

## CONCENTRATIONS WITHIN THE BSEChE PROGRAM

June 2020

All concentrations consist of 12 credits and must include at least one 300 or 400 level course. Only engineering and general electives can be used as part of a concentration. Up to three research credits in a related area can count toward a concentration with Brittany Smith's approval. Contact her for approval of any other courses. Courses taken for a concentration cannot be taken Pass/Fail. Concentrations are not available to students pursuing dual degrees or SUGS masters in the same area. Student must earn a C- or better in all courses counting towards a concentration and must earn a 2.0 or above overall concentration GPA.

### Conc. In BioPharmaceutical Engineering

12 credits total, including at least 1 course each from categories A, B, & C:

#### Category A: BioPharm Science and Engineering

ChE 517/ PharmSci 717	Biopharm engineering (3 cr.)
ChE/Pharm 519	Modern pharmaceutical engr (3 cr.)
PIBS 601	Principles of pharmacology (3 cr.)
ChE 497	Solids handling (3 cr.)
ChE 496/696	Introduction to Synthetic Biology (3 cr.)
ChE 696	Principles & Predictions of Drug Distribution (3 cr.)
ChE 574	Engr principles in drug delivery and targeting (3 cr.)
Biochem 415/515	Introductory biochemistry (3 cr.), or Chem 351 (4 cr.), MCDB 310 (3 cr.)
BME 410	Design & applictns of biomaterials (3 cr.)
Pharm Sci 608	Pharmacokinetic concepts & appl's (4 cr.)
PIBS 621	Translational pharmacology (2 cr.)

#### Category B: Applied Statistics and Math

ChE 431	Engineering stats & problem solving (3 cr.)
Stat 412	Intro to probability and statistics (3 cr.)
Stat 470	Intro to design of experiments (4 cr. w/ Instructor permission)
Stat 570	Design of experiments (3 cr.)
Math 419	Linear spaces and matrix theory (3 cr.)
Math 217	Linear Algebra (4 cr alternative-Math 419)
IOE 460	Decision analysis (3 cr.)

#### Category C: Regulatory Science

ChE/Pharm 597	Regulatory sci. for sci and engrs (2 cr.)
BME/ChE 588	Globl qual syst & regulatory innovat (2 cr.)
BL 319	Intellectual property law (3 cr.)

#### Other Relevant Courses

BME 500	BME Seminar (1 cr.)
ChE 407	Chem Process Safety Risk Manag. (2 cr.)
IOE 436	Human Factors (3 cr.)
IOE 813	Provid. better hlthcre thru syst engr (2 cr.)
Psych 449	Decision processes (3 cr.)

### Concentration in Electrical Engineering

NOTE: EECS students are given priority in enrollments.

#### Required Courses – 4 credits:

EECS 215	Intro to electronic circuits (4 cr. preferred) or
EECS 314	Electrical circuits, systems, & appl'ns (4 cr.)

#### Technical Electives - 8 credits.

##### Process Controls:

EECS 216	Intro to Signals & Systems (4cr.)
EECS 460	Control Systems Analysis & Design (4cr.)
EECS 461	Embedded Control Systems (4cr.)

##### Electronic Devices:

EECS 320	Intro to semiconductor devices (4 cr.)
EECS 414	Introduction to MEMS (4 cr.)
EECS 421	Properties of transistors (4 cr.)
EECS 423	Solid-state device laboratory (4 cr.)
EECS 429	Semiconductor optoelectronic devices(4 cr.)

### Concentration in Energy Systems Engineering

#### Technical Electives - 9 credits. Select from:

AERO 533/	Combustion processes
ENSCEN 533	(3 cr., requires AEROSP 225)
CEE 567/	Energy infrastructure systems (3 cr.)
ESEng 567	
ChE 496	Hydrogen tech: prod'n & storage (3 cr.)
ChE 496	Fuel processors & fuel cells (3 cr.)
ChE 496	Solar Energy Conversion (3 cr.)
ChE 407	Chem Proc. Safety Risk Manag. (2 cr.)
ME 432	Combustion (3 cr., req's ME 336, 320)
ME 433/	Adv. energy solutions (3 cr., req. ME 235)
AUTO 533	
ME 438	Internal combustion engines (4 cr.)
ME 538	Advanced IC Engines (3 cr.)
ME 539	Heat transfer physics (3 cr., req. ME 235 and ME 335)
ME 571/	Energy generation & storage using
ESENG 505	modern materials (3 cr.)
NERS 250/	Fundamentals of nuclear energy &
ENSCEN 211	Radiological sciences (4 cr.)

