

# How to Choose Engineering and Science Mathematics Courses

A Guide to Students and Advisors

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## 1 Overview

As a beginning Jacobs University student with a major in the School of Engineering and Science, you are required to enroll for a basic selection of mathematics courses. Depending on your choice of major, your interests, and your prior exposure to mathematics, there are a variety of options for you. In the following we describe the starting points you can choose from in your first semester; as you progress through the course sequence, you may adjust or combine these options in various ways.

- (A) The default for many students: ESM 1A *Single Variable Calculus*. This standard calculus course covers the basics of differentiation and integration, together with typical applications. It is mandatory/recommended for the majors Computer Science (CS), Electrical and Computer Engineering (ECE), Electrical Engineering and Computer Science (EECS), Earth and Space Sciences (ESS), and International Logistics (IL, both Engineering and Management).
- (B) Students of Mathematics (MATH, regular variant), Applied and Computational Mathematics (ACM), and Physics (PHY) should take ESM 1B *Multivariable Calculus and Ordinary Differential Equations* in their first semester. If your major is ESS with specialization area Astrophysics, or you are inclined towards the Electrical Engineering aspect of the EECS and ECE majors, you should also consider this track. To test whether you are up for this course, you may want to take the advanced placement exam, described in Section 2 below, for ESM 1A). If you pass it you are, as a rule, well-prepared for ESM 1B.
- (C) For students of the Life Sciences and Chemistry majors the entry course is ESM 1C *Calculus and Matrix Algebra*. It comes with a weekly tutorial, and has a larger portion of pre-calculus material compared with ESM 1A but covers similar material.

- (D) For students of MATH (advanced variant) and all others with a strong background and interest in mathematics: Consider *Analysis I* and *Linear Algebra I* in your first semester, instead or on top of attending Engineering and Science courses, depending on your situation. These courses concentrate on the theoretical concepts of the mathematical sciences, and assume that basic problem solving skills and techniques are already developed.

Any of these starting points will prepare you for, and satisfy the prerequisite requirement of the following second-semester Engineering and Science Mathematics courses. *Linear Algebra, Probability, Statistics* (ESM 2A) and *Linear Algebra, Probability, Fourier Analysis* (ESM 2B).

Students of the School of Humanities and Social Sciences who do not have a required mathematics course in their major but want to continue with their mathematics education to fulfil their Other School Electives requirement have several choices. The default would be to take ESM 1C, and mingle with the Life Science and Chemistry students. An alternative for strong students is attending one or two semesters of the *General Mathematics & Computational Science* course which covers diverse topics from group theory, graphs, simple dynamical systems to fast Fourier transform.

Note that, because of significant overlap in material, the courses ESM 1A and ESM 1C should not be taken on top of each other: only one of them will count towards the credit requirements necessary for graduation. However, taking ESM 1B after either of these single-variable calculus courses is an option.

For the detailed requirements and recommendations for the different majors in the School of Engineering and Science, it is important that you familiarize yourself with the respective handbook, and talk to your academic advisor and/or program coordinator. Some guidance is provided in Section 3 below.

## 2 Transfer Credit and Advanced Placement

If you have already taken university level Mathematics courses at an accredited institution, you may apply for transfer credit. Detailed policies can be found at

<http://www.jacobs-university.de/academics/policies/>.

Please consult with Jacobs faculty to determine the appropriate equivalences.

If you are familiar with the content of particular courses through your pre-university education, or through study on your own, you may take an advanced placement test and receive credit, but no grade, for a particular course.

For the first semester Engineering and Science Mathematics courses ESM 1A (jointly with ESM 1C), ESM 1B, as well as for the second semester ESM 2A and ESM 2B, there is a scheduled written advanced placement exam within the first two weeks the course is offered. The advanced placement exam covers the same material as the final exam of the lecture course.

