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UVa Premed Advisor
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salko@virginia.edu, Bryant Hall
### 1st Semester

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<td>Science Elective I (3 credits)</td>
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<td>BME 2104</td>
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<td>BME 2220</td>
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<td>BME 3080</td>
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<td>APMA 3110</td>
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<td>Unrestricted Elective (3 credits)</td>
<td>Chosen from any 2000-level or higher science, math, or engineering course, unless it is a course for non-science majors, duplicates required BME course work, or is a research-for-credit or capstone design course. See list of excluded courses on page 8 of this guide.</td>
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<td>Chosen from any 3000-level or higher BME elective. One of the following non-BME courses may be included as a BME elective: CHE 3347, CHE 4448, or ECE 5750. Only 3 credits of BME 4995 may be used as a BME Elective.</td>
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**Credits 126**
### Engineering Core (37 credits)
- APMA 1110 Calculus I
- APMA 2120 Multivariate
- APMA 2130 Ordinary Diff Equations
- CHEM 1610 Intro Chem
- CHEM 1611 Intro Chem Lab
- Science Elec I
- PHYS 1425 Intro Physics I
- PHYS 1429 Intro Physics I Workshop
- PHYS 2415 Intro Physics II
- PHYS 2419 Intro Physics II Workshop
- ENGR 1620 Intro to Engineering
- CS 1110 Intro Computer Science
- APMA 3100 or 3110 Prob or Prob/Stat

*APMA 1090 is an unrestricted elective

### STS (12 credits)
- STS 1500 Lang & the Tech Society
- STS Elective
- STS 4500 Tech & Culture
- STS 4600 Ethics & Society

### Engineering & Technical (9 credits)
- Engr Elective
- Engr Elective
- Tech Elective

### HSS & Unrestricted (21 credits)
- HSS
- HSS
- HSS
- Unrestricted
- Unrestricted
- Unrestricted
- Unrestricted

### BME (47 credits)
- BME 2000 Intro to BME
- BME 2101 Physiology I
- BME 2102 Physiology II
- BME 2104 Cell & Molecular Biology
- BME 2220 Biomechanics
- BME 2240 Biotransport
- BME 3310 BME Systems Analysis
- BME 3315 Computational BME
- BME 3080 IDEAS Lab I
- BME 3090 IDEAS Lab II
- BME 4063 Capstone Design I
- BME 4064 Capstone Design II
- BME Elective
- BME Elective
- BME Elective
- BME Elective

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**First Semester**

- **Fall Year 1**
  - CHEM 1610
  - CHEM 1611
  - ENGR 1620
  - STS 1500
  - APMA 1110

**Second Semester**

- **Spring Year 1**
  - CS 1110
  - PHYS 1425
  - PHYS 1429
  - APMA 2120

**Third Semester**

- **Fall Year 2**
  - BME 2101
  - BME 3315
  - PHYS 2415
  - PHYS 2419
  - APMA 2130

**Fourth Semester**

- **Spring Year 2**
  - BME 2102
  - BME 2104
  - BME 2220
  - BME 2000

**Fifth Semester**

- **Fall Year 3**
  - BME 3080
  - BME 3310

**Sixth Semester**

- **Spring Year 3**
  - BME 3090
  - BME 2240

**Seventh Semester**

- **Fall Year 4**
  - BME 4063
  - STS 4500

**Eighth Semester**

- **Spring Year 4**
  - BME 4064
  - STS 4600
Be sure to contact
Susan Salko
Rebecca Christy
Office of PreProfessional Services
Bryant Hall @ Scott Stadium
924-8900, salko@virginia.edu
www.career.virginia.edu/students/preprof/prehealth/

Attend walk-in advising hours for premeds,
or make an appointment.

PreMed Requirements:

2 semesters Chemistry Lecture & Lab.
Fulfilled by CHEM 1610, 1611 and CHEM 1620, 1621 (use your Science Elective I).

2 semesters Physics Lecture & Lab.
Fulfilled by PHYS 1425, 1429, 2415, 2419.

2 semesters Organic Chemistry Lecture & Lab.
Fulfilled by CHEM 2410, 2411, 2420, 2421 (use 1 technical and 3 unrestricted electives).

2 semesters Biology Lecture & Lab.
Most medical schools will accept BME 2101, 2102, 2104, 3080, 3090 as a substitute for BIOL 2010-2040. Talk with your BME advisor and the premed advisor about whether or not this is the right decision for your situation.

About 2/3 of U.S. medical schools require one or two English courses. About 1/3 of U.S. medical schools require one or two semesters of math; a few specify that it must be Calculus.

When you fill out the AMCAS Application Form, add Dr. Guilford as a “non-confidential” letter writer!
Dr. Bill has a boilerplate letter that explains how BME 2101, 2102, 2104, 3080, 3090 fulfill the one year general bio + lab requirement. This letter also explains what STS is all about.

