National University of San Marcos (UNMSM)
Faculty of Mathematical Sciences
Department of Mathematics
School of Scientific Computing

Book of short descriptions by course

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Equipo de Trabajo

Dra. Maria Zegarra-Garay
Decana de la Facultad de Ciencias Matemáticas
email: *mzegarrag@unmsm.edu.pe*
Ernesto Cuadros-Vargas (Editor)
Orador distinguido para la *Association of Computing Machinery* (ACM)
Miembro del Directorio de Gobernadores de la Sociedad de Computación del IEEE (2020-2023)
Miembro del *Steering Committee* de *ACM/IEEE-CS Computing Curricula 2020 (CS2020)*
Miembro del *Steering Committee de ACM/IEEE-CS Computing Curricula for Computer Science (CS2013)*
Presidente de la Sociedad Peruana de Computación (SPC) 2001-2007, 2009
email: *ecuadros@spc.org.pe*

Contents

Chapter 1

First Semester

1.1 CS111. Introduction to Programming

This is the first course in the sequence of introductory courses to Computer Science.This course is intended to cover the concepts outlined by the Computing Curricula ACM/IEEE-CS 2013. Programming is one of the pillars of Computer Science; any professional of the area, will need to program to materialize their models and proposals. This course introduces participants to the fundamental concepts of this art. Topics include data types, control structures, functions, lists, recursion, and the mechanics of execution, testing, and debugging.

1.2 MA111. Calculus I

This course introduces the fundamental concepts of differential and integral calculus of single-variable real functions. It provides the mathematical foundations necessary for analyzing problems in science and engineering, developing logical reasoning and problem-solving skills through limits, derivatives, and integrals. The course emphasizes both conceptual understanding and practical application of these concepts.

1.3 MA121. Linear Algebra I

This course introduces the fundamental concepts of linear algebra, providing the mathematical foundations for the study of vector spaces, linear transformations, and systems of linear equations. It develops abstract thinking and problem-solving skills through matrices, determinants, and vectors. The course is fundamental for applications in science, engineering, and computing.

1.4 ID101. Technical and professional English I

A fundamental part of the integral formation of a professional is the ability to communicate in a foreign language in addition to the native language itself. It not only broadens its cultural horizon but also allows a more humane and comprehensive view of people's lives. In the case of foreign languages, English is

undoubtedly the most pratical because it is spoken around the world. There is no country where it is not spoken. In careers related to tourist services English is perhaps the most important practical tool that the student must master from the outset as part of his comprehensive education.

Chapter 2

Second Semester

2.1 CS100. Introduction to Computer Science

This course serves as the foundation for understanding the fundamental concepts of computational thinking applicable across various professions.

The course provides, starting from ground zero, a panoramic view of: introductory computational thinking, data storage, computer architecture, operating systems, networks and the Internet, algorithms, sorting methods, software engineering, databases, data structures, software engineering, computer graphics, artificial intelligence among others.

Designed as an introductory course to Computer Science, the concepts are presented in a playful manner and using an Active Learning methodology. Throughout the course, active audience participation is encouraged, akin to a theatrical performance.

The related knowledge areas covered are directly aligned with the Computing Curricula ACM/IEEE-CS.

The course **does not require** any prior knowledge in computer handling topics and can be taken by student from any field.

2.2 CS112. Objects oriented programming I

This is the second course in the introductory Computer Science programming sequence.

It incorporates a programming language transition as a pedagogical strategy and focuses on core Object-Oriented Programming (OOP) concepts, expanding on the foundations from the first course while introducing low-level programming principles.

The course provides a solid foundation for advanced topics covered in the subsequent course of the sequence.

2.3 CS1D1. Discrete Structures I

Discrete structures provide the theoretical foundations necessary for computation. These fundamentals are not only useful to develop computation from a

theoretical point of view as it happens in the course of computational theory, but also is useful for the practice of computing; In particular in applications such as verification, cryptography, formal methods, etc.

