

# Curriculum Design and Faculty Evolution for the School of Mathematical Sciences and Information Technology Yachay Tech, Urcuquí, Imbabura

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## 1 Introduction

The original version of this paper was written in February 2016. Now at the end of 2016 we have made some changes in order to adopt to the limited hiring possibilities. In February 2016 the most advanced Yachay students were in the third semester and need to select their major before finishing their fourth and last semester of the common core in July 2016. They urgently needed information about the study courses that would be available to them starting in the fall<sup>1</sup> of 2016. Also the recruiting of faculty at all levels must ensure that the courses in the fifth to tenth semester can be covered competently in English. Most of them will be taught by tenure track faculty who have a regular teaching load of one course per semester. In order to fully utilize the teaching capacity and to allow for students to take courses in mathematics and computer science as well as other schools we base the curriculum on courses with 5 credit points normally taking up 5 or 6 hours of lectures and lab sessions. By sticking to 4 courses per semester we can also allow for a modular schedule, for example to have three regular courses spread over 3 months and one taught as a compact course in a single month. Now in early December 2016 the first fifth semester ever is nearing its end. The fifth semester program is being taught successfully this fall and there seems no need for a change. However, we will have to avoid repeating the same courses in the spring semester as originally planned.

## Study Program Orientation and Name

The school consists of the department of Mathematics and the department of Computer Science and Engineering. In the foreseeable future they will each be the home of just one five-year bachelor program. Therefor we will strive to provide a lot of flexibility in the last two years of the curricula allowing the students to explore their own interest, be it within the school or outside in other disciplines represented at Yachaytech. The specialties he or she chooses will be documented on a bachelor supplement but there are only two study programs. The basis is the common core for all Yachay students, which fully covers the first two years. It includes a solid introduction to physics, chemistry, biology and geology, so some students may follow that up by selectively taking

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<sup>1</sup>We use the Northern hemisphere designation of the two annual semesters, since there seems to be no alternative that does not invite confusion with other semester counts, besides Cayambe is far to the South from here!

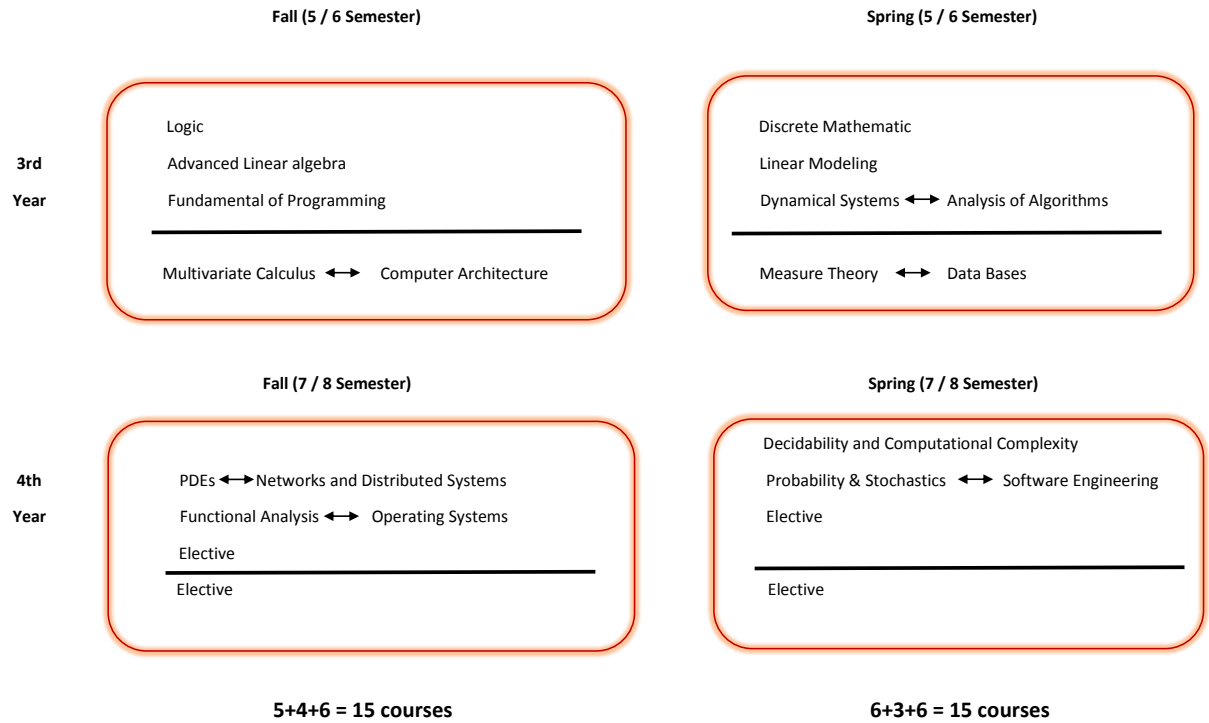
higher level electives from those areas, but there is no need to require that from all of them. The third year consists of compulsory courses within the school some of which are shared between the departments. The fourth year is consists half of compulsory courses and half of electives. There are no more compulsory courses in the fifth year, which also include an internship and a capstone project leading to a bachelor thesis.