When should BMEs take Orgo and MCAT? BME recommends that you take MCAT soon after completing the courses that are most relevant to the exam, namely: CHEM 2410, 2420 and BME 2101, 2102, and 2104. In the schedule above, we recommend taking the Orgo lectures in 2nd year and preparing for and taking the MCAT the summer after 2nd year. The Orgo Labs can be taken any time thereafter, including during the summer. They are generally not necessary as a prerequisite to the MCAT. An added benefit of taking the MCAT early is that there’s time to re-take it, if needed.

In the end, how you schedule these courses and the MCAT is a personal decision based on a number of factors, including AP credits/advanced standing, GPA and comfort level taking 5 technical courses in the same semester. Talk to your academic advisor, research mentor, and/or more senior BMEs, and consider their advice.
Here is a plan of study for BME Majors interested in Medical Imaging. This is a guide. Work with your advisor to design a plan of study that meets your specific objectives.

Here's how the Medical Imaging Schedule fulfills the requirements of the BME Major (prereqs in parentheses):

ECE 2630 is your technical elective
ECE 3750 (ECE 2630) replaces BME 3310
ECE 3760 (ECE 3750) & ECE 5750 (ECE 3750, 3760) are your two engineering electives
Take APMA 3100, not APMA 3110

**Recommended BME Electives:**

- BME 4995 BME Advanced Projects
- BME 7782 Medical Imaging Systems Theory (BME 3310 or ECE 3750)
- BME 4550 Diagnostic Ultrasound Imaging (BME 3310 or ECE 3750)
- ECE 6782 Digital Image Processing (will count as BME elective)

Other BME graduate-level classes.

Graduate-level courses require instructor permission.

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**Variation #2: MEDICAL IMAGING**

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**Complete the 19-credit ECE Minor by Adding Two Courses:**

Use ECE 5750 as a BME Elective, add ECE 2330 (use as Technical Elective), use ECE 2630 as the 1st Engineering Elective, and add ECE 3630 (2nd Engineering Elective).
Variation #3: APMA 1090

First Semester
Fall Year 1

Intro Chem I + Lab
CHEM 1610, 1611

Intro to Engineering
ENGR 1620

Calculus I
APMA 1090

Lang & Tech Society
STS 1500

Second Semester
Spring Year 1

Science Elective I

Intro Physics I + Lab
PHYS 1425, 1429

Intro Comp Science
CS 1110

Calculus II
APMA 1110

HSS Elective

Third Semester
Fall Year 2

Physiology I
BME 2101

Intro Physics II + Lab
PHYS 2415, 2419

Computation I
BME 3315

Ordinary Diff Equations
APMA 2130

Multivariate Calculus
APMA 2120

STS Elective
2xxx, 3xxx

Fourth Semester
Spring Year 2

Physiology II
BME 2102

Cell & Molecular Bio
BME 2104

BME Design & Discovery
BME 2000

Biomechanics
BME 2220

BME IDEAs Lab I
BME 3080

BME IDEAs Lab II
BME 3090

BME Capstone Design I
BME 4063

Engineering Elective
2xxx, 3xxx

Technical Elective

Fifth Semester
Fall Year 3

BME Capstone Design II
BME 4064

Biotransport
BME 2240

BME Systems Analysis
BME 3310

Probability or Prob/Stats
APMA 3100 or 3110

Engineering Elective
2xxx, 3xxx

HSS Elective

Sixth Semester
Spring Year 3

BME Elective

BME Elective

HSS Elective

Unrestricted Elective

Seventh Semester
Fall Year 4

BME Elective

BME Capstone Design I
BME 4063

Engineering, Ethics & Society
STS 4600

Unrestricted Elective

Eighth Semester
Spring Year 4

BME Elective

BME Elective

Unrestricted Elective

Page 6
HSS Elective Requirements

a. Instructional categories generally acceptable for HSS elective credit. A student may normally take any course under any one of these categories, with the exception of those listed under b.

- AAS
- CZ
- FREN
- KOR
- PSYC
- PTR
- AMEL
- EAST
- FRTR
- LATI
- RELA
- SRBC
- AMST
- ECON
- GERM
- LING
- RELB
- STS
- AMTR
- ENAM
- GETR
- LNGS
- RELC
- SWAG
- ANTH
- ENCR
- GREE
- MDST
- RELG
- SWAH
- AR H
- ENEC
- HEBR
- MEST
- RELH
- SWED
- ARAB
- ENGL
- HIAD
- MSP
- RELI
- TBTN
- ARTH
- ENGN
- HIEA
- MUSI
- RELJ
- TMP 3052
- ARTR
- ENLS
- HIEU
- PERS
- RELS
- TURK
- ASL
- ENLT
- HILA
- PETR
- RUSS
- UKR
- BULG
- ENMC
- HIME
- PHIL
- RUTR
- URDU
- CCFA
- ENMD
- HIND
- PLAD
- SANS
- YIDD
- CCIA
- ENNC
- HISA
- PLAP
- SATR
- CCLT
- ENRN
- HIST
- PLCP
- SCAN
- CCSS
- ENSP
- HIUS
- PLIR
- SLAV
- CHIN
- ENWR
- ITAL
- PLPT
- SLFK
- CHTR
- ETP 2030
- ITTR
- POL
- SLTR

b. Exceptions to 2.a., i.e., courses in the acceptable categories that are NOT suitable for HSS elective credit, generally because of their specialized nature for majors in that field or because they are predominantly skills courses.

