PROGRAM C, BA/BS: MATHEMATICS + SPECIALIZATION

Program C allows students to earn a Mathematics degree (B.A. or B.S.) by combining courses in the Department of Mathematics with courses from one other department. In most areas of specializations, mathematical and/or quantitative courses in other departments are part of the math degree program. All Program C students take a minimum of five core math courses: Calculus I, Calculus II, Calculus III, Introduction to Linear Algebra, and a proofs course, usually either Introduction to Abstract Algebra or Fundamental Properties of Spaces and Functions I.

As of Spring 2014, the pre-approved areas of specialization are as follows: Biomathematics, Biostatistics, Chemistry, Computer Science, Economics, Engineering (each department), Finance, Optimal Business Decision-Making, Physics, Risk Management/Insurance, Statistics and Actuarial Science. All areas of specialization include electives in their plans of study. Some of the specializations have required courses in addition to the electives and five-course Mathematics core.

Every student in Program C must file a plan of study before the start of the senior year. In consultation with a mathematics advisor, a student prepares a proposed list of courses. The plan (with the advisor’s endorsement) is then forwarded to the Department’s Director of Undergraduate Studies for approval. If the proposal follows one of the pre-approved established templates, then approval is automatic. If a student and advisor select courses that vary from the established templates or constitute a new area of specialization, the proposed plan of study must receive the approval of the Mathematics Department Undergraduate Committee. The plans for B.A. courses usually have 11-12 courses, and the plans for B.S. courses usually have 13-14 courses (depending on the specialization).

All Program C course plans must fulfill the following four requirements.

1. Each elective satisfying a course requirement must be at least 3 semester hours. Combining lower semester-hour courses to satisfy one course requirement is not allowed.

2. Every subtrack has a list of approved electives. (MCS) At least three of the approved electives that students can select must be in the mathematical sciences (Mathematics, Statistics and Actuarial Science, Computer Science), though not every course from these departments has been approved. See the list below. At least two of these three courses must have MATH (22M) prefix, and must be post-calculus. If an area of specialization requires additional courses beyond the five core Mathematics courses, these additional courses are counted toward the electives.

3. Every math major must take at least one upper-level MATH course. (U) Upper-level math courses are MATH:3900 or courses numbered 4000 or higher but excluding MATH:4010, 4020, and 4120, (courses numbered 22M:096 or 22M:113 or higher excluding 22M:196-199).

4. Students majoring in mathematics must satisfy the department’s residency requirement. Every math major must earn at least 15 semester hours at U1 in post-calculus courses offered in Mathematical Sciences, and at least 12 s.h. of them must be offered by (or be cross-listed with) the Mathematics Department. The post-calculus courses in Mathematics (PC) are those with numbers higher than 2000 excluding MATH:3700, 3750, 3995-3997, 4010, and 4020 (courses with numbers 22M:27 or higher excluding 22M:31, 32, 81, 104, 105, 109, 110 and 196-199). Acceptable post-calculus Computer Science and Statistics courses must have a calculus prerequisite. No transfer courses or credit by examination will be accepted for the post-calculus course requirement.
Core Mathematics Courses for Program C

Calculus I and Calculus II  
8-10 s.h.  
*(starting in Spring 2014, all MATH Calculus I and II courses will each be 4 s.h.)*

Either of the sequences MATH:1550-1560 (22M:031-032, 8 s.h.) or MATH:1850-1860 (22M:025-026, 8-10 s.h.) is acceptable. The sequences are distinct enough that the Department does not encourage students to switch from one version of Calculus I to a different version of Calculus II unless there is a strong need and good preparation. Advanced placement credit, CLEP credit, and credit obtained through the Mathematics Incentive Program is accepted for all or part of the calculus requirement.

MATH:2700 *(22M:027)* Introduction to Linear Algebra  
4 s.h.

MATH:2850 *(22M:028)* Calculus III  
4 s.h.

MATH:3720 *(22M:050)* Introduction to Abstract Algebra I  
4 s.h.

OR

MATH:3770 *(22M:055)* Fundamental Properties of Spaces and Functions I  
4 s.h.

Higher level courses may be substituted for core courses if approved by the Mathematics Department Director of Undergraduate Studies.

List of Mathematical Sciences Courses for Program C

1. Mathematics courses MATH: 3600 or higher, but excluding 3700, 3750, 3995-3997, 4010, 4020, and 4120 *(22M:72 or higher excluding 22M: 081, 095, 104, 105, 107, 109, 110, 196-199)*. Independent study, reading, topics, seminar, project courses are not allowed unless approved by the Math Department in advance.

2. Computer Science courses CS:1210 *(22C:016)* or higher that count toward an undergraduate major in Computer Science, excluding independent study, reading, topics, seminar, project courses unless approved by the Math Department in advance.

