



SCHOOL OF BIOMEDICAL
ENGINEERING
COLORADO STATE UNIVERSITY

B.S. Biomedical Engineering + B.S. Mechanical Engineering BME+MECH Curriculum Guide Fall 2018

This Guide is designed to help students understand the academic requirements and selected career resources in the Colorado State University undergraduate dual-degree program in Biomedical Engineering and Mechanical Engineering (BME+MECH). Students graduate with full BS degrees in *both* disciplines and benefit from classroom and experiential learning through lecture, team projects, laboratory, and design courses in a unique multidisciplinary environment. Ours is the first ABET-Accredited BME program in Colorado, and the only accredited BME degree in the country that has an obligatory tie to a partner degree.

During the first and second years, BME+MECH students are introduced to biomedical and mechanical engineering, in addition to learning the fundamentals of physics and mathematics. The third year of study provides continued depth in BME and MECH, including a multidisciplinary, hands-on problem-based BME learning lab. The fourth year rounds out the MECH curriculum and adds a 'gateway' BME course that transitions key MECH concepts into BME applications. The fifth year culminates in a year-long capstone Senior Design course in which students work in multidisciplinary teams creating solutions to BME industry or research problems.

Students are required to satisfy the scholastic standards of the university, college, and engineering department. Full course descriptions and prerequisites can be found at <http://www.catalog.colostate.edu>. All-University Core Curriculum (AUCC – “General Education”) [courses can be found here](#). Students will also meet with their advisors each semester to review academic plans and university resources.

We also encourage students to get involved in experiential learning via research and internships. BME faculty are spread among four different colleges, providing students a broad range of research opportunities. BME's academic home is the Scott Bioengineering Building, a cutting-edge interdisciplinary research and academic facility that opened in 2013. The Student Success Center in the Scott Building helps students develop resumes and interviewing skills, and gain access to internships and co-ops. Study Abroad is also encouraged in our program, as biomedical engineering is a global field. Visit www.engr.colostate.edu/sbme for further information!

We are here to support your CSU experience and warmly welcome you to BME @ CSU!

Sincerely,

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Biomedical Engineering and Mechanical Engineering