- ANTH 1090, 3810, 3820, 4991, 4993, 4998, 4999, 5080, 5080, 5870, 5880, 5989
- ECON 3710, 3720, 4010, 4350, 4710, 5090, 5100
- ENSP 1600
- ENWR 1505, 1506, 1510, 2510, 2520
- MDST 2010, 3702
- MUSI 1310, 1993, 2993, 3310, 3320, 3360, 3390, 3993, 4457
- PSYC 2200, 2210, 2220, 3005, 3006, 3210, 3870, 3590, 4111, 4125, 4200, 4290, 4330, 4500, 4910, 4970, 4930, 4940, 4980, 5200, 5210, 5260, 5330, 5350, 5401
- SOC 4800, 4810, 4820, 4970, 5010, 5110, 5120, 5595, 5596
- STS 3993
Technical Electives
3 credits

Chosen from any 2000-level or higher math, science, or engineering course, unless it is a course for non-science majors, it duplicates required BME classwork, or it is a “research-for-credit” or capstone design course.

The list on page 8 (this page) shows all the courses that will not count as either a technical or an engineering elective in the BME Major.

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* (due to overlap with BME 2104)
Engineering Elective Sequence - CLASS of 2014 and later.

Engineering Electives
6 Credits
A two-course sequence of 2000-level or higher engineering courses in a single area of concentration. The two courses are chosen from the approved list on this page. Starting with the Class of 2014, you may NOT use a BME course in your sequence. Class of 2012 & 2013 may refer to prior versions of this Student Guide for allowed sequences.

MAY I CREATE MY OWN SEQUENCE? Yes, with approval of the UG Program Director. Use Form on page 16. Work through Kitter to code this exception in your SIS degree audit.

Engineering Elective Sequences. Choose any two (2) courses from a single group to create a pre-approved sequence. Prereqs in parentheses.

<table>
<thead>
<tr>
<th>Area 1</th>
<th>Area 2</th>
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<tbody>
<tr>
<td>CHE 2202. See also MAE 2100 Thermodynamics</td>
<td>CHE 2215 Material and Energy Balances</td>
</tr>
<tr>
<td>CHE 2215 Material and Energy Balances</td>
<td>CHE 2216 Modeling and Simulation in Chem Eng (CHE 2215)</td>
</tr>
<tr>
<td>CHE 3xxx or higher</td>
<td>CHE 3321 Transport Processes I (CHE 2215)</td>
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<tr>
<td>CHE 4561, 4562—permission required, use the form on p 16</td>
<td>CHE 3xxx or higher</td>
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<td>CHE 4561, 4562—permission required, use the form on p 16</td>
<td>CHE 4561, 4562—permission required, use the form on p 16</td>
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<tbody>
<tr>
<td>CS 2110 Software Development Methods</td>
<td>CE 2300 Statics. See also MAE 2300</td>
</tr>
<tr>
<td>CS 2102 Discrete Mathematics</td>
<td>CE/MAE 2310 Strength of Materials (CE/MAE 2300)</td>
</tr>
<tr>
<td>CS 2150 Program and Data Representation (CS 2110, 2102)</td>
<td>CE/MAE 2320 Dynamics (CE/MAE 2300)</td>
</tr>
<tr>
<td>CS 4750 Database Systems (CS 2102, 2150)</td>
<td>CE 2210 or MAE 3210 Fluid Mechanics</td>
</tr>
<tr>
<td>CS 3xxx or higher</td>
<td>CE 3xxx or higher—not CE 3000, 3100, 3400, 4000, 4030, 4100, 4110, 4400, 4410, 4810</td>
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<tr>
<td>CS 4993, 4501, 5501—permission required, use the form on p 16</td>
<td>CE 4500—permission required, use the form on p 16</td>
</tr>
<tr>
<td>SYS 2202 or 2004 Data and Information Engineering (CS 2110)</td>
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<tr>
<td>SYS 3062 Discrete Event Simulation (CS 2110, APMA 3100, 3112)</td>
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<tbody>
<tr>
<td>CS 2102 Discrete Mathematics I</td>
<td>MAE 2100 Thermodynamics: See also CHE 2202</td>
</tr>
<tr>
<td>CS 2150 Program and Data Representation (CS 2110, 2102)</td>
<td>MAE 3120 Thermal Systems Analysis (MAE 2100)</td>
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<tr>
<td>APMA 5070 Numerical Methods</td>
<td>MAE 3210 Fluid Mechanics (MAE 2100)</td>
</tr>
<tr>
<td>CS 3xxx or higher</td>
<td>MAE 3xxx or higher—not BME/MAE 4280</td>
</tr>
<tr>
<td>CS 4993, 4501, 5501—permission required, use the form on p 16</td>
<td>MAE 4501, 4502—permission required, use the form on p 16</td>
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<tr>
<td>SYS 2202 or 2004 Data and Information Engineering (CS 2110)</td>
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<td>SYS 3062 Discrete Event Simulation (CS 2110, APMA 3100, 3112)</td>
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<tr>
<td>ECE 2630 Introductory Circuit Analysis</td>
<td>MAE 2300 Statics: See also CE 2300</td>
</tr>
<tr>
<td>ECE 3630 Electronics I (ECE 2630)</td>
<td>MAE 3xxx or higher—not BME/MAE 4280. Orthopedic Injury</td>
</tr>
<tr>
<td>ECE 3760 Signals and Systems II (ECE 2630 and ECE 3750 or</td>
<td>Biomechanics (if it’s offered) may count, check with Dr. Guilford</td>
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<td>BME 3310)</td>
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<td>MAE 4501-4502—permission required, use the form on p 16</td>
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<td>ECE 5501, 5502—permission required, use the form on p 16</td>
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<tr>
<td>ECE 2066 Science of Information</td>
<td>MSE 2090 Intro to the Science and Engineering of Materials</td>
</tr>
<tr>
<td>ECE/CS 2330 Digital Logic Design</td>
<td>CHE 2202 / MAE 2100 Thermodynamics</td>
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<tr>
<td>ECE/CS 3330 Computer Architecture (CS 2110, ECE/CS 2330)</td>
<td>MSE 3080 Corrosion (MSE 2090)</td>
</tr>
<tr>
<td>ECE 4435 Computer Organization and Design (ECE 3330)</td>
<td>MSE 3xxx or higher</td>
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<tr>
<td>ECE 4960—permission required, use the form on p 16</td>
<td>MSE 4960—permission required, use the form on p 16</td>
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<tr>
<td>CE/MAE 2310 Strength of Materials (CE/MAE 2300)</td>
<td>CE/MAE 2310 Strength of Materials (CE/MAE 2300)</td>
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<tr>
<td>CHE 4442 Applied Surface Chemistry</td>
<td>CHE 4442 Applied Surface Chemistry</td>
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<tr>
<td>ENGR 2500 Introduction to Nanoscience and Technology</td>
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<tr>
<td>SYS 2202 or 2004 Data and Information Engineering (CS 2110)</td>
<td>CS 4753 Electronic Commerce Technologies</td>
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<tr>
<td>SYS 3021 Deterministic Decision Models (SYS 2001, APMA 3080)</td>
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<td>SYS 3xxx or higher, except SYS 4081</td>
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BME Electives

