2012 Information for Students

Department of Chemical & Biological Engineering

www.chbe.montana.edu

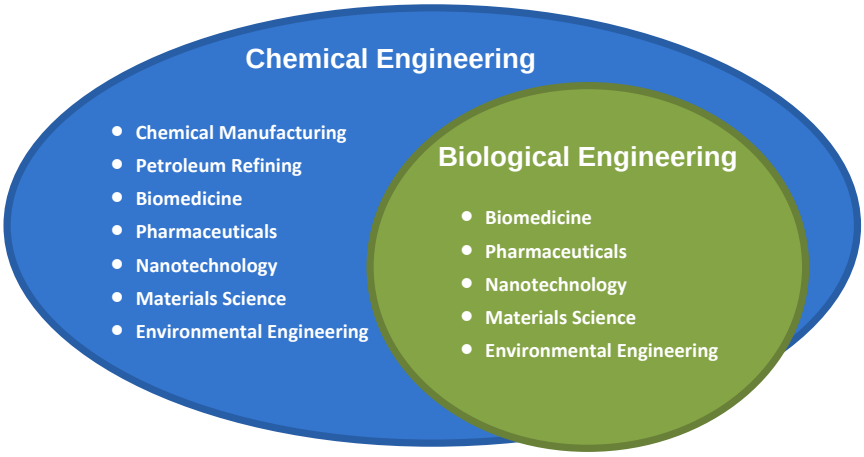
STUDENT INFO

Welcome to Chemical and Biological Engineering!

Our goal is to prepare students to use their knowledge and skills to contribute to society and their profession. We offer undergraduate degrees in both chemical engineering and bioengineering.

The basis of both chemical and biological engineering is the useful transformation of matter from one form to another. That transformation can be brought about by direct chemical reactions, or chemical reactions mediated by living organisms.

Right now, chemical and biological engineers can work in many of the same areas. That may change as bioengineering develops as a profession, but bioengineers are likely to work closely with chemical engineers for the foreseeable future.



Both chemical and biological engineers are working with:

- Novel materials
- Food products
- Energy sources
- Pharmaceuticals

The list is expanding all the time - tomorrow's graduates may find careers in fields that do not even exist today as chemical and biological engineering research continually expands the opportunities.

If you haven't decided whether you want a career in chemical or biological engineering, take heart - the curricula for chemical engineering and bioengineering are identical for the first three semesters.

In the first three semesters the focus is on basic math and science courses, and both bioengineers and chemical engineers need chemistry, calculus, and physics. The curricula start diverging in the junior year when bioengineering majors take more bio-based science courses while chemical engineering majors take more engineering courses.

Focus Areas

Both the chemical engineering curriculum and the bioengineering curriculum include 11 credits (about four courses) of technical electives. The Bioengineering program adds another 9 credits of Bioengienering Electives. Students in either major can use these elective credits to focus on an area of interest. Lists of suggested courses are available for a variety of Focus Areas:

Chemical Engineering Focus Areas:

- **Process and Product Engineering** (Classic Chemical Engineering)
- **Materials Engineering**
- **Environmental Engineering**
- **Bioengineering**

Bioengineering Focus Areas:

- **Biomedical Engineering**
- **Environmental Engineering**
- **Bioprocess Engineering**
- **Food Engineering**

Technical elective courses are typically taken in the junior and senior years, so you have some time to consider which area you might like to focus on.

Academic Advising

General Advising in Chemical and Biological Engineering

The Academic Advisor and Departmental Certifying Officer is Shelley Thomas. For most academic advice she will be your first contact. She is available to assist students with registration questions and processes. Shelley's office is located in 309 Cobleigh Hall.

For additional information regarding career focus advice, each CHBE student is assigned to two academic advisors, according to the following schedule:

A-E	Jennifer Brown, Ross Carlson
F-L	Paul Gannon, Robin Gerlach
M-R	Jeff Heys, Brent Peyton
S-Z	Abbie Richards, Joe Seymour

Additionally, Dr. Jeffrey Heys (Interim Department Head) serves as back-up advisor for all CHBE students.