Policy/law course – 3 credits. Select from:

ESENG 501	Seminars on energy systems, tech, and policy (3 cr.)
NRE 475 /	Environ law (3 cr.)
EHS 588/	Environ 475
NRE/ BE 527	Energy markets and politics (3 cr.)
PubPol 250	Soc. systems, energy, & pub policy (3cr.)
PubPol 468/	Oil and Gas Policy in the US (3 cr.)
Environ 468	
PubPol 481	Science, tech, & pub policy (3 cr.)
PubPol 519/EAS	Sustainable Energy Systems (3 cr.)
574/RCNSCI 419	

### Concentration in Environmental Engineering

#### Technical electives - 9 credits. Select from:

(sustainability-focused courses are underlined)

ChE 407	Chem Proc. Risk Safety Manag. (2 cr.)
<u>CEE 265</u>	<u>Sustainable engineering principles (3 cr.)</u>
CEE 365	Enviro engr principles (4 cr.)
CEE 366	Enviro engr lab (2 cr. reqs CEE 270 and 365)
CEE 428	Groundwater hydrology (3 cr., requires CEE 265 and CEE 325 or equivalent)
CEE 465	Enviro process engr (3 cr., requires CEE 325 and CEE 365)
CEE 480	Design of enviro. engr systems (3 cr.)
CEE 481	Aquatic chemistry (3 cr.)
CEE 482	Enviro microbiology (3 cr., requires CEE 325 and 365)
CEE 501-7	Wind energy development, engr, & construction
CEE 501-14	Greenhouse gas control (3 cr.)
CEE 526	Design of hydraulic systems (3 cr., requires CEE 325 or equivalent)
CEE 563	Air quality engineering fundamentals (3 cr.)
<u>CEE 586</u>	<u>Industrial ecology (3 - 4 cr., sr, std.)</u>
CEE 589/	Risk and benefit analysis in
NRE 595	enviro engr (3 cr., sr, std.)
<u>CEE 686</u>	<u>Case studies in environ sustainability (2-3 cr., sr std)</u>
CEE 686-001	Enviro finance (3 cr.)

CLIMATE 350 Atmospheric thermodynamics (3 cr.)  
 CLIMATE 410 Earth system modeling (4 cr.)  
 CLIMATE 467/ Biogeochemical cycles (3 cr.)  
 CHEM 467  
 CLIMATE 475 Earth system interactions (4 cr., sr std)  
 Earth 305 Earth's surface and sediment (4 cr.)  
 Earth 313 Geobiology (4 cr.)  
 Earth 325 Environ geochemistry (3 cr.)  
 Earth 477 Hydrogeology (4 cr.)  
 Earth 478 Geochemistry of natural waters  
 ME 589 Sustainable design of technology systems  
 (3 cr., sr, std.)  
 SPACE 370 Solar terrestrial relations (4 cr.)

**Policy/law/economics course - 3 credits. Select from:**

BE 562 Grwth & Stabilization in the Macro Econ  
 (2.25 cr.)  
 CEE 587 Water resource policy (3 cr., sr, std.)  
 CEE 589 Risk & benefit analysis in environ-  
 mental engineering (3 cr. sr. std.)  
 Earth 380 Mineral resources, economics, & the envi-  
 ronment (4 cr.)  
 Econ 370/ Environ 375 Environ & resource econ (3 cr.)  
 Environ 235 Natural Resources & Environ Econ (3 cr.)  
 Environ 312/ Environ politics and policy (3 cr.)  
 Polsci 380  
 Environ 365 International environmental law (3 cr.)  
 Environ 412/ Environ values in public policy (3 cr.)  
 PubPol 412  
 NRE 475/ Environmental law (3 cr.)  
 EHS 588/Environ 475  
 NRE/BE 527 Energy markets and energy politics (3cr)  
 PubPol 481 Science, tech, and public policy (3 cr.)

**Concentration in the Life Sciences**

**Required Course:**

MCDB 310 Intro biochem (3 cr.), (or Chem 351  
 (4 cr.) or Biolchem 415/515 (3 cr.)

**Technical Electives - 8 or 9 credits, for 12 credits total:**

Biology 205 Developmental biology (3 cr.)  
 Biology 207 Intro microbiology (4 cr.)  
 Biology 208 Embryology (3 cr.)  
 Biology 222 Introduction to neurobiology (3 cr.)  
 Biology 225 Principles of animal physiology (3 cr.)  
 Biology 305 Genetics (3 cr.)  
 BME 418 Quantitative cell biology (3 cr.)  
 BME 419 Quantitative physiology (4 cr.)  
 BME 476 Biofluid mechanics (4 cr.)  
 BME 479/ Biotransport (4 cr.)  
 CDB 580 Developmental biology (3 cr.)  
 CEE 482 Environmental microbiology (3 cr.,  
 requires CEE 325 and 365)  
 ChE 517 Biopharm engineering (3 cr.)