BME Electives, 2011-2012

Fall 2011

BME 4414 Biomaterials. Botchwey. Prerequisite: BME 2101, BME 2104 or CHE 2246, 3rd or 4th year standing, or instructor permission.

BME 4280 Motion Biomechanics. Blemker. Prerequisite: BME 2101, BME 2220, or instructor permission.

BME 4641 Bioelectricity. Kim. Prerequisite: BME 3310 or ECE 2630, and BME 2101, or instructor permission.

BME 4890 Nanomedicine. Kelly. Prerequisite: BME 2104 or CHE 2246, BME 2220, 4th year standing, or instructor permission.


Spring 2012

BME 3636 Neural Network Models of Cognition and Brain Computation. Levy. Cross-listed as PSYC 5330. Prerequisite: BME 2101, and CS 1110, or instructor permission.

BME 4783 Medical Imaging Modalities. Hossack. Prerequisites: BME 2101 and BME 3310.

BME 4806 Biomedical Applications of Genetic Engineering. French. Prerequisite: BME 2101, BME 2102, BME 2104 or CHE 2246, and 3rd/4th year standing, or instructor permission.

BME 4550 BME Electronics Lab. Kim. Prereq: 2nd year standing.


Fall/Spring 2010-2011

BME 4995 BME Advanced Projects. Varies. Prerequisite: instructor permission and approval of the BME Undergraduate Program Director. Only 3 credits (total) of BME 4995-454 will count as BME elective. Another 3 credits will count as an Unrestricted elective.

BME 4550 Special Topics in Biomedical Engineering. Prerequisite: 3rd or 4th year standing or instructor permission.

BME 4993 Independent Study. Prerequisite: Instructor permission and approval of the Undergrad Program Director.

May I use a graduate level BME course as “BME” Electives? Yes, with instructor permission. The instructor will need to add you to his course roll in the SIS and you may need to fill a Dean’s Office form called “Undergraduate Request to Take Graduate Courses.”
This is an *optional advising tool* to help students use their various elective “buckets” to build depth in a relevant area. Prerequisites are in parentheses.