Entering Freshmen

Your first advising contact will be Shelley Thomas. The ChBE Department Head is also available to advise new students. After admission, new students are encouraged to become acquainted with their long term academic advisors, following the schedule above.

Transfer Students

The evaluation of your credits transferred from your previous institution takes place in two parts:

1. The University evaluates your transfer courses for course equivalencies.
2. The Department then evaluates your transfer credits for allowable course substitutions. Transfer students will need to meet with a transfer advisor (Shelley Thomas or Jeff Heys) until they get on track with the standard curriculum flowchart.

Department Contact Information

- 306 Cobleigh Hall
- PO Box 173920
- Bozeman, MT 59717-3920
- chbe@coe.montana.edu
- 406-994-2221

Degree Requirements

Credit Requirements

The Department requires 128 credits for graduation, 43 of which must be in courses numbered 300 or higher.

Performance Requirements

Students starting their academic program in the fall of 2005 or later are required by Board of Regents policy to achieve a C- or better grade in each class used to satisfy the Bachelor of Science degree requirements.

Specific Course Requirements

Specific course requirements are listed in several places; however, the **MSU Undergraduate Catalog** is the official source of degree requirements. Degree requirements for the 2008-2010 Catalog are listed in this packet as well. Also, degree requirements are available as a flowchart (showing course prerequisites). These documents are available online at the following web addresses.

MSU CORE 2.0 Requirements

MSU's general education requirements are called "CORE" courses. In 2004 MSU adopted a new set of CORE requirements called CORE 2.0. These requirements, as they apply to CHBE majors, are summarized here.

CHBE majors must complete 12 credits of CORE 2.0 electives in the following areas:

- **IA** Inquiry Arts (3 cr)
- **IH** Inquiry Humanities (3 cr)
- **IS** Inquiry Social Sciences (3 cr)
- **D** Diversity (3 cr)

There are several other CORE 2.0 areas that are automatically met by courses required by the chemical and biological engineering curricula:

- **US** University Seminar (3 cr)
- **W** Writing (3 cr)
- **IN** Inquiry Natural Science
- **CS** Contemporary Issues in Science
- **Q** Quantitative Reasoning
- **R** Research and Creative Experience

Useful Web Sites

MSU Catalog
www.montana.edu/wwwcat

CHBE Homepage
www.chbe.montana.edu

CHBE Prerequisite Flowcharts
www.chbe.montana.edu/Students/Academic%20Information%20Undergraduate.htm

Approved CORE 2.0 Courses
www.montana.edu/core2/approved_courses.html

Required Courses

Chemical Engineering

Freshman Year	F	S
ECHM 100 Intro to Chemical Engineering	2	
EGEN 102 Intro to Engineer Computer Applications		2
CHMY 141 College Chemistry I	4	
CHMY 143 College Chemistry II		4
M 171Q Calculus I	4	
M 172Q Calculus II		4
US or W CORE course	3	3
Univ. CORE Electives (IA, IH, IS OR D)	3	3
	16	**16**

Sophomore Year	F	S
EMAT 251 Materials Structures and Properties		3
ECHM 215 Elem Princ of Chemical & Biol Engr I	3	
ECHM 216 Elem Princ of Chemical Engr II		3
ECHM 321 Chemical Engr Fluid Mechanic Ops		3
CHMY 211 Elements of Organic Chemistry	5	
M 273Q Multivariable Calculus	4	
M 274 Intro to Differential Equations		4
PHSX 220 Physics I (w/ calculus)	4	
PHSX 222 Physics II (w/ calculus)		4
	16	**17**

Junior Year	F	S
BCH 380 Biochemistry	5	
ECHM 307 Chemical Engr Thermodynamics I	3	
ECHM 322 Chemical Engr Heat Transfer Operations	3	
ECHM 323 Chemical Engr Mass Transfer Operations		3
ECHM 328 Chemical Engr Reaction Engineering		3
EBIO 438 Bioprocess Engineering		3
EGEN 310R Multidisc Engineering Design		3
EGEN 350 Applied Engr Data Analysis	2	
Univ. CORE Electives (IA, IH, IS OR D)	3	3
	16	**15**

