

# BME Undergraduate Handbook

Last Revision 22 October, 2009

## Application to BME Program

All engineering students, regardless of intended major, are advised during their freshman year by the New Student Academic Advising Center (NSAAC). Students who intend to major in Biomedical Engineering must submit a short application, available from the BME department (SL 220), in the semester in which they are finishing their prerequisite requirements (typically the second semester of the freshman year). This application should be submitted by **April 1** in the academic year prior to enrolling in BME 222. At the time of submitting the application, students should have successfully completed (or be in the process of completing during the spring and summer) the following prerequisite classes: ENGR 195, 196, and 197; MATH 165, 166, and 171; PHYS 152; CHEM-C 105 and 125; and either CHEM-C 106 or BIOL-K 101. Students accepted into the program will be notified by June 1.

The purpose of the application is to ensure that students entering the program are properly prepared: that they have satisfied the appropriate prerequisites with an average GPA in those courses of at least 2.0, and have given some thought to their reasons for pursuing the major. It also provides important information on the background, interests, and career plans of entering students. So far, the program has had the resources to accommodate all qualified students who are interested in the program. If the number of interested students begins to exceed available space, however, applications may become competitive.

## Courses Required for Graduation

The BME Undergraduate Plan of Study is included below. BME students must complete a minimum of 131 credit hours of courses in three categories:

### Required engineering, science, and BME courses

ENGR 195, 196, 197 and 297      BIOL-K 101, 324, 325      PHYS 152, 251  
CHEM-C 105, 106, 125, 341, 343      MATH 165, 166, 171, 261, 266  
BME 222, 241, 322, 331, 334, 352, 354, 381, 383, 402, 404, 411, 442, 461, 491, 492

### Required and elective General Education classes

ENG-W 131      COMM-R 110      TCM 360

Four General Education electives chosen from the approved list and meeting all requirements for Gen Ed electives (Appendix A).

### Depth Area electives

This sequence of four courses must be selected in consultation with a BME advisor to gain some depth in a sub-discipline of Biomedical Engineering. At least two of these four electives must be engineering courses (BME, ECE, ME); the other two may be engineering, science, or math electives as approved by an advisor. These are described in more detail below, under "Schedule Planning in the BME Program".

## **Grade Policy**

Beginning with courses taken in Fall 2009, students must earn a minimum grade of C- in required BME and ENGR courses in order to count those courses for credit on the Plan of Study. REQUIRED BME and ENGR courses are those courses that are required of ALL students for the undergraduate BME degree. As of Spring 2009, these courses include:

ENGR 196, 197 and 297

BME 222, 241, 322, 331, 334, 352, 354, 381, 383, 402, 404, 411, 442, 461, 491 and 492

Passing grades below C- earned in these courses PRIOR TO Fall 2009 will still count toward the plan of study.

<p><b>Biomedical Engineering</b>  <b>BEGINNING FALL 2008</b></p>
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**Freshman Year**

<i>First Semester</i>	SCH	<i>Second Semester</i>	SCH
ENGR 19600 Engineering Problem Solving	3	Biol. K101 Concepts of Biology I	5
Chem. C105 Principles of Chemistry I	3	Phys 15200 Mechanics	4
Chem. 125 Experimental Chem. I	2	ENGR 19700 Intro. to Computing (C prog.)	2
Math 16500 Integrated Calculus and Analytic Geometry	4	Math 16600 Integrated Calculus and Analytic Geometry II	4
ENGR 19500 Engineering Seminar	1	Math 17100 Multidimensional Mathematics	3
Eng W 131 Elementary Composition I	3		
<b>TOTAL SCH</b>	<b>16</b>		<b>18</b>

**Sophomore Year**

<i>First Semester</i>	SCH	<i>Second Semester</i>	SCH
Math 26100 Multivariate Calculus	4	Math 26600 Differential Eqns.	3
Phys 25100 Elec., Heat, Optics	5	Biol. K324 Cell Biology	3
BME 22200 Biomeasurements	4	Biol. K325 Cell Biology Lab	2
Chem. C106 Principles of Chemistry II	3	BME 24100 Intro. Biomechanics	4
ENGR 29700 Intro. to Computing (MATLAB)	1	Comm. R110 Fundamentals of Speech Communication	3
		General Education Elective	3
<b>TOTAL SCH</b>	<b>17</b>		<b>18</b>