### Biomaterials and Regenerative Medicine
- MSE 2090 Intro to the Science and Engineering of Materials
- CHE 4449 Polymer Chemistry and Engineering (inst. permission)
- BME 4414 Biomaterials
- BME 4417 Tissue Engineering

### Pharmaceutical Biotechnology
- CHE 2215 Material and Energy Balances
- CHE 3321 Transport Processes I (CHE 2215)
- CHE 3347 Biochemical Engineering (CHE 3321)
- CHE 4442 Applied Surface Chemistry
- BME 4890 Nanomedicine
- BME 4550 Systems Bioengineering Modeling and Experimentation

### Computational Systems Bioengineering
- SYS 3021 Deterministic Decision Models (SYS 2001)
- CS 2102 Discrete Mathematics I (CS 2110)
- BIOL 4160 Functional Genomics (Inst. permission)
- APMA 3080 Linear Algebra
- BME 4550 Systems Bioengineering Modeling and Experimentation

### Biomedical Software
- CS 2110 Software Development Methods
- CS 2102 Discrete Mathematics I (CS 2110)
- CS 2150 Program and Data Representation (CS 2110, 2102)
- CS 3240 Advanced Software development Techniques (CS 2150)

### Musculoskeletal Biomechanics
- MAE/CE 2300 Statics
- MAE/CE 2310 Strength of Materials (MAE 2300)
- MAE 2320 Dynamics (MAE 2300)
- BME 4280 Motion Biomechanics

### Neural Systems Engineering
- ECE 2630 Introductory Circuit Analysis
- ECE 3630 Electronics I (ECE 2630)
- BIOL 3170 Neurobiology
- BME 3636 Neural Network Models
- BME 4641 Bioelectricity

### Entrepreneurship
- BME 4550 Spc Tpc BME Advanced Design
- CS 4753, CE 4000, SYS 4044, SYS 5044

### Bioinstrumentation
- ECE 2630 Intro to Circuits
- ECE 3630 Electronics I (ECE 2630)
- ECE 2330 Digital Logic Design
- ECE 3760 Signals and Systems II (ECE 2630, BME 3310)
- ECE 3632 Electronics II (ECE 3630)

### Signal Processing
- ECE 2630 Intro Circuit Analysis
- ECE 3760 Signals and Systems II (ECE 2630, ECE 3750 or BME 3310)
- ECE 2066 Science of Information
- ECE 5750 Digital Signal Processing (ECE 3750 or BME 3310, ECE 3760)

### Biomedical Imaging (see page 5!)
- ECE 2630 Intro Circuit Analysis
- ECE 3760 Signals & Systems II (ECE 2630, ECE 3750 or BME 3310)
- ECE 5750 Digital Signal Processing (ECE 3750 or BME 3310, ECE 3760)
- Graduate-level BME imaging courses, as appropriate
- ECE 6782 Digital Image Processing

### Clinical Applications in Biomedical Engineering
- MAE 2300 Statics
- BIOL 5010 Biochemistry (prereq organic chemistry)
- Advanced Biology course, as appropriate, such as BIOL 3080, BIOL 3090, BIOL 3140, BIOL 3240
- BME 4414 Biomaterials
- BME 4280 Motion Biomechanics

### Nanomedicine Engineering
- BME 4890 Nanomedicine Engineering
- MSE 4055 Nanoscale Science and Technology (MSE 3670, PHYS 2320, PHYS 2620, or CHEM 3410 or CHEM 3820)
- Physical Chemistry (Organic Chemistry)
- BME 4414 Biomaterials
BME 2000 - (3) REQUIRED, Spring
Intro to BME Design & Discovery
Prerequisite: CS 1110, PHYS 1425, and ENGR 1620, or instructor permission. Provides an overview of the BME discipline and major sub-disciplines (biomechanics, genetic engineering, tissue engineering, bioelectricity, imaging, cellular engineering, computational systems biology), covers conceptual and detail design processes, and introduces quantitative tools utilized throughout the BME curriculum. Includes formulation and execution of a major design project.

BME 2101 - (3) REQUIRED, Fall
Physiology for Engineers I
Prerequisite: CHEM 1610, and PHYS 1425, or instructor permission. Studies how excitable tissue, nerves and muscle, and the cardiovascular and respiratory systems work. Focuses on understanding mechanisms and includes an intro to structure, an emphasis on quantitative function, and integration of hormonal and neural regulation and control.

BME 2102 - (3) REQUIRED, Spring
Physiology for Engineers II
Prerequisite: BME 2101, or instructor permission. Introduces the physiology of the kidney, salt and water balance, gastrointestinal system, endocrine system, and central nervous system, with reference to diseases and their pathophysiology.

BME 2104 - (3) REQUIRED, Spring
Cell & Molecular Biology for Engineers
Prerequisite: CHEM 1610 and BIOL 2101, or instructor permission. Introduces the fundamentals of cell structure and function, emphasizing the techniques and technologies available for the study of cell biology. A problem-based approach is used to motivate each topic. Divided into three general sections: cell structure and function includes cell chemistry, organelles, enzymes, membranes, membrane transport, intracellular compartments and adhesion structures; energy flow in cells concentrates on the pathways of glycolysis and aerobic respiration; information flow in cells focuses on modern molecular biology and genetic engineering, and includes DNA replication, the cell cycle, gene expression, gene regulation, and protein synthesis. Also presents specific cell functions, including movement, the cytoskeleton and signal transduction. Students may not receive credit for both CHE 2246 and BME 2104.