Senior Year	F	S
ECHM 407 Chem Engr Thermodynamics II	2	
ECHM 411R Chemical Engineering Design I	3	
ECHM 412R Chemical Engineering Design II		3
ECHM 424 Transport Analysis	3	
ECHM 442 Chemical Engineering Laboratory I	2	
ECHM 443 Chemical Engineering Laboratory II		2
ECHM 451 Chemical Engr Process Dyn & Control		3
CHMY 373 Phys Chem Kinetics & Thermo		3
EGEN 488 Fund of Engineering Exam		0
Technical Electives	6	5
	16	**16**

Bioengineering

Freshman Year	F	S
EBIO 100 Intro to Biological Engineering	2	
EGEN 102 Intro to Engineer Computer Applications		2
CHMY 141 College Chemistry I	4	
CHMY 143 College Chemistry II		4
M 171Q Calculus I	4	
M 172Q Calculus II		4
US or W CORE course	3	3
Univ. CORE Electives (IA, IH, IS OR D)	3	3
	16	**16**

Sophomore Year	F	S
CHMY 211 Elements of Organic Chemistry	5	
ECHM 215 Elem Princ of Chemical & Biol Engr I	3	
EBIO 216 Elem Princ of Bioengineering		3
ECHM 321 Chemical Engr Fluid Mechanic Ops		3
M 273Q Multivariable Calculus	4	
M 274 Intro to Differential Equations		4
PHSX 220 Physics I (w/ calculus)	4	
BIOM 360 General Microbiology		5
	16	**15**

Junior Year	F	S
BCH 380 Biochemistry	5	
BIOB 375 General Genetics		3
EMAT 251 Materials Structures and Properties		3
EBIO 324 Bioengineering Transport	3	
EBIO 438 Bioprocess Engineering		3
EBIO 439 Downstream Processing		3
EGEN 310R Multidisc Engineering Design		3
EGEN 350 Applied Engr Data Analysis	2	
PHSX 222 Physics II (w/ calculus)	4	
Univ. CORE Electives (IA, IH, IS OR D)	3	
	17	**15**

Senior Year	F	S
EBIO 411R Biological Engineering Design I	3	
EBIO 412R Biological Engineering Design II		3
EBIO 442 Bioengineering Laboratory I	2	
EBIO 443 Bioengineering Laboratory II		2
Bioengineering Elective	3	6
Technical Elective	6	5
Univ. CORE Electives (IA, IH, IS OR D)	3	
EGEN 488 Fund of Engineering Exam		0
	17	**16**

Information from the US Bureau of Labor Statistics

www.bls.gov/oco/ocos027.htm

Chemical engineers apply the principles of chemistry to solve problems involving the production or use of chemicals and biochemicals. They design equipment and processes for large-scale chemical manufacturing, plan and test methods of manufacturing products and treating byproducts, and supervise production. Chemical engineers also work in a variety of manufacturing industries other than chemical manufacturing, such as those producing energy, electronics, food, clothing, and paper. They also work in health care, biotechnology, and business services. Chemical engineers apply principles of physics, mathematics, and mechanical and electrical engineering, as well as chemistry. Some may specialize in a particular chemical process, such as oxidation or polymerization. Others specialize in a particular field, such as nanomaterials, or in the development of specific products. They must be aware of all aspects of chemicals manufacturing and how the manufacturing process affects the environment and the safety of workers and consumers.

Related Areas Described at the USBLS site:

- **Biomedical Engineers**
- **Environmental Engineers**
- **Materials Engineers**

Chemical engineers are expected to have employment growth of 8 percent over the projections decade, about as fast as the average for all occupations. Although overall employment in the chemical manufacturing industry is expected to decline, chemical companies will continue to research and develop new chemicals and more efficient processes to increase output of existing chemicals. Among manufacturing industries, pharmaceuticals may provide the best opportunities for jobseekers. However, most employment growth for chemical engineers will be in service-providing industries such as professional, scientific, and technical services, particularly for research in energy and the developing fields of biotechnology and nanotechnology.