**Junior Year**

<i>First Semester</i>	SCH	<i>Second Semester</i>	SCH
Chem. C341 Organic Chemistry I	3	BME 32200 Probability & Applications for BME	3
Chem. C343 Organic Chemistry Lab I	2	BME 35200 Tissue Behavior and Properties	3
BME 38100 Implantable Materials & Biological Response	3	BME 35400 Problems in Tissue Behavior and Properties	1
BME 38300 Problems in Implantable Materials & Biological Response	1	BME/Sci/Tech Elective*	3
BME 33100 Biosignals and Systems	3	General Education Elective	3
BME 33400 Biomedical Computing	3	BME 40200 BME Seminar	1
General Education Elective	3	TCM 36000 Communications in Engineering Practice	2
<b>TOTAL SCH</b>	<b>18</b>		<b>16</b>

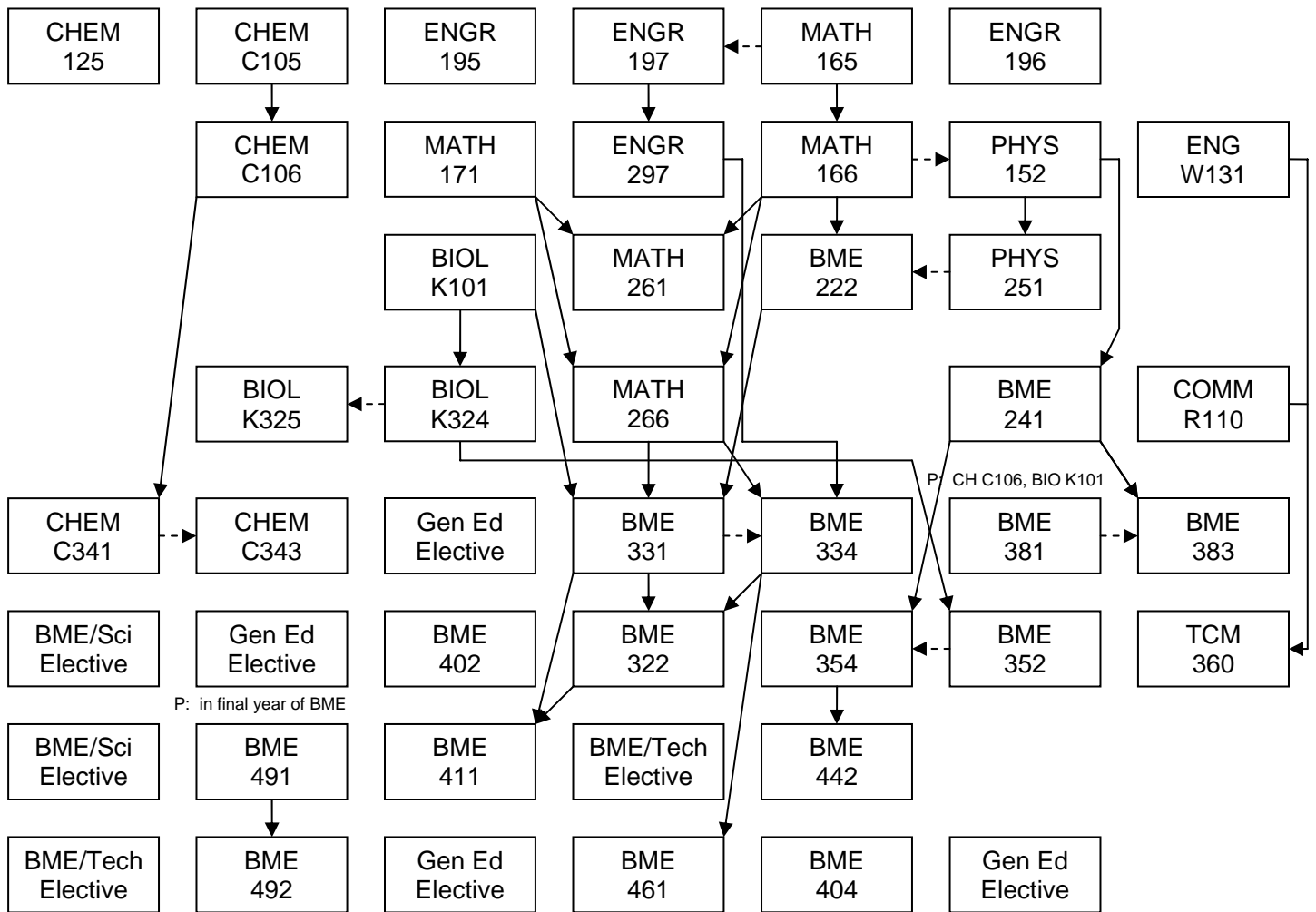
**Senior Year**

<i>First Semester</i>	SCH	<i>Second Semester</i>	SCH
BME 49100 Biomedical Engineering Design I	3	BME 49200 Biomedical Engineering Design II	3
BME 41100 Quantitative Physiology	3	BME 46100 Transport Processes in BME	3
BME 44200 Biofluid and Biosolid Mechanics	3	BME/Tech Elective*	3
BME Elective*	3	BME 40400 Ethics for Biomedical Engineers	1
BME/Sci/Tech Elective*	3	General Education Elective	3
<b>TOTAL SCH</b>	<b>15</b>		<b>13</b>

\* The four BME/Sci/Tech electives must be selected in consultation with an advisor to form an appropriate Depth Area.

# BIOMEDICAL ENGINEERING UNDERGRADUATE CURRICULUM FLOWCHART

Last Revision: 14 October 2009



## Schedule Planning in the Biomedical Engineering Program

Because the Biomedical Engineering Program (1) offers most of its required BME courses only once per year, and (2) requires many courses with laboratory and/or recitation components, planning your schedule for the coming semester should take into account how the courses you choose may affect your schedule in future semesters.

The curriculum flowchart shows the prerequisites (solid arrows) and corequisites (dotted arrows) for all the courses in the BME Plan of Study. The sections below provide scheduling information that will help ensure all BME requirements can be completed in four years. Please note, though, that students who feel that they may improve their chances of success in the program by taking fewer credit hours per term and spreading the requirements out over an extra semester or year can be easily accommodated. Such students, particularly those who have work or other outside commitments, are encouraged to speak to their BME advisor if they think such an option may be a good choice for them.

