



SCHOOL OF BIOMEDICAL  
ENGINEERING  
COLORADO STATE UNIVERSITY

## B.S. Biomedical Engineering + B.S. Electrical Engineering – Concentration in Lasers & Optics BME+EE-L&O 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 Electrical Engineering with a concentration in Lasers & Optics (BME+EE – L&O). 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+EE-L&O students are introduced to biomedical and electrical engineering, in addition to learning the fundamentals of physics and mathematics. The third year of study provides continued depth in BME and EE, including a multidisciplinary, hands-on problem-based BME learning lab. The fourth year rounds out the EE curriculum, adds in lasers and optics classes as well as a ‘gateway’ BME course that transitions key EE 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. (Note that many ECE courses must be passed with a minimum grade of “C”.) 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](http://www.engr.colostate.edu/sbme) for further information!

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

Sincerely,

*Robyn*

Academic Advisor

*(First year students and  
prospective transfers with 1 year  
or less of transfer work)*

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**Curriculum Checksheet - Effective Fall 2018 And After**

**Program Total Credits = 159**

COURSE	NAME (PREREQS (";" DENOTES "AND"))	TERM	C R	COURSE	NAME (PREREQS (";" DENOTES "AND"))	TERM	C R
<b>1st Year Fall</b>				<b>1st Year Spring</b>			
BIOM 100	Overview of Biomedical Engineering	F	1	CHEM 112	General Chemistry Lab I (CHEM 111 or 117 or conc.)	F, S, SS	1
<b>ECE 102</b>	Digital Circuit Logic	F, S	4	<b>ECE 103</b>	DC Circuit Analysis ( <b>MATH 160</b> )	F, S	3
CHEM 111	General Chemistry I (MATH 118 or 141 or 155 or 160 or 161 or 229 or 261; CHEM 105 or an appropriate score in the chemistry preparation module)	F, S, SS	4	LIFE 102	Attributes of Living Systems	F, S, SS	4
CO 150	College Composition (CO 130 or placement by ACT or SAT or DSP Survey or Challenge Exam)	F, S, SS	3	<b>MATH 161</b>	Calculus for Physical Scientists II (MATH 124; MATH 159 or 160)	F, S, SS	4
<b>MATH 160</b>	Calculus for Physical Scientists I ( <b>MATH 124 and 126 (B or better)</b> )	F, S, SS	4	<b>PH 141</b>	Physics for Scientists and Engineers I (MATH 126 or conc.; MATH 155 or 159 or 160 or conc.)	F, S, SS	5
<b>Total 16</b>				<b>Total 17</b>			

<b>2nd Year Fall</b>				<b>2nd Year Spring</b>			
BIOM 200	Fundamentals of Biomedical Engineering (BIOM 100 or conc.; LIFE 102; MATH 160)	F	2	<b>ECE 202</b>	Circuit Theory Applications ( <b>ECE 103; MATH 161</b> )	S, SS	4
CS 163 OR CS 164	Java (CS1) No Prior Programming ( <b>MATH 124</b> ) OR Java (CS1) Prior Programming ( <b>MATH 124</b> )	F, S	4	<b>ECE / STAT 303</b>	Introduction to Communication Principles ( <b>MATH 261</b> ; MATH 340 or conc.)	S	3
<b>MATH 261</b>	Calculus for Physical Scientists III (MATH 161)	F, S, SS	4	<b>MATH 340</b>	Introduction to Ordinary Differential Equations (MATH 255 or 261)	F, S, SS	4
<b>PH 142</b>	Physics for Scientists and Engineers II (MATH 161 or 255 or 271 or conc.; PH 141)	F, S	5	PH 314	Introduction to Modern Physics (MATH 261 or conc.; PH 142)	S	4
<b>Total 15</b>				<b>Total 15</b>			

<b>3rd Year Fall</b>				<b>3rd Year Spring</b>			
<b>ECE 311</b>	Linear Systems Analysis I ( <b>ECE 202; MATH 340; ECE 331</b> or conc.; ECE 341 or ECE 451 or conc.)	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
<b>ECE 331</b>	Electronics Principles I ( <b>ECE 202; MATH 340; PH142</b> ; ECE 311 or conc.; ECE 341 or ECE 451 or conc.)	F	4	BMS 300	Principles of Human Physiology (BZ 101 or 110 or LIFE 102; CHEM 103 or 107 or 111)	F, S, SS	4
<b>ECE 341</b>	Electromagnetics Fields and Devices I ( <b>ECE 202; MATH 340; PH 142</b> ; ECE 311 or conc.; ECE 331 or conc.)	F	3	<b>ECE 332</b>	Electronics Principles II ( <b>ECE 331</b> )	S	4
BME BE	BME Broad Elective	F, S, SS	3	<b>ECE 342</b>	Electromagnetic Fields and Devices II ( <b>ECE 341</b> )	S	3
AUCC		F, S, SS	3				
<b>Total 16</b>				<b>Total 15</b>			

<b>4th Year Fall</b>				<b>4th Year Spring</b>			
CHEM 113	General Chemistry II (CHEM 107 or 111 or 117; MATH 124 or MATH 141, 155, 160, 161, 229, 261 or conc.)	F, S, SS	3	BIOM 431	Biomedical Signal and Image Processing ( <b>ECE 303; ECE 311; PH 142</b> )	S	3
<b>ECE 404</b>	Experimental Optical Electronics (conc. w/ ECE 441)	F	2	CHEM 245	Fundamentals of Organic Chemistry (CHEM 107 or 113)	F, S, SS	4
<b>ECE 441</b>	Optical Electronics ( <b>ECE 342</b> )	F	3	<b>ECE 457</b>	Fourier Optics ( <b>ECE 311; ECE 342</b> )	S	3
MECH 337	Thermodynamics (MATH 261; PH 141)	F, S	4	ECON 202 (AUCC 3C)	Principles of Microeconomics (MATH 117 or 118 or 141 or 155 or 160)	F, S, SS	3
PH 353	Optics and Waves (MATH 261; PH 142)	F	4	MECH 262	Engineering Mechanics (MATH 161; PH 141)	S	4
<b>Total 16</b>				<b>Total 17</b>			