Curriculum *(2009 Data)*	**BS Starting**
Aerospace/aeronautical/astronautical	$56,311
Agricultural	$54,352
Bioengineering and biomedical	$54,158
Chemical	$64,902
Civil	$52,048
Computer	$61,738
Electrical/electronics and communications	$60,125
Industrial/manufacturing	$58,358
Materials	$57,349
Mechanical	$58,766
Mining and Mineral	$64,404
Nuclear	$61,610
Petroleum	$83,121
Aerospace/aeronautical/astronautical	$56,311
Agricultural	$54,352

Internship and Research Experiences

- Industrial internship opportunities are most often available after the junior year. Companies interview interested students through on-campus recruiting.
- Students may seek research internships after the sophomore year by searching for REU (Research Experiences for Undergraduates) Programs. The Department tries to help get the word out to sophomores about these programs by posting information on bulletin boards and via e-mail messages to students.
- About 20% of our undergraduates participate in research experiences as undergraduates. There is no formal selection process; interested students simply contact researchers in the Department, or elsewhere on campus.

Our first ITU/DDP graduate!

Celebrating the first graduate of the Bioengineering Dual-Degree Program between Istanbul Technical University and Montana State University. Featured, left to right: Dean Robert Marley, Bige Vardar, Provost Joseph Fedock, and Department Head Ron Larsen

Spring 2012 Commencement

Pre-Approved[1] Technical Electives - Chemical Engineering and Bioengineering

(NOTE: Bioengineering Technical Electives ≠ Bioengineering Electives)[2]

Updated: March 2011

Old #	Course #	Title	Offered	Credits
BCHM 441	BCH 441	Biochemistry of Macromolecules	[F]	3
BIOL 301	BIOB 375	General Genetics	[F,S]	3
BIOL 302	BIOB 425	Advanced Cell and Molecular Biology	[S]	3
MB 301	BIOM 360	General Microbiology I	[F,S]	5
MB 449	BIOM 410	Microbial Genetics	[S]	3
MB 433	BIOM 430	Applied and Env Microbiology	[F]	4
MB 420	BIOM 450	Microbial Physiology	[F]	3
CHEM 228	CHMY 311	Analytical Chemistry-Quant Analysis	[S]	4
CHEM 323	CHMY 371	Phys Chem-Quantum Chem & Spectroscopy I	[F]	3
CHEM 325	CHMY 372	Physical Chemistry Laboratory I	[F]	1
CHEM 324	CHMY 374	Physical Chemistry Laboratory II	[S]	2
CHEM 334	CHMY 401	Advanced Inorganic Chemistry	[S]	3
CHEM 417	CHMY 417	Synthetic Chemistry	[S odd]	3
CHEM 426	CHMY 421	Advanced Instrument Analysis	[F]	3
CHEM 428	CHMY 422	Instrumental Analysis Lab	[F]	2
	EBIO 490	Undergraduate Research	[F,S,Su]	1 to 3
	EBIO 498	Internship (1 cr per work period)	[F, S, Su]	1 to 3
CHBE 490	ECHM 490	Undergraduate Research	[F,S,Su]	1 to 3
CHBE 476	ECHM 498	Internship (1 cr per work period)	[F, S, Su]	1 to 3
EE 206	EELE 201	Circuits I for Engineering	[F,S]	4
EE 207	EELE 203	Circuits II for Engineering	[S]	4
EE 250	EELE 250	Circuits, Devices, and Motors	[F,S]	4
CE 340	EENV 340	Principles of Environmental Engineering	[F,S]	3
BREN 434	EENV 434	Groundwater Supply and Remediation	[S]	3
BREN 441	EENV 441	Natural Treatment Systems	[S]	3
ENVE 443	EENV 443	Air Pollution Control	[F even]	3
ENVE 445	EENV 445	Hazardous Waste Treatment	[F odd]	3
ENVE 444	EENV 447	Hazardous Waste Management	[S even]	3
EM 251	EGEN 201	Engineering Mechanics-Statics	[F,S,Su]	3
EM 252	EGEN 202	Engineering Mechanics- Dynamics	[F,S,Su]	3
EM 253	EGEN 205	Mechanics of Materials	[F,S]	3
	EGEN 211	Honors Statics	[F,S,Su]	3
I&ME 313	EIND 313	Work Analysis & Design	[S]	3
I&ME 354	EIND 354	Engr Probability and Statistics I	[F]	3
I&ME 434	EIND 434	Project and Engineering Management	[F]	3
ME 251	EMAT 252	Materials Science Laboratory	[F,S]	1
ME 450	EMAT 452	Adv. Engineering Materials	[on demand]	3
ME 321	EMEC 321	Thermodynamics II	[F,S]	3
ME 464	EMEC 444	Mechanical Behavior of Materials	[F even]	3
LRES 355	ENSC 345	Soil and Environmental Chemistry	[S odd]	3
ME 255	ETME 215	Manufacturing Processes	[F,S]	3
MATH 348	M 348	Techniques of Applied Mathematics I	[F]	3
MATH 349	M 349	Techniques of Applied Mathematics II	[S]	3
	M 386R	Software Applications In Mathematics	[S]	3
MATH 441	M 441	Numerical Linear Algebra & Optimization	[F]	3
MATH 442	M 442	Numerical Solution of Differential Equations	[S]	3