List: CS: 1210, 2110, 2210, 2230, 2420, 2520, 2620, 2630, 2820, 3330, 3620, 3640, 3820, 4330, 4340, 4350, 4640, and advanced electives: between 3620-4990 except 3910, 3980, 3990, and 4980. *(22C:16, 19, 21, 22, 31, 60, 80, 82, 84, 86, 111, 112, 118, 131, 135, 169, 188, and advanced electives)*

3. Statistics and Actuarial Science courses that count toward an undergraduate major in Statistics or Actuarial Science, excluding independent study, reading, topics, seminar, project, exam preparation courses unless approved by the Math Department in advance.

List: Only one of STAT:2020 or 3100 or 3120 *(22S:39 or 120 or 130)* (only one of these can be counted, and only if taken before STAT:4100); Additional accepted courses are:

STAT: 2010, 3101, 3200, 3210, 3620, 4100, 4101, 4510, 4520, 4740, 5100, 5101, 5120

ACTS: 3080, 3085, 4130, 4180, 4230, 4280, 4380

*(22S:30, 131, 133, 138, 150, 152, 153, 154, 158, 169, 174, 175, 179, 180, 181, 182, 183, 190, 193, 194)*
Program C Specialization:  Engineering (each department)
(B.A.) program requires 5 core courses and 3 electives in Mathematics, plus at least 4 electives from one Engineering Department. For (B.S.), 2 more electives in Mathematics or Engineering are required beyond the (B.A.) program. All Program C degree requirements on upper level math courses, Mathematical Sciences courses, math residency, and 3-4 sh electives apply (see pages 1, 2).  A Program C Plan of Study must be filed before the start of the senior year.

Students majoring in the College of Engineering need to be aware that a mathematics degree in the College of Liberal Arts and Sciences requires different General Education courses, including the completion (or equivalent competency) of four semesters of one foreign language.

Required Core Courses

Option 1: Engineering sequence (16 sh)
   ______ MATH:1550 (22M:031) Engineering Math I
   ______ MATH:1560 (22M:032) Engineering Math II
   ______ MATH:2550 (22M:033) Engineering Math II
   ______ MATH:2560 (22M:034) Engineering Math IV
   ______ MATH:3550 (22M:037) Engineering Math V

Option 2: Standard math sequence (16 sh)
   ______ MATH:1850 (22M:025) Calculus I
   ______ MATH:1860 (22M:026) Calculus II
   ______ MATH:2700 (22M:027) Introduction to Linear Algebra
   ______ MATH:2850 (22M:028) Calculus III

Option 1 and 2 courses may be combined according to Mathematics Department rules. Please discuss this with the Director of Undergraduate Program in Mathematics.

Additional at least 3 MATH Courses
   ______ MATH:3720 (22M:050) Introduction to Abstract Algebra  OR
   ______ MATH:3770 (22M:055) Fundamental Properties of Spaces & Functions I

Post-calculus MATH course beyond the core courses:
   MATH:3600* or higher, but excluding 3700, 3750, 3995-3997, 4010, 4020, and 4120
   (22M:72 or higher excluding 22M: 081, 095, 104, 105, 107, 109, 110, 196-199).
*Only one of MATH:2560 and 3600 (22M:034 and 100) counts if both are taken.

   ______ (U)  Upper-level MATH course(s): (1 required, and more than 1 is recommended.)
      MATH:3900 or numbered 4000 or higher but excluding MATH:4010, 4020, and 4120
      (22M:096 or 22M:113 or higher excluding 22M:196-199).

Every upper level MATH course, MATH 3720, and 3770 are post-calculus courses. One of MATH:3720 or 3770 can be counted as a post-calculus elective if both are taken. Each course can satisfy only one of these requirements, and one needs 3 different courses to satisfy these requirements.

Engineering Elective Courses
For (B.A.), at least 4 junior- or senior-level Engineering courses are required, all from the same Engineering Department of the student’s choice. For (B.S.), 6 electives are required, at least 4 electives must be from Engineering (as specified as in B.A.), and the additional 2 electives can be in Mathematics or in Engineering or one in each. Please go to the next pages for the current lists. Proposals containing Engineering courses beyond these tentative lists must be discussed with DUS.
Electives for ENGINEERING in PROGRAM C in MATH

**Biomedical Engineering**
051:182 BME:5200 Biomedical Signal Processing  
051:185 BME:5210 Medical Imaging Physics  
051:148 BME:5220 Digital Imaging Processing  
051:186 BME:5230 Multidimensional Image Processing  
051:141 BME:5251 Advanced Biosystems  
051:170 BME:5401 Biomaterials & Implant Design  
051:167 BME:5430 Biotransport  
051:154 BME:5510 Cardiac and Vascular Mechanics  
051:155 BME:5520 Cardiovascular Fluid Mechanics  
051:150 BME:5610 Musculoskeletal Biomechanics

**Chemical & Biochemical Engineering**
The lists of electives for this department are not finalized yet. Electives are determined in consultation with the Director of the Undergraduate Program in Mathematics (DUS).