ChE 519 Pharmaceutical eng.. (3 cr., sr. std.)  
 ChE 574 Engineering principles in drug delivery &  
 targeting (3 cr.)  
 ChE 584 Tissue Engineering (3 cr.)  
 ChE 696 Tech innovation, law, & regulation (3 cr.)  
 MCDB 411 Protein structure function (3 cr.)  
 MCDB 436 Introductory immunology ( 3 cr.)  
 MedAdm 403 The human anatomy (5 cr.)  
 Micrbiol 301 Intro. microbiology ( 3 cr.)  
 Micrbiol 405 Medical microbiology & infectious  
 diseases (3 cr.)  
 Micrbiol 440 Human Immunology (3 cr.)  
 Micrbiol 460 Eukaryotic Microbiology (3 cr.)  
 Physiol 201 Intro to human physiology (4 cr.)  
 Physiol 502 Human physiology (4 cr.)  
 Stats 449 Topics in biostatistics (3 cr.)

**Conc. in Materials Science and Engineering**

**Technical Electives - 12 credits. Select from:**

MSE 242 Physics of materials (4 cr.)  
 Any 300, 400, 500 level MSE course

**Concentration in Mechanical Engineering**

**Required Courses:**

ME 211 Intro. to solid mechanics (4 cr.)  
 ME 240 Intro. to dynamics and vibrations (4 cr.)

**Technical Electives - 4 credits. Select from:**

ME 311 Strength of materials (3 cr.)  
 ME 350 Design and manufacturing II (4 cr. requires  
 ME 211, 240 and 250)  
 ME 382 Mechanical Behavior of Materials (4 cr. -  
 requires ME 211)  
 ME 400 Mechanical engr analysis (3 cr.)  
 ME 401 Statistical quality control & design (3 cr.)  
 ME 420 Fluid mechanics II (3 cr., requires ME 320)  
 ME 432 Combustion (3 cr., reqs ME 336 & 320)  
 ME 440 Intermediate dynamics & vibrations (4 cr.)  
 ME 476 Biofluid Mechanics (4 cr. requires ME 320)

**Concentration in Nuclear Engineering**

**Required Courses:**

NERS 250 Fundamentals of NERS (4 cr.)  
 NERS 311 Elements of NERS I (3 cr.)  
 NERS 312 Elements of NERS II (3 cr.)

**At least 2 additional credits, which require the above 3 courses. Choose from:**

NERS 421 Nuclear engineering materials (3 cr.)  
 NERS 425 Applications of radiation (4 cr.)  
 NERS 441 Nuclear reactor theory I (4 cr. reqs NERS  
 312 and Math 454)

NERS 471 Introduction to plasmas (3 cr.)  
 NERS 481 Engr principles of radiation imaging (2 cr.)  
 NERS 484 Radiological health engr fund (4 cr.)

**Conc. in Petroleum and Gas Exploration**

*To include 3 lecture courses, composed of at least 3 credits of 300 level or higher EARTH courses and 3 credits of 300 level or higher CEE courses. Only one of Earth 116 or Earth 119 can count toward the concentration*

Earth 116/ Introductory geology (5 cr.)  
 Earth 118 Introductory geology laboratory (1 cr.)  
 Earth 119 Introductory geology lecture (4 cr.)  
 Earth 284 Environmental geology (4 cr.)  
 Earth 305 Earth's surface & sediments (4 cr., requires  
 intro geology course)  
 Earth 310 Geochemistry of the solid earth (4 cr.  
 requires intro geology course)  
 Earth 314 Global & applied geophysics (4 cr.)  
 Earth 351 Earth structure (4 cr.)  
 Earth 380 Mineral resources, econ, & the  
 environment (4 cr.)  
 Earth 422 Principles of geochemistry (3 cr., requires  
 intro geology course)  
 Earth 467 Stratigraphy & basis analysis (4 cr.  
 requires introductory geology course)  
 Earth 477 Hydrogeology (4 cr.)  
 CEE 345 Geotechnical engineering (4 cr.)  
 CEE 428/ Groundwater hydrology (3 cr.)  
 Ensccn 428  
 CEE 446 Engr geology & site characterization  
 (3 cr., requires CEE 345)  
 CEE 522 Sediment transport (3 cr.)  
 CEE 527 Coastal hydraulics (3 cr.)  
 CEE 528/ Flow and transport in porous media (3 cr.,  
 Ensccn 528 requires CEE 428 or equivalent)  
 CEE 535 Excavation and tunneling (3 cr.)

*Check web for updates at:*

[www.engin.umich.edu/che/undergraduate/program](http://www.engin.umich.edu/che/undergraduate/program)