BME 2220 - (3) REQUIRED, Spring
Biomechanics
Prerequisite: APMA 2120, 2130, and BME 2101, or instructor permission. Introduces the principles of continuum mechanics of biological tissues and systems. Topics include 1) review of selected results from statics and strength of materials, continuum mechanics, free-body diagrams, constitutive equations of biological materials, viscoelastic models, and fundamental concepts of fluid mechanics and mass transport; 2) properties of living tissue; 3) mechanical basis and effects of pathology and trauma, 4) introduction to mechanotransduction, circulatory transport, growth and remodeling, and tissue-engineered materials, and 5) low Reynolds number flows in vivo and in microsystems.

BME 2240 - (3) REQUIRED, Spring
Biotransport
Prerequisite: APMA 2120, 213, BME 2101, 2104 or equivalent, or instructor permission. Biotransport in biological living systems is a fundamental phenomenon important in all aspects of the life cycle. Course will introduce principles and application of fluid and mass transport processes in cell, tissue and organ systems. Topics include introduction to physiological fluid mechanics in the circulation and tissue, fundamentals of mass transport in biological systems, effects of mass transport and biochemical interactions at the cell and tissue scales, and fluid and mass transport in organs.

BME 3310 - (3) REQUIRED, Fall
Biomedical Systems Analysis & Design
Prerequisites: APMA 2130, CS 1110, and PHYS 1425, or instructor permission. Presents the analytical tools used to model signals and linear systems. Specific biomedical engineering examples include multicomponent modeling of drug delivery, modeling of dynamic biomechanical systems, and electrical circuit models of excitable cells. Major topics include terminology for signals and systems, convolution, continuous time Fourier transforms, electrical circuits with applications to bioinstrumentation and biosystems modeling, and applications of linear system theory. Students may not receive credit for both ECE 3750 and BME 3310.

BME 3315 - (3) REQUIRED, Fall
Computational BME
Prerequisite: BME 2101, 2104, and 2220, or instructor permission. Introduces techniques for constructing predictive or analytical engineering models for biological processes. Teaches modeling approaches using example problems in transport, mechanics, bioelectricity, molecular dynamics, tissue assembly, and imaging. Problem sets will include 1) linear systems and filtering, 2) compartmental modeling, 3) numerical techniques, 4) finite element / finite difference models, and 5) computational automata models.

BME 3080, 3090 - (4+4) REQUIRED, Fall, Spring
BME IDEAS Lab I & II
Prerequisite: BME 2101, 2104, and 2220, and 3rd year standing in the BME major, or Inst. permission. Yearlong course to integrate concepts and skills from prior courses in order to formulate and solve problems in biomedical systems, including experimental design, performance, and analysis. Lab modules include testing in tissues/cells and manipulation of molecular constituents.
of living systems to determine their structural and functional characteristics for design of therapeutic or measurement systems. Methods include biochemical, physiological, cell biology, mechanical, electrical and computer, systems, chemical, imaging, and other approaches.

BME 3636 - (3) ELECTIVE, Spring
Neural Network Models of Cognition and Brain Computation. Cross-listed as PSYC 5330. Prerequisite: CS 1110, BME 2101, or instructor permission. Introduction to neural networks research, specifically biologically-based networks that reproduce cognitive phenomena. The goal is to teach the basic thinking and methodologies used in constructing and understanding neural-like networks.

BME 4063, 4064 - (3+3) REQUIRED, Fall, Spring
Biomedical Engineering Capstone Design I & II
Prerequisite: Fourth year standing in BME major, or instructor permission. A year-long design project in biomedical engineering required for BME majors. Students select, formulate, and solve a design problem related to a device or a system. Projects use conceptual design, skills obtained in the integrated lab, and substantial literature and patent reviews. Projects may be sponsored by BME faculty, medical doctors, and/or companies. Students may work on their own with outside team members when appropriate or with other SEAS students in integrative teams.

BME 4280 - (3) ELECTIVE, Spring
Motion Biomechanics
Prerequisite: BME 2101, 2220, or instructor permission. Focuses on the study of forces (and their effects) that act on the musculoskeletal structures of the human body. Based on the foundations of functional anatomy and engineering mechanics (rigid body and deformable approaches); students are exposed to clinical problems in orthopedics and rehabilitation.

BME 4414 - (3) ELECTIVE, Fall
Biomaterials
Prerequisite: BME 2101, 2104 or equivalent, 3rd or 4th year standing, or instructor permission. This course will provide an introduction to biomaterials science and biological interactions with materials, including an overview of biomaterials testing and characterization. The emphasis of this course, however, will be on emerging novel strategies and design considerations of biomaterials. Areas of concentration will include the use of polymers and ceramics in biomaterials today, drug delivery applications, tissue engineering from both an orthopaedic and vascular perspective, and nanotechnology related to biomaterials. Specific attention will also be paid to the in vitro and in vivo testing of biomaterials, and a review of current research in the field.