Name: _____

Curriculum Checksheet - Effective Summer 2018 and Prior

157 Credits

COURSE	NAME (PREREQS)	TERM*	CR	COURSE	NAME (PREREQS)	TERM*	CR
1st Year Fall				1st Year Spring			
BIOM 101	Introduction to Biomedical Engineering	F	3	CHEM 113	Gen Chem II (CHEM 107 or 111 or 117; MATH 124 or MATH 141, 155, 160, 161, 229, 261 or conc.)	F, S, SS	3
CHEM 111	General Chemistry I (MATH 118 or 141 or 155 or 160 or 161 or 229 or 261)	F, S, SS	4	MECH 105	Mechanical Engineering Problem Solving (MECH 103; MATH 160; PH 141 or conc.)	F, S	3
CHEM 112	General Chem Lab I (CHEM 111 or 117 or conc.)	F, S, SS	1	MATH 161	Calculus for Physical Scientists II (MATH 124; MATH 159 or 160)	F, S, SS	4
MATH 160	Calculus for Physical Scientists I (MATH 124 (B or better); MATH 126 (B or better))	F, S, SS	4	PH 141	Physics for Scientists and Engineers I (MATH 126 or conc.; MATH 155 or 159 or 160 or conc.)	F, S, SS	5
MECH 103	Introduction to Mechanical Engineering	F,S	3				
	Total		15				Total 15
2nd Year Fall				2nd Year Spring			
CIVE 260	Engr. Mechanics: Statics (MATH 160; PH 141)	F, S, SS	3	CIVE 261	Engineering Mechanics: Dynamics (CIVE 260)	F, S, SS	3
MATH 261	Calculus for Physical Scientists III (MATH 161)	F, S, SS	4	LIFE 102	Attributes of Living Systems	F, S, SS	4
CO 150	College Composition (CO 130 or placement by ACT/SAT or DSP Survey or Challenge Exam)	F, S, SS	3	MATH 340	Introduction to Ordinary Differential Equations (MATH 255 or 261)	F, S, SS	4
MECH 201	Engineering Design I (MECH 105)	F, S	2	MECH 200	Introduction to Manufacturing Processes (MECH 105)	F, S, SS	3
PH 142	Physics for Scientists and Engineers II (PH 141; MATH 161 or F, S 255 or 271 or conc.)	F, S	5	MECH 231	Engineering Experimentation (MECH 105; PH 142)	F, S	3
	Total		17				Total 17
3rd Year Fall				3rd Year Spring			
LIFE 210	Introductory Eukaryotic Cell Biology (LIFE 102; CHEM 111; CHEM 112)	F	3	BIOM 300	Problem-Based Learning BME Lab (BIOM 101 or BIOM 200 or (BIOM 100; CBE 205; MECH 262); MATH 340 or 345)	S	4
CIVE 360	Mechanics of Solids (CIVE 260 or MECH 262)	F, S, SS	3	BMS 300	Principles of Human Physiology (BZ 101 or 110 or LIFE 102; CHEM 103 or 107 or 111)	F, S, SS	4
MECH 202	Engineering Design II (MECH 200 or conc.; MECH 201)	F, S	3	MECH 324	Dynamics of Machines (CIVE 261; MATH 340 or conc.)	F, S	4
MECH 337	Thermodynamics (MATH 261; PH 141)	F, S	4	MECH 342	Mechanics & Thermodynamics of Flow Processes (MECH 337 or conc.; MATH 340; PH 141)	F, S	3
AUCC		F, S, SS	3				
	Total		16				Total 15
4th Year Fall				4th Year Spring			
BIOM 441	Biomechanics and Biomaterials (BMS 300 or conc.; CIVE 360; MECH 324 or conc.; MECH 331 or conc.; MECH 342)	F	3	CHEM 245	Fundamentals of Organic Chemistry (CHEM 107 or 113)	F, S, SS	4
ECE 204	Intro to Electrical Engineering (MATH 161; PH 142)	F, S, SS	3	MECH 301	Engineering Design III (MECH 202 or conc.; MECH 342; CIVE 360)	F, S	2
MECH 325	Machine Design (CIVE 360)	F, S	3	MECH 344	Heat and Mass Transfer (MECH 342)	F, S	3
MECH 331	Introduction to Engineering Materials (MECH 231; CHEM 111; CHEM 112)	F, S	4	MECH 307	Mechatronics and Measurement Systems (MECH 231; CIVE 261; ECE 204; MATH 340)	F, S	4
MECH 338	Thermal/Fluid Sciences Lab (MECH 337; MECH 342)	F, S	1	AUCC		F, S, SS	3
	Total		14				Total 16
5th Year Fall				5th Year Spring			
BIOM 486A	Biomedical Design Practicum: Capstone Design I (BIOM 300; F (BIOM 421; CBE 320; CBE 442) or (BIOM 431; ECE 311; ECE 332; ECE 342) or (BIOM 441; MECH 301; MECH 307)	F	4	BIOM 486B	Biomedical Design Practicum: Capstone Design II (BIOM 486A; (CBE 451) or (ECE 312) or (MECH 325; MECH 344; MECH 402) or (PH 353).	S	4
MECH TE	Change pending in DARS to replace MECH 402 with MECH Technical Elective _____	F, S	3	BME-TE	BME Technical Elective _____	F, S, SS	3
BME-TE	BME Technical Elective _____	F, S, SS	3	AUCC		F, S, SS	3
ME-TE	MECH Technical Elective _____	F, S	3	AUCC		F, S, SS	3
Advanced Writing	CHEM 301 or CO300 or CO301B or JTC 300 or LB 300 (CO150 or HONR193)	F, S, SS	3	AUCC		F, S, SS	3
	Total		16				Total 16

Please note that curricula can change; be sure to check with your advisers regularly to ensure you are on track.

