective 1	3
BMME 3*5	Gateway Elective 2	3
BMME 3*5	Gateway Elective 3	3
	Engineering Elective	3
	Approaches 2	3
	Approaches 3	3
Hours		32
Senior Year		
	BME Specialty Elective 1	3
	BME Specialty Elective 2	3
	BME Specialty Elective 3	3
	BME Specialty Elective 4	3

BMME 697	Biomedical Engineering Senior Design I	3
BMME 698	Biomedical Engineering Senior Design II	3
Remaining General Education courses and electives to reach 124 credits		12
Hours		30
Total Hours		125

^H Honors version available. An honors course fulfills the same requirements as the nonhonors version of that course. Enrollment and GPA restrictions may apply.

¹ Strongly recommended, but not required.

² With a grade of C or better. AP, IB, or transfer credit will be accepted according to university policies.

³ With a grade of C- or better. Transfer credit will be accepted according to university policies.