BME 4417 - (3) ELECTIVE, Spring
Tissue Engineering (not offered 2011-12)
Prerequisite: APMA 2130, BME 2101, and 2104 or equivalent, or instructor permission. Introduces the fundamental principles of tissue engineering. Topics include: tissue organization and dynamics, cell and tissue characterization, cell-matrix interactions, transport processes in engineered tissues, biomaterials and biological interfaces, stem cells and interacting cell fate processes, and tissue engineering methods. Examples of tissue engineering approaches for regeneration of cartilage, bone, ligament, tendons, skin and liver are presented.

BME 4550 - (3) ELECTIVE, Spring
BME Electronics Lab
Prerequisite: 2nd year standing. Course objectives: (1) To provide an understanding of basic techniques involving electrical and electronic circuit analysis; and (2) To enable students to apply the knowledge and techniques in electrical systems to problems in biomedical engineering. These goals will be achieved through lectures and labs in combination.

BME 4550 - (3) ELECTIVE, Fall
Medical Imaging Systems Theory (not offered 2011-12)
Prerequisite: ECE 3750 or BME 3310 or equivalent exposure to linear systems theory, and instructor permission. Develops an intuitive understanding of the mathematical systems theory needed to understand and design biomedical imaging systems, including ultrasound, magnetic resonance imaging and computed tomography. Emphasis is on 2D continuous systems, but 1D and discrete systems are also covered. Topics include multidimensional Fourier transform theory, image reconstruction techniques, diffraction theory, and Fourier optics.
BME 4550 - (3) ELECTIVE, Fall
Quantitative Biological Reasoning (offered 2012-2013)
rerequisite: 4th year standing and instructor permission.
Provides a quantitative framework for identifying and addressing important biological questions at the molecular, cell, and tissue levels. Covers methods, with an emphasis on the biochemical, biophysical, and mathematical themes that emerge repeatedly in quantitative experiments. Discussions preceded by primary literature that illustrates how in-depth understanding of such themes led to significant conceptual advances in biochemistry, molecular biology, and cell biology. Part II covers how quantitative methods combine to aid scientific logic. Topics include practical implementations of the scientific method, falsification of hypotheses and strong inference. Course concludes with an intro to how quantitative biological reasoning can be effectively presented through scientific writing and information design.

BME 4641 - (3) ELECTIVE, Fall
Bioelectricity
Prerequisite: BME 3310 or ECE 2630, BME 2101, or instructor permission. Studies the biophysical mechanisms governing production and transmission of bioelectric signals, measurement of these signals and their analysis in basic and clinical electrophysiology. Introduces the principles of design and operation of therapeutic medical devices used in the cardiovascular and nervous systems. Includes membrane potential, action potentials, channels and synaptic transmission, electrodes, electroencephalography, electromyography, electrocardiography, pacemakers, defibrillators, and neural assist devices.

BME 4783 - (3) ELECTIVE, Spring
Medical Imaging Modalities
Prerequisite: BME 3310 or ECE 3750, or instructor permission. An overview of modern medical imaging modalities with regard to the physical basis of image acquisition and methods of image reconstruction. Topics cover the basic engineering and physical principles underlying the major medical imaging modalities: x-ray (plain film, mammography, and CT), nuclear medicine (PET and SPECT), ultrasound, and MRI.

BME 4806 - (3) ELECTIVE, Spring
Biomedical Applications of Genetic Engineering
Prerequisite: BME 2101, 2102, and 2104, and 3rd/4th year standing, or instructor permission. Provides a grounding in molecular biology and a working knowledge of recombinant DNA technology, thus establishing a basis for the evaluation and application of genetic engineering in whole animal systems. Beginning with the basic principles of genetics, this course examines the use of molecular methods to study gene expression, deliver viral and non-viral vectors, and its critical role in health.

BME 4890 - (3) ELECTIVE, Fall
Nanomedicine Engineering
Prerequisite: BME 2104 or CHE 2246, BME 2220, or 4th year standing, or instructor permission. BME 2240 or CHE 3321 recommended. Students will design treatment strategies for cancer and cardiovascular disease based on molecular bioengineering principles. Special topics will include design of nanoparticle drug and gene delivery platforms, materials biocompatibility, cancer immunotherapy, and molecular imaging.

BME 4993 - (1-3) ELECTIVE, Fall, Spring
Independent Study
Prerequisite: instructor permission. In-depth study of a biomedical engineering area by an individual student in close collaboration with a departmental faculty member. Requires advanced analysis of a specialized topic in biomedical engineering that is not covered by current offerings. Requires faculty contact time and assignments comparable to regular course offerings. See page 15.