Additional All University Core Courses (AUCCs)
6 cr - 3B Arts and Humanities: _____
3 cr - 3C Social/Behavioral Science: _____
3 cr - 3D Historical Perspective: _____
3 cr - 3E Global/Cultural Awareness: _____

Key:
"conc." = concurrent enrollment Term: F = Fall, S = Spring, SS = Summer Session
Grey indicates Biomedical Engineering courses
Light green indicates labs
Red indicates exceptionally time-consuming/difficult courses

BME+MECH Technical Electives

Technical Electives (TEs) are designed to provide additional breadth and depth in the Biomedical and partner major degrees.

BME+MECH students must take 6 credits of BME TEs and 3 credits of MECH TEs chosen from the following lists.

Key:	
F - Fall	* Available Every Other Year (Even)
S - Spring	** Available Every Other Year (Odd)
SS - Summer	
♦ See last page of this document for information on how to obtain course overrides	

NOTE: 1. Classes otherwise required for the degree are not allowed for TE credit.
 2. Course availability changes frequently. Please check with individual departments regarding course availability.
 3. Crosslisted courses (e.g. BIOM/MECH 570) are in italics and must be taken as *BIOM* courses to count for BME Technical Elective credit.

•BME-MECH students must take 6 credits from the following BME Technical Electives:

BME Technical Electives			
COURSE	NAME	TERM	CR
BC 351	Principles of Biochemistry	F,S,SS	4
BC 401	Comprehensive Biochemistry I	F	3
BC 403	Comprehensive Biochemistry II	S	3
BC 404	Comprehensive Biochemistry Laboratory	F,S	2
BC 411	Physical Biochemistry	F	4
BC 463	Molecular Genetics	F	3
BC 465	Molecular Regulation & Cell Function	S	3
BC 565	Molecular Regulation of Cell Function	S	4
BIOM 421	Transport Phenomena in BME	S	3
BIOM 422	Kinetics of Biomolecular and Cellular Systems	F	3
<i>BIOM/ECE 431</i>	Biomedical Signal and Image Processing	S	3
BIOM 476 (A & B) ¹	Biomedical Clinical Practicum (formerly BIOM 486)	F,S,SS	Δ 3-4
BIOM 495 ¹	BME Independent Study	F,S,SS	1-6
<i>BIOM/CBE 504</i>	Fundamentals of Biochemical Engineering	S	3
<i>BIOM/ECE 518</i>	Biophotonics	F	3
<i>BIOM/CBE 522</i>	Bioseparation Processes	F	3
<i>BIOM/MECH 525</i>	Cell and Tissue Engineering	S	3
<i>BIOM/ECE 526</i>	Biological Physics	S	3
<i>BIOM/MECH 531</i>	Materials Engineering	S	3
<i>BIOM/CIVE 533</i>	Biomolecular Tools for Engineers	F	3
<i>BIOM/ECE 537</i>	Biomedical Signal Processing	S	3
<i>BIOM/CBE 543</i>	Membranes for Biotechnology and Biomedicine	F	3
<i>BIOM/MECH 570</i>	Bioengineering	F	3
<i>BIOM/MECH 573</i>	Structure and Function of Biomaterials	S	3
<i>BIOM/MECH 574</i>	Bio-Inspired Surfaces	S	3
<i>BIOM/MECH 576</i>	Quantitative Systems Physiology	S	4
<i>BIOM/MECH 578</i>	Musculoskeletal Biosolid Mechanics	F	3
BMS 301	Human Gross Anatomy	F,S,SS	5
BMS 302	Laboratory in Principles of Physiology	F,S	2
BMS 310	Anatomy for the Health Professions (online)	F, S, SS	4
BMS 325	Cellular Neurobiology	F	3
BMS 345	Functional Neuroanatomy	S	4
BMS 405	Nerve and Muscle-Toxins, Trauma and Disease	S	3
BMS 409	Human and Animal Reproductive Biology	F	3
BMS 420	Cardiopulmonary Physiology	F	3
BMS 430	Endocrinology	F	3
BMS 450	Pharmacology	S	3
BMS 500	Mammalian Physiology I	F	4
BMS 501	Mammalian Physiology II	S	4
BMS/NB 503	Developmental Neurobiology	S	3