Note 1: Other courses may be allowed for technical elective credit, but you should get any course you are considering approved prior to enrolling. See your advisor about approving potential technical elective courses.

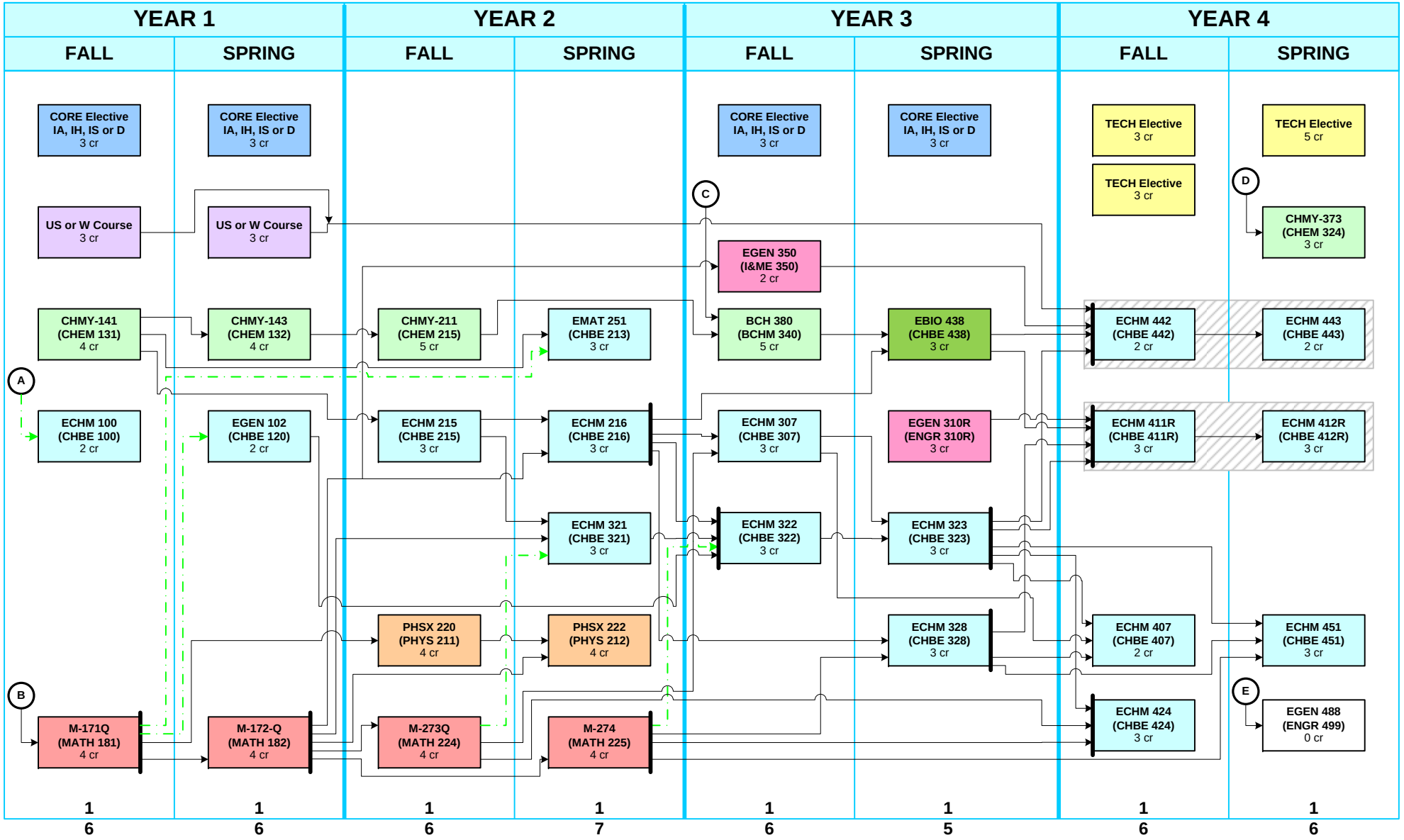
Courses that are required in a program cannot also be counted as technical electives. (No double counting allowed.)