### Biology Sequence

#### Cell Biology

BIOL-K 324/325, Cell Biology and Cell Biology Lab, are currently ONLY offered in the Spring. BIOL-K 324 is a prerequisite for BME 352, Cell/Tissue Behavior and Properties, normally taken during the spring of the junior year. Therefore, to stay on-track, **BIOL-K 324 should be taken in the sophomore year** (spring). (The lecture and lab do not have to be taken together, however; so even if you are unable to get into a lab section during your sophomore year, you should go ahead and take the lecture course.) The Biology department has made noises about possibly starting to offer the Cell Biology lecture in both the spring and fall semesters – but it has not happened yet, so you should plan your schedule assuming that this course will continue to be offered only in the spring.

#### BIOL-K 101 – The Prerequisite to Cell Biology

The official prerequisite for Cell Biology is BIOL-K 103. **However**, BME students have special permission from the Biology department to use BIOL-K 101 as the prerequisite instead of BIOL-K 103. Grade data from recent years indicates that on average BME students perform as well as or better than other students in the Cell Biology class; therefore, we do not believe that the missing prerequisite will be a hindrance to dedicated students.

If Cell Biology is to be taken in spring of the sophomore year, BIOL-K 101 must be completed no later than fall of the sophomore year. **It is recommended, however, that students take BIOL-K 101 either in the spring of the freshman year or over the summer before the sophomore year.** If the course is taken during fall of the sophomore year, students end up with three courses in the same semester with a lab component: BME 22200 (only offered in the fall, and a prerequisite to junior-year BME classes), PHYS 251 (a co-requisite for BME 22200), and BIOL-K 101. While do-able, this makes for a challenging semester, and is not recommended, especially for students who also

work or participate in research projects or extracurricular activities with more than a couple-hour-per-week time commitment.

### **Math Sequence**

The required sequence of math courses on the BME Plan of Study is MATH 165, 166, 171 (freshman year), 261 and 266 (sophomore year). Note that 166 and 171 are the prerequisites for both 261 and 266, and 266 is the prerequisite for several BME courses in the junior year. Since MATH 261 is not a direct prerequisite for either MATH 266 or any 1<sup>st</sup>-semester junior year BME courses, if you are unable to fit all five math courses into your schedule during the first two years, MATH 261 is the best choice to delay to a later semester.

### **Physics Sequence**

Because MATH 166 is a co-requisite for PHYS 152, students who start the freshman year in MATH 165 can take PHYS 152 no earlier than their 2<sup>nd</sup> semester. If not taken in the spring of the freshman year, it should be taken over the summer: it is a prerequisite for PHYS 251, which is a pre- or corequisite for BME 22200 in the fall semester of the sophomore year. Because BME 22200 is a prerequisite for many courses in the junior year, delaying Physics may delay your graduation by at least a semester.