BME Technical Electives (Continued)			
COURSE	NAME	TERM	CR
BMS/NB 505	Neuronal Circuits, Systems and Behavior	S	3
BZ 311	Developmental Biology	S,SS	4
BZ 350	Molecular and General Genetics	F,S,SS	4
BZ 476*/BZ 576	Genetics of Model Organisms	F	3
CBE 330	Process Simulation	F	3
CHEM 334	Quantitative Analysis Laboratory	F, S	1
CHEM 335	Intro to Analytical Chemistry	F,S	3
CHEM 343	Modern Organic Chemistry II	F,S,SS	3
CHEM 344	Modern Organic Chemistry Laboratory	F,S,SS	2
CHEM 346	Organic Chemistry II	S	4
CHEM 433**	Clinical Chemistry	S	3
CHEM 539A-C	Principles of NMR and MRI	S	1
CM 501	Advanced Cell Biology	F	4
CM/NB 502	Techniques in Molecular & Cellular Biology	F	2
ECE/MECH 569*	Micro-Electro-Mechanical Devices	S	3
ERHS 450	Introduction to Radiation Biology	S	3
ERHS 502	Fundamentals of Toxicology	F	3
ERHS 510	Cancer Biology	S	3
ERHS 540	Principles of Ergonomics	F	3
FSHN 470	Integrated Nutrition & Metabolism	F,S	3
HES 307	Biomechanical Principles of Human Movement	F,S,SS	4
HES 319	Neuromuscular Aspects of Human Movement	F,S	4
HES 403	Physiology of Exercise	F,S,SS	4
HES 476	Exercise and Chronic Disease	F,S,SS	3
MATH 455**	Mathematics in Biology and Medicine	F	3
MECH 432	Engineering of Nanomaterials	F	3
MECH 543**	Biofluid Mechanics	S	3
MIP 300	General Microbiology	F,S,SS	3
MIP 302	General Microbiology Laboratory	F,S	2
MIP 342	Immunology	F,S	4
MIP 343	Immunology Laboratory	S	2
MIP 351	Medical Bacteriology	S	3
MIP 352	Medical Bacteriology Lab	S	3
MIP 420	Medical and Molecular Virology	F	4
MIP 436*	Industrial Microbiology	F	4
MIP 443	Microbial Physiology	S	4
MIP 450	Microbial Genetics	F	3
MIP/BSPM 576	Bioinformatics	F,S	3
NB 500	Readings in Cellular Neurobiology	F	1
NB 501	Cellular and Molecular Neurophysiology	F	2

¹ A maximum total of 3 credits of BIOM 476 and/or BIOM 495 may be applied towards BME technical elective degree requirements.

●BME-MECH students must take 6* credits from the following approved MECH Technical Electives:

MECH Technical Electives			
All students may choose from:			
COURSE	NAME	TERM	CR
MECH 303	Energy Engineering	F	3
Any 400-level MECH Course	EXCEPT MECH 486A, MECH 486B, MECH 495, and MECH 498A, or MECH498B. Please refer to the full university course catalog for a list of the remaining 400-level MECH courses.		

MECH Technical Electives	
Students with a 3.0 GPA or higher may also choose from:	
COURSE	NOTES
MECH 495	Requires written permission from Associate Department Head
MECH 498	Requires written permission from Associate Department Head

NOTE: Certain courses are “Alternative TEs” (e.g. CS 163/164, MGT 305) for standalone MECH students but do not qualify as MECH TEs for MECH+BMEs. MECH TEs for BME+MECHs must have a MECH prefix.