The study program based in the mathematics department is simply called *mathematics* (MAT) and largely based on the recommendations of the American Mathematical Society (AMS), the Mathematical Association of America (MAA), and the Society of Industrial and Applied Mathematics (SIAM) taking into account the mission of the Yachay project. The latter emphasizes both scientific excellence and technological applicability to enhance the productive matrix of Ecuador and the region. To formulate and facilitate a suitable synergy between these goals proved more difficult in designing and naming of the study program based in the department of computer science and engineering. The common curricular recommendations of the Association of Computer Machinery (ACM) and the Institute of Electrical and Electronic Engineers (IEEE) specify five different flavors of computer science curricula, named *Computer Science*, *Computer Engineering*, *Information Systems*, *Information Technology*, and *Software Engineering*. In view of the Yachay mission we deem the Computer Science curriculum as too much restricted towards fundamental research alone and both the *Information Systems* and *Information Technology* curriculum as too much oriented towards the mere training of IT professionals rather than researchers. We thus have attempted to strike a balance between the remaining two curricula *Computer Engineering*, and *Software engineering*. Consequently we suggest to call the study program *Software and Computer Engineering* (SCE). The alternative order and thus the reversed acronym is to be avoided since (CSE) is widely understood to mean *Computational Science and Engineering*, an interdisciplinary field suggesting a significant mathematical and engineering content.

## 2 Course Design and Scheduling

We have planned for both MAT and SCE twelve compulsory courses of which six are joint, i.e. taught for both MAT and SCE together. Originally, we planned certain courses to be scheduled in a strict sequence so that some of them would have to be taught every semester. We have now rescheduled the course such that no course ever needs to be taught more often than once per year. This will require some flexibility of students and instructors. In the 4th year there are 2 electives in each career and in the fifth year 3. Depending on whether the students finishes the common core with a fall or spring semester he enters into the professional career with the top-left or the top-right box of the scheme below. He or she then traverses it along a trajectory that looks either like a Z or its reflection about the horizontal axes. Depending on the number of students that enroll in the two careers, any one of the courses involving the SCE students of two successive semesters is likely to significantly exceed the number of 60 students that can currently be accommodated in Yachay's largest aulas.

### 3rd and 4th Year Courses in School of Mathematical Sciences and Information Technology



### Selection of Electives

There are ten slots for electives can be selected by the students according to the following rules. In order to ensure a certain breadth of the students academic experience the elective MAT and SCE courses are grouped into two main category each and a third mixed category of in-between courses. For MAT they are called Pure Mathematics, Applied Mathematics and for SCE they are called Software Engineering and Computer Engineering. A MAT student must take at least three pure courses and at least three applied courses, where the mixed courses can be counted as either, but of course each one only once. That leaves the possibility to take maximally four courses from the other study course or from outside the school altogether. Analogously the SCE students must take at least three software engineering and at least three computer engineering classes. To ensure that all students can comply with the given rules the school guarantees that from each of the three categories two electives are taught at least once a year. These courses are marked with a star in the lists below and will be referred to as priority electives.