Note 2: The Bioengineering curriculum includes 11 credits of *technical electives* and 9 credits of *bioengineering electives*. The courses listed on this list are pre-approved as technical electives, but most of these courses are not suitable for use a bioengineering electives (unless they have "bio" content).

MATH 450	M 450	Applied Mathematics I	[F odd]	3
MATH 451	M 451	Applied Mathematics II	[S even]	3
MATH 454	M 454	Introduction to Dynamical Systems I	[F even]	3
MATH 455	M 455	Introduction to Dynamical Systems II	[S odd]	3
MATH 449	M 472	Introduction to Complex Analysis	[S even]	3
PHYS 213	PHSX 224	Physics III	[S]	4
PHYS 231	PHSX 301	Intro. to Theoretical Physics	[S]	3
PHYS 426	PHSX 327	Optics	[S even]	3
PHYS 427	PHSX 337	Laser Applications	[S odd]	3
PHYS 441	PHSX 441	Solid State Physics	[F even]	3
PHYS 425	PHSX 446	Thermo. & Statistical Physics	[S odd]	3

Chemical Engineering Prerequisite Flowchart

Catalog: 2010-2012 updated March 2011



A — M-151Q (MATH 160) Co-Req.

B — Math Placement Exam

Pre-Requisite

Co-Requisite

C — BIOL 102 pre-requisite, or ChBE Junior course standing (by agreement with Department)

D — ChBE students who have taken an organic chemistry course may take CHMY-373 (CHEM 324) w/o CHMY-371 (CHEM 323) pre-requisite (by agreement with Chem Department). There is a pre-requisite of M-273Q (MATH 224).

CHMY-373 (CHEM 324) could be taken Spring of year 3.

Also, CHMY-371 (CHEM 323) may be substituted for CHMY-373 (CHEM 324).