*** - Change pending that removes MECH 402 as required and increases MECH TE requirement for BME+MECH students from 3 credits to 6 credits.**

- To Request Overrides** - Include your CSU ID and verification that you meet prerequisites; If you do not meet prerequisites, request permission from the prof and indicate why you think you would be successful in the course. If
- ◆ For 500-level BIOM courses, forward permission to Sara.Mattern@colostate.edu (BME grad adviser) to request override
 - ◆ For 500-level CBE courses, you should be able to register if you meet the pre-requisites. If you need an override, forward permission to Claire.Lavelle@colostate.edu.
 - ◆ For 500-level ECE courses, you should be able to register if you meet the pre-requisites. If you need an override, forward permission to Courtney.Johnsrud@colostate.edu
 - ◆ For CIVE courses, email your BME adviser with the reason you want the override (e.g. meet pre-reqs but are not in the major) and she will forward request to the department on your behalf.
 - ◆ For MECH courses, request approval via your BME adviser, who will forward to MECH on your behalf. If you do not meet prerequisites for 500-level courses (cum 3.0+ gpa or coursework), request permission from the prof and
 - ◆ To request overrides for other courses (e.g. 500-level or prereq override), email the course professor or the department teaching the course.



The biomedical engineering (BME) degree combined with mechanical engineering (MECH) degree program allows students to apply mechanical engineering principles to human and animal health and biological systems. Career paths include analyzing and designing devices such as exercise equipment, prosthetic limbs, exoskeletons that work outside the body to enhance functionality of the body externally; or working with things like orthopedic implants or biocompatible materials that work inside the body to enhance or replace bone or soft tissues.

Learn more about [biomedical engineers](http://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm) - <http://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm> - in the Bureau of Labor Statistics Occupational Outlook Handbook or at the Biomedical Engineering Society: [BMES.org](http://www.bmes.org).

Learn more about [mechanical engineers](http://www.bls.gov/ooh/architecture-and-engineering/mechanical-engineers.htm) - <http://www.bls.gov/ooh/architecture-and-engineering/mechanical-engineers.htm> - in the Bureau of Labor Statistics Occupational Outlook Handbook.

Additional resources: Society for Biomaterials (<http://www.biomaterials.org/>); American Society of Biomechanics (<http://www.asb-biomech.org/>) ; Orthopedic Research Society (<http://www.ors.org/>) ; Veterinary Orthopedic Society (<http://www.vosdvm.org/>) ; International Cartilage Repair Society (<http://www.cartilage.org/>).

Finding BME Internships/Jobs

Take advantage of CSU resources

- **Career Fairs** – fall and spring. Many biotech companies don't go to these, but some do. Check with companies for your partner majors, also.
- **Biotech Connect** – held in early March – networking event for biotech companies
- **Handshake** – internship/job posting database (<https://career.colostate.edu/experience/handshake>)
- **Engineering Success Center** – help with resumes, interviewing, job/internship search, co-ops

Attend events, look at job posting and company websites (sign up to have updated jobs sent to you)

- **Biomedical Engineering Society** – www.BMES.org
 - Active student chapter @CSU - <https://www.engr.colostate.edu/organizations/bmes/>
 - Email for further information/membership: csu.bmesociety@gmail.com
 - Job Postings - <http://jobboard.bmes.org/search.cfm>; especially good for academic positions.
- **Colorado Bioscience Association** (THE organization for biotech in CO): www.cobioscience.com
 - **Job postings** -- www.cobioscience.com/careers.php; www.aftercollege.com ; www.glassdoor.com ; www.biospace.com
 - **Local information and opportunities** -- find industry updates and a company directory in the back! <http://www.cobioscience.com/sponsorship/marketing-magazine>
- **General Biotech** - www.Biospace.com – wordsearch specific terms (i.e. medical devices, tissue engineering)
- **Pharmaceuticals** – <https://ispe.org/>
- **Medical Device** - <https://novoengineering.com/product-development-services/medical-device-development/>
- **Clinical Research** - <https://www.biospace.com/jobs/clinical/#browsing>