<b>5th Year Fall</b>				<b>5th Year Spring</b>			
BIOM 486A	Biomedical Design Practicum: Capstone Design I (BIOM 300; (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) or (PH 353).	S	4
ECE-TE	ECE Technical Elective _____		3	ECE-TE	ECE Technical Elective _____		3
PH 451	Intro Quantum Mechanics I (PH 314; MATH 340 or 345)	F	3	ECE-TE	ECE Technical Elective _____		3
CO 301B OR JTC 300	Writing in the Disciplines: Sciences OR Professional & Technical Communication (CO 150 or HONR 193)	F, S, SS	3	AUCC		F, S, SS	3
AUCC		F, S, SS	3	AUCC		F, S, SS	3
<b>Total 16</b>				<b>Total 16</b>			

\* - All course prerequisites for required undergraduate ECE courses must be completed with a C or better

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

<b>Additional All University Core Courses (AUCCs)</b>
6 cr - 3B Arts and Humanities: _____
3 cr - 3C Social/Behavioral Science: <i>ECON 202</i>
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

**Must have at least a "C" in BOLDED courses**

# BME-EE+L&O Technical Electives

Technical Electives (TEs) are designed to provide additional breadth and depth in the Biomedical and partner major degrees.  
BME-EE-L&O students take 9 credits of ECE TEs chosen from the following lists.

<b>Key:</b>	
<b>F - Fall</b>	<b>* Available Every Other Year (Even)</b>
<b>S - Spring</b>	<b>** Available Every Other Year (Odd)</b>
<b>SS - Summer</b>	
<b>See below for information on how to obtain course overrides</b>	

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.

<b>●BME-EE-L&amp;O students must take 9 credits of ECE TEs from the following list:</b>			
ECE Technical Electives			
COURSE	NAME	TERM	CR
ECE 312	Linear System Analysis II	S	3
ECE/MATH 430	Fourier and Wavelet Analysis with Apps	S	3
ECE471A	Semiconductor Physics	F	1
ECE471B	Semiconductor Junctions	F	1
ECE495 (A-C) <sup>2</sup>	Independent Study	F, S, SS	1-6
ECE 503	Ultrafast Optics	S	3
ECE 504	Physical Optics	F	3
ECE 505	Nanostructures: Fundamentals & Applications	F	3
ECE 506	Optical Interferometry & Laser Metrology	F	3
ECE 507	Plasma Physics and Applications	S	3
ECE/BIOM 517	Advanced Optical Imaging	F	3
ECE/BIOM 518	Biophotonics	F	3
ECE/BIOM 526	Biological Physics	F	3
ECE/BIOM 527B	Signals and Noise in Biosensors "Changes Pending in DARS"	S*	1
ECE/BIOM 527F	Biophotonic Sensors Using Refractive Index "Changes Pending in DARS"	S*	1
ECE 546	Laser Fundamentals & Devices	S	3
ECE 572	Semiconductor Transistors	S	1
ECE 573	Semiconductor Optoelectronics Laboratory	S	3
ECE 574	Optical Properties in Solids	S	3
MATH 419	Introduction to Complex Variables	F	3
PH 315	Modern Physics Lab	S	2
PH 425	Advanced Physics Lab	S	2
PH 452	Intro to Quantum Mechanics II	S	3
PH 462	Statistical Physics	F	3

**ECE 48X and 58X (experimental) courses in Lasers and Optics may also be available; check with your ECE Adviser**

<sup>2</sup> A maximum total of 3 credits of 495 Independent Study may be applied towards EE technical elective degree requirements.

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

To request overrides for other courses (e.g. 500-level or prereq override), email the course professor or the department teaching the course.

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Biomedical Engineering (BME) combined with an Electrical Engineering (BME+EE) provides a strong background in applied physics, signal and image processing, and instrumentation controls. BME+EE with a concentration in Lasers & Optics (BME+EE-L&O) further refines electrical engineering principles with additional physics, optics and lasers courses, resulting in a specialty that works in areas such as optics, biosensors, or ultra-fast lasers that help image and/or treat biological systems (e.g. radiation therapy, electro-chemical microfluidics) and improve animal and human healthcare.

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

Additional resources: SPIE – the International Society for Optics and Photonics ([www.spie.org](http://www.spie.org)); IEEE (the Institute of Electrical and Electronics Engineers – [www.ieee.org](http://www.ieee.org)); IEEE spectrum - <http://spectrum.ieee.org/biomedical>; EMBS (IEEE Engineering in Medicine & Biology) - <http://www.embs.org> or <http://tbme.embs.org/>.

Our alumni have worked in a variety of companies and fields, including Applied Medical, QuSpin, 3D Systems, and have also gone on to pursue graduate studies. The BME+EE-L&O degree provides background for many career options!

## 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](http://www.BMES.org)
  - Active student chapter @CSU - <https://www.engr.colostate.edu/organizations/bmes/>
    - Email for further information/membership: [csu.bmesociety@gmail.com](mailto: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](http://www.cobioscience.com)
  - **Job postings** -- [www.cobioscience.com/careers.php](http://www.cobioscience.com/careers.php); [www.aftercollege.com](http://www.aftercollege.com); [www.glassdoor.com](http://www.glassdoor.com); [www.biospace.com](http://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](http://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>