### 3 Recommendation by major of study

#### 3.1 Biochemical Engineering (BCE) Biochemistry and Cell Biology(BCCB) Bioinformatics and Computational Biology (BICB) Biology/Neuroscience (BIO) Chemistry (CHE)

Students of Biochemistry and Cell Biology, Biochemical Engineering, Biology & Neuroscience, and Chemistry have currently only one Engineering and Science Mathematics course (typically ESM 1C *Calculus and Matrix Algebra*) as a mandatory graduation requirement for their major. However, depending on specialization (this is especially true for Bioinformatics and Computational Biology students), it might be necessary to broaden the scope of mathematical education. An early consultation with the academic advisor cannot hurt!

#### 3.2 Mathematics (MATH) Applied & Computational Mathematics (ACM)

Mathematics and ACM students may either take the Engineering and Science Mathematics courses ESM 1B and ESM 2B during their first year (“regular variant” of the curriculum) or Analysis and Linear Algebra during their first year (following the “advanced variant” of the Mathematics major), or something in between, depending on preparation level, and after consultation with the academic advisor.

#### 3.3 Computer Science (CS) Electrical and Computer Engineering (ECE) Electrical Engineering and Computer Science (EECS)

Students of the Electrical Engineering and Computer Science majors are required to take four semesters of Engineering and Science Mathematics: *Single Variable Calculus* (ESM 1A), *Linear Algebra, Probability, Fourier Analysis* (ESM 2B), *Advanced Linear Algebra and Stochastic Processes* (ESM 3A), and *Numerical Methods* (ESM 4A).

Students with an interest in theory, particularly those thinking of specializing in Electrical Engineering, are encouraged to take *Multivariable Calculus and Ordinary Differential Equations* (ESM 1B) as well; this course is not a graduation requirement.

Students with a strong background in Mathematics should take the Advanced Placement Exams for the mandatory first year Engineering and Science Mathematics courses, and enroll for *Analysis I/II* (Math 211/212) and *Linear Algebra I/II* (Math 221/222). The mandatory second year Engineering and Science Mathematics courses cannot usually be replaced—consult your advisor

and faculty from your major in case you wish to credit more advanced mathematics courses toward your major requirements.

### 3.4 Earth and Space Sciences (ESS) International Logistics (IL)

The mandatory program for these majors consists of ESM 1A and ESM 2A. Students in ESS with specialization Astrophysics should follow the advice for Physics students. Please consult with your advisor.

### 3.5 Physics (PHY)

Students of Physics (and of ESS with specialization area Astrophysics) are required to take two first year Engineering and Science Mathematics courses and two second year Engineering and Science Mathematics courses. The recommended sequence is *Multivariable Calculus and Ordinary Differential Equations* (ESM 1B), *Linear Algebra, Probability, Fourier Analysis* (ESM 2B), *Complex Variable Calculus and Partial Differential Equations* (ESM 3B), and *Orthogonal Functions, Transforms, and Groups* (ESM 4B). Taking *Multivariable Calculus and Ordinary Differential Equations* (ESM 1B) in the first year, though not a graduation requirement, is strongly recommended; second year courses in Physics will assume a working knowledge in this area.

In addition to the regular Engineering and Science Mathematics sequence, Physics faculty offers the course *Mathematical Concepts in Physics* which reviews the necessary mathematical tools particularly in the context of physical modeling. It is not a graduation requirement, but recommended for first year students of Physics, and may be considered by students of ACM, ESS, and EECS as well.

Students with a strong background and interest in mathematics may want to consider taking further and more advanced Mathematics courses, for example, by taking the Advanced Placement Exams for the mandatory first year Engineering and Science Mathematics courses and then enrolling for *Analysis I/II* and/or *Linear Algebra I/II*. The mandatory second year Engineering and Science Mathematics courses should not usually be replaced. In any case, you are strongly advised to consult with the Physics program coordinator to work out a suitable selection of courses.

**Disclaimer:** This document has been compiled from the undergraduate handbooks in their 2008/2009 version. Since some changes might have been implemented since then, it should be considered a guide, but not the authoritative source for information on graduation requirements.

If in doubt, please read the undergraduate handbooks carefully. If you are interested in choosing courses that are not the default for your major, it is absolutely necessary to talk to a professor from your major, as well as to your academic advisor.