### **BME Depth Areas**

The four courses labeled “BME/Tech Elective” or “BME/Sci/Tech Elective” should be selected in consultation with your BME advisor to form a depth area: a sequence of courses exploring a subdiscipline of Biomedical Engineering. At least two of these courses must be from either the BME department or another engineering department; the other two may be math or science courses, if they are appropriate to the depth area.

The options below are the main depth areas in Biomedical Engineering. The courses listed are the most common choices for these depth areas; however, other courses not listed may also be applied if approved by your BME Advisor.

#### *Biomaterials/Tissue Engineering*

Courses appropriate to this depth area include:

- Organic Chemistry II lecture, Biochemistry, or other upper-level chemistry courses
- Thermodynamics (ME 200)
- 300- or 500-level BME courses in Biomaterials, Polymers, Tissue Engineering, or Drug Delivery

### *Bioinstrumentation/Biosignal Processing/Neural Engineering*

Courses appropriate to this depth area include:

- Instrumentation or Signal Processing courses in the ECE department
- 300- or 500-level BME courses in Bioinstrumentation, Neural Engineering, or topics related to membrane biomechanics or neuronal modeling
- Neural Anatomy
- upper-level math courses

### *Biomechanics*

Courses appropriate to this depth area include:

- Finite element modeling or mechanical design courses in the ME department
- 300- or 500-level BME courses in biomechanics
- Linear Algebra (MATH 351 or 511)
- Human Anatomy (BIOL-N 261 or ANAT-D 501)

In addition, the BME department sometimes offers 300-level electives (such as Cardiovascular Engineering) that touch on topics in more than one depth area, and thus may be an appropriate elective for more than one depth area.

### **Applying Experiential Learning to the Plan of Study.**

With the approval of the Dept Chair, three credits of related internship or research work (for example, three semesters of industrial internship, or three related one-credit research projects under the same mentor), may be applied as a technical elective on the Plan of Study. Students who plan to take advantage of this option must fill out an Experiential Learning Agreement. Contact a BME advisor for more information.

### **BME Advising Team**

Academic Advising: Karen Alfrey      [kalfrey@iupui.edu](mailto:kalfrey@iupui.edu)  
Director of the Undergraduate Program in Biomedical Engineering

BME Careers: Ed Berbari      [eberbari@iupui.edu](mailto:eberbari@iupui.edu)  
Chair of the Department of Biomedical Engineering

# ACADEMIC INTEGRITY

Discussing course material, assignments, and approaches to programming with your classmates is highly encouraged. Rote copying, or even paraphrasing, without contributing or fully understanding the material is prohibited.

The IUPUI Student Code of Conduct (<http://www.iupui.edu/code>) includes a section on Academic Responsibilities and Misconduct (Part II, Section G). Note in particular the university's definition of plagiarism:

### 3. Plagiarism

Plagiarism is defined as presenting someone else's work, including the work of other students, as one's own. Any ideas or materials taken from another source for either written or oral use must be fully acknowledged, unless the information is common knowledge. What is considered "common knowledge" may differ from course to course.

- a. A student must not adopt or reproduce ideas, opinions, theories, formulas, graphics, or pictures of another person without acknowledgment.
- b. A student must give credit to the originality of others and acknowledge indebtedness whenever:
  - 1. Directly quoting another person's actual words, whether oral or written;
  - 2. Using another person's ideas, opinions, or theories;
  - 3. Paraphrasing the words, ideas, opinions, or theories of others, whether oral or written;
  - 4. Borrowing facts, statistics, or illustrative material; or
  - 5. Offering materials assembled or collected by others in the form of projects or collections without acknowledgment.

Students are expected to abide by the IUPUI Student Code of Conduct. Consistent with school and university procedures, instances of academic dishonesty will be documented by the instructor and discussed with the student. Depending on the severity of the offense, an academic penalty may be imposed (ranging from a deduction of points on an assignment for a minor infraction, to dismissal from the program for severe or repeated offences). A diagram summarizing these procedures can be viewed here:

[http://www.iupui.edu/code/misconduct\\_diagram.pdf](http://www.iupui.edu/code/misconduct_diagram.pdf)



## APPENDIX A

### GUIDE TO GENERAL EDUCATION ELECTIVES IN BIOMEDICAL ENGINEERING

#### INTRODUCTION

General education is an important part of the biomedical engineering (BME) program at the Purdue School of Engineering and Technology, IUPUI. Perhaps more so than in any other engineering discipline, BME students must possess good communication and critical thinking skills in order to interface effectively with colleagues in medicine, biology and engineering. Because their work directly impacts human lives through medicine, they also must be aware of the many ethical issues that may arise during their careers. Furthermore, they must be prepared to serve as effective leaders in society and policy-making relative to the development and use of technology in medicine and biology.