BME 4995 - (1-3) ELECTIVE, Fall, Spring
BME Advanced Projects (a.k.a. Research- or Design-for-Credit)
Prerequisite: instructor permission and approval of the BME Undergrad Program Director. Use Form on pg 17. Research project in biomedical engineering conducted in consultation with a department faculty advisor, usually related to ongoing faculty research. Includes the design, execution, and analysis of experimental laboratory work and computational or theoretical computer analysis of a problem. Requires a comprehensive report of the results. Only 3 credits of BME 4995 will count as BME elective. Another 3 credits will count as an Unrestricted Elective.
Required Approval Form
BME Independent Study (BME 4993) - 3 credits maximum

Independent Study is an in-depth exploration of a technical area in biomedical engineering for which there is no formal course offering. It exhibits the hallmarks of a formal course offering - e.g. regular and significant faculty contact time, assigned reading, regular homework or projects, and a final exam or paper. Requires approval from the Undergraduate Program Director. Use this form to propose and describe your topic.

- Listed as BME 4993 "BME Independent Study."
- Up to 3 credits of BME 4993 will count as a BME Elective in the BME Major.
- Does NOT count toward the BME Minor.

Procedure:

Your Name: ________________________________ BME Advisor: ______________

Today's Date: ___________ Year of Graduation: ______ Your Email: __________________

1) Instructor information. If the proposed instructor is not a primary BME primary faculty member, see the Undergrad Program Director for special instructions. Instructor's Name (print): ____________________________

2) Attach a one-page COURSE MEMO. Include 1) a one-paragraph Course Description, 2) Planned Assignments for the semester, 3) Textbook and/or reading list, 4) and Meeting Times and Frequency.

3) SIGNATURES. Have the course instructor sign the Course Memo. Return the signed memo and this form to the BME Undergrad Coordinator, MR5 2010. You will be informed of the success of your petition via email.

Approved: ________________________________

BME Undergraduate Program Director
Required Approval Form
Substituting a Core Course / Replacing a Requirement

Name: ___________________ Major: ___________________ BME Advisor: _______________
Today's Date: ______________ Year of Graduation: ______ Email: ______________________

Procedure: Fill out this form (duplicate if necessary for multiple requests) and return to Undergrad Coordinator in MR5 2010. You will be informed of the success of your petition via email.

Course/Requirement #1
1) What course/requirement would you like to replace? _______________________  
2) What would you like to replace it with? ________________________  
3) Reason:

Approved: _____________________________________  
BME Undergraduate Program Director

Course/Requirement #2
1) What course/requirement would you like to replace? _______________________  
2) What would you like to replace it with? ________________________  
3) Reason:

Approved: _____________________________________  
BME Undergraduate Program Director
Required Approval Form for BME Advanced Projects (BME 4995, “Research- or Design-for-Credit”)

Consists of the design, execution, and analysis of lab work, computational modeling, or theoretical analysis in a biomedical engineering subject area. Requires a comprehensive final report describing methods and results. You may work with any BME primary faculty member. It is possible to work with non-BME faculty, if a BME primary faculty member agrees to co-advise your project. In this case, the BME faculty member is listed as the course instructor and assigns the grade, in consultation with the research mentor. Under certain circumstances, this rule may be waived. See the Undergrad Coordinator for details.

Use BME 4995 "BME Advanced Projects.” All projects must approved by the Undergraduate Program Director using this form.

- You must submit this form for approval EACH SEMESTER you plan to do research-for-credit (even for a continuing project).
- For each credit hour earned, you must spend at least 3-4 hours per week in the lab, for a minimum of 10 hours/week for 3 credit-hour course.
- Relationship between Advanced Projects & Capstone Projects: Unless the two projects are entirely separate, you may NOT earn credit for BME 4995 at the same time you are earning credit for BME 4063, 4064.
- BME Majors may count up to six credits (total) toward the degree. Three (3) credits can be used as a BME Elective, and the other three (3) credits can be used as an Unrestricted Elective.

Procedure

Your Name: ___________________________ Email: _______________________ Today's Date: _____________________Lab Name: ___________________________ Research Advisor's name (print): __________________________

If your research advisor is not a primary BME faculty member, which primary BME faculty member is co-advising this project?

Will you be attending lab meetings? (circle one)  Yes  No  If no, why not?

1) Attach a PROJECT PROPOSAL (half-page). The proposal should include i) Project Title and Study Name (more specific than title), ii) Purpose/Objective of your proposed project, iii) your Hypothesis (if applicable), iv) the Experimental Design (i.e. experimental conditions and measurable output), v) your Methods, and vi) the Significance of your research (what is the impact of your results in the field?)

2) Attach a PROJECT EXPECTATIONS STATEMENT (one paragraph). Here you describe the project guidelines worked out between you, your research mentor, and (if applicable) the BME primary faculty member co-advising your project. You must cover i) Days and times you are scheduled to work in the lab, ii) How often you will be meeting with your research mentor, iii) When your final report is due and iv) Other expectations, including required background literature, monthly progress reports, etc. If you are working in a non-BME lab, you must also report how often you plan to meet with your BME primary advisor.

3) SIGNATURES. Both you and your Research Advisor must sign the Project Proposal / Expectations Statement. If you plan to work in a non-BME lab, your BME primary advisor must sign, too. Return this form and the signed Project Proposal / Expectations Statement to the Undergraduate Coordinator (MR5 2010). You will be informed of the success of your petition via email.

Approved: __________________________________
BME Undergraduate Program Director