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|---|---|--|
| <ul style="list-style-type: none"> <li>• <b>Pure Math</b></li> <li>• Abstract Algebra*</li> <li>• Differential Geometry*</li> <li>• Topology</li> <li>• Complex Analysis</li> <li>• Number Theory</li> <li>• Algebraic Geometry</li> <li>• Operator Theory</li> </ul>   | <ul style="list-style-type: none"> <li>• <b>Hybrid</b></li> <li>• Stochastic Processes*</li> <li>• Calculus of Variations*</li> <li>• Approximation Theory</li> <li>• Harmonic Analysis</li> </ul>  | <ul style="list-style-type: none"> <li>• <b>Applied Math</b></li> <li>• Continuous Optimization*</li> <li>• Numerics of PDEs*</li> <li>• Optimal Control</li> <li>• Operations Research</li> <li>• Discrete Optimization</li> <li>• Inverse Problems</li> <li>• Financial Mathematics</li> </ul>   |
| <ul style="list-style-type: none"> <li>• <b>Software Engineering</b></li> <li>• Parallel Programming*</li> <li>• Data Base Administration*</li> <li>• Web Programming</li> <li>• Programming Languages</li> <li>• Web Service Admin.</li> <li>• Software Security</li> <li>• Functional Programming</li> <li>• Human-Comp. Interaction</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Hybrid</b></li> <li>• Artificial Intelligence*</li> <li>• Neural Nets*</li> <li>• Computer Vision</li> <li>• Cryptography</li> <li>• Machine Learning</li> <li>• Image Processing</li> <li>• Graphic Computing</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Computer Engineering</b></li> <li>• Network and Systems Administration*</li> <li>• Information Security*</li> <li>• Computer Architecture 2</li> <li>• Operating Systems II</li> <li>• Coding Theory</li> <li>• Design of Mobile Networks</li> <li>• Web Design</li> <li>• Business Information Syst.</li> <li>• E-Commerce</li> </ul> |

Naturally the list of nonpriority electives will change a lot depending on faculty availability and preferences. Just to cover the priority electives for MAT and SCE once a year requires  $(2+2+2)/2 = 3$  extra faculty for each department. If at least two non priority electives of varying topic are to be offered in each semester we need two more faculty member in each department. Some of these courses can be used also in the graduate program.

### 3 Course Load and Teaching

It yields the following annual teaching load units for the professional career without the common core

1. 6 for the separate courses in MAT and SCE
2.  $6 + 6$  for the joint courses of MAT and SCE
3. 12 for the priority electives discussed below

That adds up to a total teaching load of 30 courses per year and thus 15 per semester. This would require the same number of tenure track faculty without any additional researchers for graduate programs. Overall we get the following staffing numbers.

Term	Fall 16	Spring 17	Fall 17	Spring 18	Fall 18
Ocasionales	13	14+3	13+3	12+3	16+4
Titulares	4	6	13	13	19
Tutors	2	6	8	8	8

Hence we arrive at a minimal number of tenured faculty of 19 which would add up to a school size of about 40 including some 20 non-tenured faculty. That means roughly 23 members of the mathematics department and 17 of the computer science and engineering department. The difference arise solely through the leveling course and the common core, where there is only one course to be taught by SCE faculty. Of the 9-10 tenure track faculty in each department about a third could be assistant, associate and full professors, but that can certainly not be hard rule and will in any case change in time. Certainly having 3 full professors per department appears to be a minimal starting staff for an internationally renowned university. From there we can then build the Master and PhD program hopefully reaching a total size of some 40 members per department in the long term.