The IUPUI Department of Biomedical Engineering (BME) curriculum includes strong general education components to provide students an integrated and well-rounded education in the humanities, social sciences, fine arts, and related areas. A total of 12 credit hours of courses are required in the general education category. These courses are in addition to the 9 credit hours of courses in written communication (ENG W131), oral communications (COMM R110), technical communications (TCM 360), and engineering ethics (BME 404).

With the assistance of an academic advisor in the department, each student must select the 12 credit hours of general education courses in accordance with the following requirement and rules:

#### REQUIREMENT

At least 6 credit hours of the 12 credits must be chosen from the approved list of courses that are indicated as having significant *contemporary*, *societal*, or *cultural* emphasis. Approved courses in this category are shown in **bold** on the Approved General Education Electives List below.

#### ADDITIONAL RULES

1. General education electives may be found in subjects such as philosophy, religion, history, literature, fine arts, classical studies, sociology, psychology, anthropology, economics, geology, geography, environment, public affairs, music, and modern languages. A list of currently approved courses follows this list of rules.
2. Students are encouraged to explore different areas of general education.
3. At least two of the courses must be at 200 or higher level (to assure *depth*). In the case of foreign languages, however, coursework beyond the first three hours of a particular language may be used in place of 200-level courses.
4. To further assure *depth* a minimum of 6 credit hours must be selected in at least one department.
5. Courses taken must be from at least two different departments. To assure that students experience a *breadth* of topics, no more than 9 credits taken from one department will be counted as general education credit, including credit by examination.

6. When used as electives, modern language courses must include at least one 5 credit hour course or two 3- or 4 credit hour courses in a single language. Grammar or vocabulary courses in a student's native language may not count as a general education elective.
7. Courses such as accounting, industrial management, personal finance, ROTC, and personnel administration do not fulfill the purpose of the general education program, regardless of their general value in total engineering education, since they basically teach personal skills.
8. Courses that build skills, such as keyboard/computer music courses, physical education, photography, drawing etc., cannot be used to satisfy these general education requirements.
9. The Pass/Fail option may not be used for ANY courses on an engineering Plan of Study including general education electives. Also courses completed by correspondence may not be used on an engineering Plan of Study.
10. The approved list of courses may vary from semester to semester. Courses on the approved list during the semester the student takes the course will be accepted even if they are subsequently removed from the list.
11. Students may petition their academic advisor and department chairperson for approval of courses not listed here.

### **APPROVED GENERAL EDUCATION ELECTIVES LIST**

The approved general education courses are listed below. Those with strong *contemporary*, *societal*, or *cultural* emphasis are indicated with **bold** characters.

<i>Afro-American Studies:</i>	AFRO <b>A150, A202</b> , A303, <b>A352</b>
<i>American Studies:</i>	AMST A301, A302, A303, A304
<i>Anthropology:</i>	ANTH <b>A103, A104, A303, A304, A361, A454, B370, B371, E300, E310, E316, E320, E326, E335, E336, E356, E380, E384, E391, E402, E403, E411, E421, E445, E455, E457, E470, L300, L401, P220</b>
<i>Arabic:</i>	NELC <b>A117, A118, A119, A200, A250</b>
<i>Art:</i>	HER H100, H101, H103, H300, H301, H302, H326, H333, H334, H341, H342, H344, H345, H347, H351, H352, H355, H361, H362, H402, H404, H413, H414, H418
<i>Chinese:</i>	EALC <b>C117, C118, C119, C131, C132, C201, C202</b>
<i>Classical Studies:</i>	CLAS C205, C310, C311, C351, C361, C491
<i>Communication Studies:</i>	COMM T130, T133, T205, R310, T337, T338
<i>Economics:</i>	ECON E201, <b>E202, E303, E304, E305</b> , E307, E308, E321, E322, E323, E325, E363, E380, E385, E420, E430, E447, E485
<i>English:</i>	ENG <b>G104, G205, G310, L105, L115, L200, L202, L203, L204, L205</b> , L206, <b>L207, L213, L214, L200</b> and all <b>300</b> or