**Civil & Environmental Engineering**
053:136 CEE:3136 Design of Concrete Structures  
053:055 CEE:3155 Principles of Environmental Engineering  
053:071 CEE:3371 Principles of Hydraulics and Hydrology  
053:030 CEE:3530 Soil Mechanics  
053:033 CEE:3533 Principles of Structural Engineering  
053:086 CEE:3586 Civil Engineering Materials  
053:063 CEE:3763 Principles of Transportation  
053:157 CEE:4157 Environmental Engineering Design  
053:071 CEE:4370 Flow in Open Channels  
053:174 CEE:4374 Water Resource Design  
053:112 CEE:4512 Engineering Design Optimization  
053:133 CEE:4533 Finite Element I  
053:134 CEE:4535 Design of Steel Structures  
053:162 CEE:4762 Design of Transportation Systems  
053:163 CEE:4763 Traffic engineering  
CEE:5000 Level Courses (subject to approval by the Math Department)  
The following are already approved:  
053:169 CEE:5369 Intermediate fluid mechanics  
053:140 CEE:5540 Intermediate mechanics of deformable bodies
### Electrical & Computer Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>055:032</td>
<td>ECE:3320 Intro to Digital Design</td>
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<tr>
<td>055:033</td>
<td>ECE:3330 Introduction to Software Design</td>
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<td>055:035</td>
<td>ECE:3350 Computer Architecture and Organization</td>
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<td>055:036</td>
<td>ECE:3360 Embedded Systems and Systems Software</td>
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<td>055:043</td>
<td>ECE:3400 Linear Systems II</td>
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<td>055:041</td>
<td>ECE:3410 Electronic Circuits</td>
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<td>055:050</td>
<td>ECE:3500 Communication Systems</td>
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<tr>
<td>055:060</td>
<td>ECE:3600 Control Systems</td>
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<tr>
<td>055:070</td>
<td>ECE:3700 Electromagnetic Theory</td>
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<tr>
<td>055:072</td>
<td>ECE:3720 EE Materials and Devices</td>
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ECE:5000 level courses (subject to approval by the Math Department)

The following are already approved:

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<th>Course Code</th>
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<tbody>
<tr>
<td>055:130</td>
<td>ECE:5300 Switching Theory</td>
</tr>
<tr>
<td>055:133</td>
<td>ECE:5330 Graph algorithms and combinatorial optimization</td>
</tr>
<tr>
<td>055:146</td>
<td>ECE:5460 Digital signal processing</td>
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<tr>
<td>055:152</td>
<td>ECE:5520 Intro Information &amp; coding theory</td>
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<tr>
<td>055:150</td>
<td>ECE:5500 Communication theory</td>
</tr>
<tr>
<td>055:160</td>
<td>ECE:5600 Control theory</td>
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<tr>
<td>055:170</td>
<td>ECE:5700 Advanced electromagnetics</td>
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### Mechanical and Industrial Engineering

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<td>058:40</td>
<td>ME:3040 Thermodynamics II</td>
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<tr>
<td>058:45</td>
<td>ME 3045 Heat Transfer</td>
</tr>
<tr>
<td>058:52</td>
<td>ME 3052 Mechanical Systems</td>
</tr>
<tr>
<td>058:48</td>
<td>ME 4048 Energy System Design</td>
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<tr>
<td>058:55</td>
<td>ME 4055 Mech System Design</td>
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ME 4000/5000 level courses (subject to approval by the Math Department)

The following are already approved:

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>058:112</td>
<td>ME:4112 Engineering Design Optimization</td>
</tr>
<tr>
<td>058:115</td>
<td>ME:4115 Finite element I</td>
</tr>
<tr>
<td>058:154</td>
<td>ME:5154 Intermediate kinetics &amp; dynamics</td>
</tr>
<tr>
<td>058:160</td>
<td>ME:5160 Intermediate fluid mechanics</td>
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056:131      | IE:3300 Manufacturing Systems                            |
| 056:134     | IE:3350 Process Engineering                              |
| 056:144     | IE:3400 Human Factors                                    |
| 056:147     | IE:3450 Ergonomics                                      |
| 056:150     | IE:3500 Information Systems Design                       |
| 056:162     | IE:3600 Quality Control                                 |
| 056:166     | IE:3610 Stochastic Modeling                              |
| 056:171     | IE:3700 Operations Research                              |
| 056:178     | IE:3750 Digital Systems Simulation                       |
| 056:176     | IE:3760 Applied Linear Regression (Cross listed 22S:152)  |
| 056:172     | IE:4172 Big Data Analytics                              |

IE: 5000 Level courses (subject to approval by the Math Department)