E — Take the FE Exam your last semester before graduation

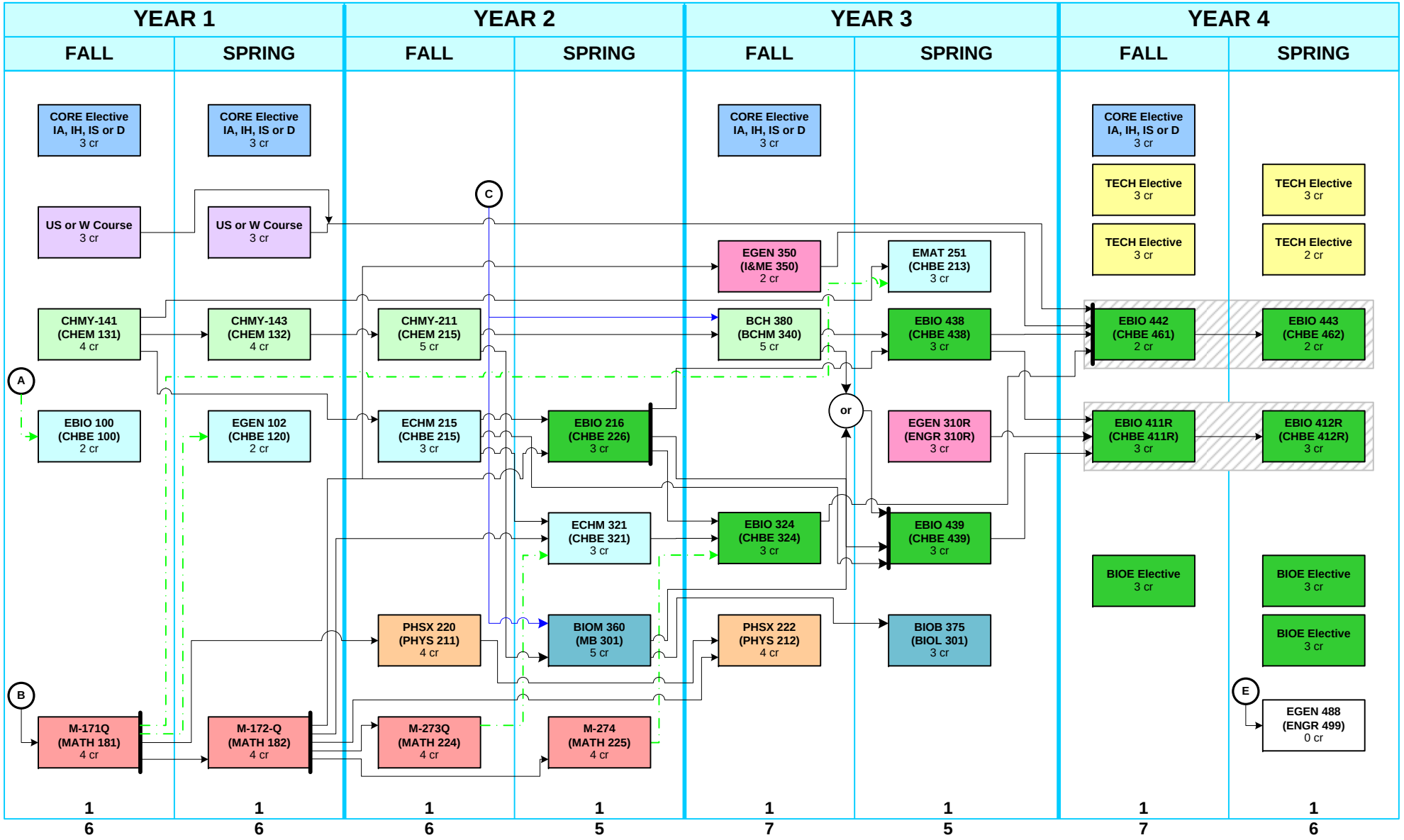
rev. 7/13/12 SIT

NOTE: This flowchart has been reviewed and updated, but there could still be errors. Please report any errors to Shelley Thomas

A hatched box indicates courses which should be taken in sequence.

Bioengineering Prerequisite Flowchart

Catalog: 2010-2012 updated March 2011



A — M-151Q (MATH 160Q) Co-Req.

B — Math Placement Exam

Pre-Requisite

Co-Requisite

C — BIOL 102 pre-requisite, or ChBE Junior course standing (by agreement with Departments)

E — Take the FE Exam your last semester before graduation

rev. 7/13/12 – SIT

NOTE: This flowchart has been reviewed and updated, but there could still be errors. Please report any errors to Shelley Thomas.