higher level **ENG Lxx** courses

<i>Film Studies:</i>	FILM C292, <b>C390</b> , C391, C392, <b>C393</b> , <b>C394</b> , C398, C491, C493
<i>Folklore:</i>	FOLK <b>F101</b> , <b>F131</b> , <b>F354</b> , F360, F363
<i>French:</i>	FREN <b>F117</b> , <b>F118</b> , <b>F119</b> , <b>F131</b> , <b>F132</b> , <b>F203</b> , <b>F204</b> , and all <b>300</b> or higher level <b>FREN</b> courses
<i>Geography:</i>	GEOG <b>G107</b> , <b>G110</b> , <b>G130</b> , <b>G315</b> , <b>G331</b>
<i>Geology:</i>	GEOL <b>G107</b> , <b>G110</b> , <b>G115</b> , <b>G132</b>
<i>German:</i>	GER <b>G117</b> , <b>G118</b> , <b>G119</b> , <b>G131</b> , <b>G132</b> , <b>G225</b> , <b>G230</b> , <b>G265</b> , and all <b>300</b> or higher level GER courses
<i>History:</i>	HIST <b>H105</b> , <b>H106</b> , <b>H108</b> , <b>H109</b> , <b>H113</b> , <b>H114</b> , H220, H221, and all <b>300</b> or higher level courses with prefix <b>A</b> , <b>B</b> , <b>C</b> , <b>D</b> , <b>F</b> , <b>G</b> , or <b>H</b> .
<i>Italian:</i>	ITAL <b>M117</b> , <b>M118</b> , <b>M119</b> , <b>M200</b>
<i>Japanese:</i>	EALC <b>J117</b> , <b>J118</b> , <b>J119</b> , <b>J131</b> , <b>J132</b> , <b>J201</b> , <b>J202</b> , <b>J301</b> , <b>J302</b> , <b>J394</b> , <b>J401</b> , and all Japanese culture courses taught in English EALC <b>E231</b> , <b>E351</b> , <b>E472</b>
<i>Latin:</i>	CLAS L131, L132, L200, L250
<i>Music:</i>	MUS M174, M393, M394, Z105, Z200, Z201, Z301, Z315, Z374, Z380, Z401
<i>Organizational Leadership and Supervision:</i>	OLS <b>263</b> , <b>327</b> , <b>331</b>
<i>Philosophy:</i>	PHIL <b>P110</b> , <b>P120</b> , <b>P162</b> , <b>P237</b> , <b>P265</b> , <b>P280</b> , <b>P281</b> , <b>P307</b> , <b>P314</b> , <b>P316</b> , <b>P317</b> , <b>P322</b> , <b>P323</b> , <b>P325</b> , <b>P326</b> , <b>P331</b> , <b>P358</b> , <b>P365</b> , <b>P367</b> , <b>P368</b> , <b>P369</b> , <b>P382</b> , <b>P383</b> , <b>P385</b> , <b>P393</b> , <b>P394</b> , <b>P414</b> , <b>P418</b> , <b>P448</b> , <b>P468</b>
<i>Political Science:</i>	POLS Y101, Y103, Y215, Y217, <b>Y219</b> , Y300 and higher level courses
<i>Psychology:</i>	PSY <b>B104</b> , <b>B310</b> , B334, B344, B354, B356, B360, B366, B368, B370, <b>B376</b> , B380, B424
<i>Public and Environmental Affairs:</i>	SPEA <b>V170</b> , <b>V264</b> , <b>V362</b> , <b>V366</b> , <b>V372</b> , <b>V376</b> , <b>V443</b> , <b>E162</b> , <b>E272</b> , <b>H120</b>

*Religious Studies:*

REL R100, R111, **R133**, R173, R200, R212, **R223**, R283,  
R293, **R300**, R303, R310, R312, **R313**, R326, **R339**, R343,  
R344, **R352**, **R360**, **R361**, **R383**, **R393**

*Spanish:*

SPAN **S117**, **S118**, **S119**, **S131**, **S132**, **S203**, **S204**, **S210**, and all  
**S300** or higher level courses

*Sociology:*

SOC **R100**, **R121**, R220, R234, R305, **R312**, R315, **R317**,  
**R320**, **R321**, **R325**, **R329**, **R330**, R338, R344, **R345**, **R346**,  
R356, R357, **R381**, **R382**, R410, **R415**, **R425**, R461, **R463**,  
R467, **R476**, **R478**, R480