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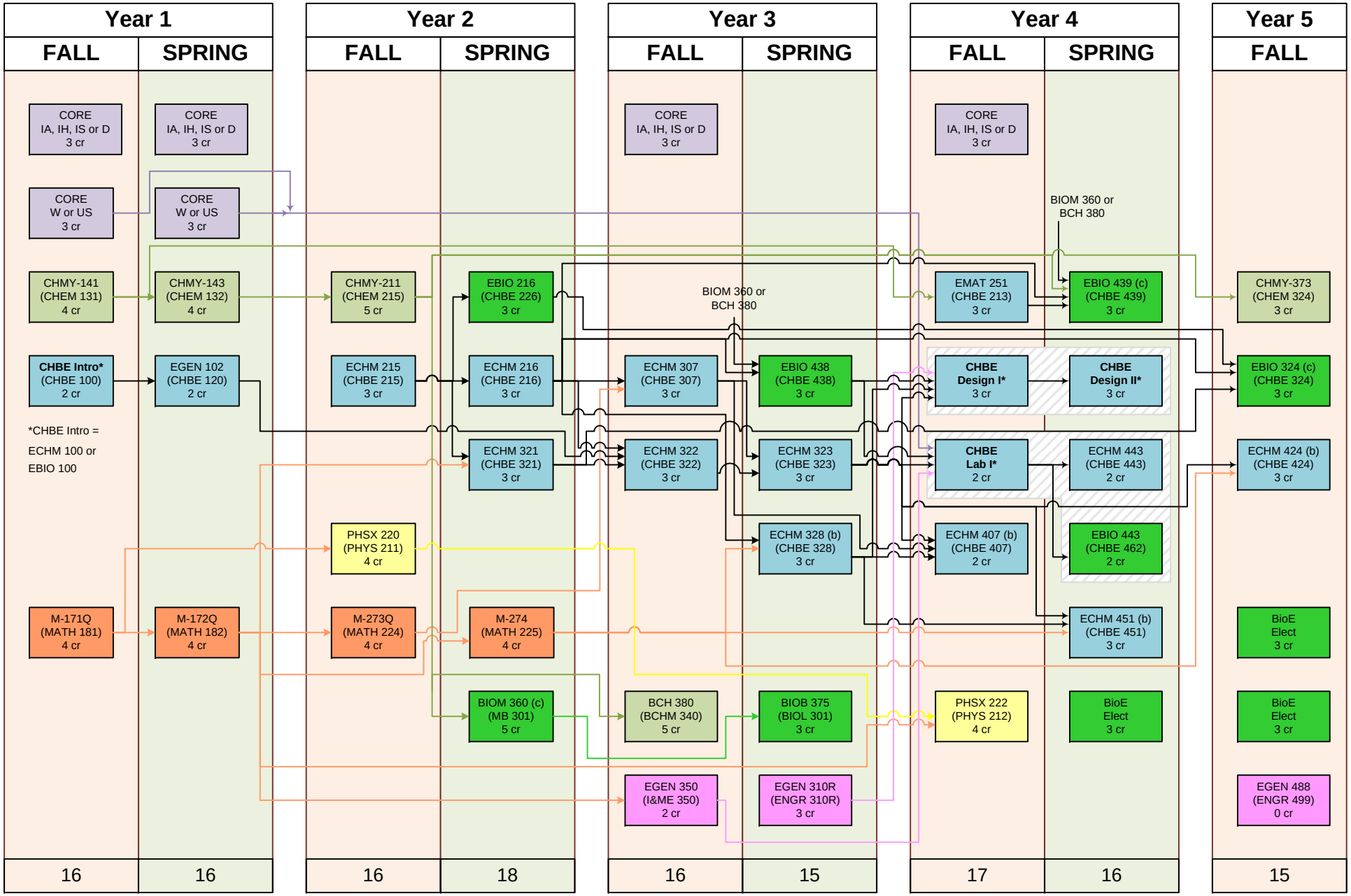
Dual Major CHE/BIOE Prerequisite Flowchart

Catalog: 2010-2012



*CHBE Lab I → ECHM 442 or EBIO 442
*CHBE Design I → ECHM 411R or EBIO 411R
*CHBE Design II → ECHM 412R or EBIO 412R

(b) – course used to meet BioE Tech Elective Reqt.
(c) – course used to meet CHE Tech Elective Reqt

Note: A dual-major curriculum must meet graduation requirements for each degree. This flowsheet shows one way to do this, but this is not the only way to arrange these courses to meet the goal. [For dual degree, an additional 13 credits are required.]

Revised 7/13/12 = SIT