2.4 MA112. Calculus II

This course continues the study of calculus with functions of several variables, integrating concepts of vector calculus, partial derivatives, multiple integrals, and geometric and physical applications. It develops skills for modeling and solving problems in three dimensions, providing the foundations for advanced areas such as mathematical analysis, physics, and engineering.

2.5 MA122. Linear Algebra II

This course deepens advanced concepts of linear algebra, focusing on inner product spaces, advanced linear transformations, matrix decompositions, and computational applications. It develops skills to analyze complex algebraic structures and apply matrix methods to problems in data science, signal processing, and optimization.

2.6 ID102. Technical and professional English II

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Chapter 3

Third Semester

3.1 CS113. Objects oriented programming II

This is the third course in the sequence of introductory courses in computer science. This course explores C++-specific OOP mastery, focusing on high-performance systems development. Key topics include:

Core Advanced Concepts:

- Template metaprogramming (TMP) and Substitution Failure Is Not An Error (SFINAE)
- Move semantics, perfect forwarding, and Resource Acquisition Is Initialization (RAII) optimization
- Multiple inheritance pitfalls and virtual inheritance patterns

Concurrency & Systems Programming:

- std::thread, async/await, and thread synchronization
- Lock-free programming with atomic types
- Thread-safe OOP design patterns (e.g., singleton variants)

Modern C++ Paradigms:

- CRTP (Curiously Recurring Template Pattern)
- Expression templates for performance-critical code
- Compile-time introspection with constexpr and type traits

Real-World Applications:

- Interfacing C++ with other languages (FFI)
- Benchmarking and profiling template-heavy code

Prepares students for game engines, high performance computing, and embedded development where C++ dominates.

3.2 CS1D2. Discrete Structures II

In order to understand the advanced computational techniques, the students must have a strong knowledge of the Various discrete structures, structures that will be implemented and used in the laboratory in the programming language..

3.3 CS2B1. Platform Based Development

The world has changed due to the use of fabric and related technologies, rapid, timely and personalized access to the information, through web technology, ubiquitous and pervasive; they have changed the way we do things, how do we think? and how does the industry develop? Web technologies, ubiquitous and pervasive are based on the development of web services, web applications and mobile applications, which are necessary to understand the architecture, design, and implementation of web services, web applications and mobile applications.

3.4 AI161. Applied AI

This course provides a practical introduction to Artificial Intelligence (AI) for students from all scientific and engineering disciplines. Focused on developing AI literacy and practical skills, it covers fundamental concepts, modern AI tools (including Western and Chinese platforms), and responsible usage. Students will learn to effectively interact with diverse AI systems, write quality prompts, and apply AI solutions to problems across various domains while understanding ethical implications and cultural contexts of AI deployment.

3.5 MA211. Calculus III

This course advances the study of multivariable calculus, integrating concepts of vector calculus, vector fields, line and surface integrals, and fundamental theorems of vector calculus. It develops skills to analyze scalar and vector fields in space, providing foundations for applications in physics, engineering, and computational sciences.

3.6 ID201. Technical and professional English III

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Chapter 4

Fourth Semester

4.1 CS210. Algorithms and Data Structures

The theoretical foundation of all branches of computing rests on algorithms and data structures, this course will provide participants with an introduction to these topics, thus forming a basis that will serve for the following courses in the career.

4.2 MA212. Differential Equations

This course introduces fundamental methods for solving ordinary and partial differential equations. It develops skills for modeling dynamic phenomena in physics, engineering, and sciences through differential equations, providing mathematical foundations for analyzing continuous systems and simulating natural processes.

4.3 MA351. Statistics and Probabilities

This course introduces the fundamentals of probability theory and statistics, providing mathematical foundations for data analysis and statistical inference. It develops skills for modeling random phenomena, conducting hypothesis testing, and applying statistical methods to problems in science, engineering, and social sciences.

4.4 ID202. Technical and professional English IV

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Chapter 5

Fifth Semester

5.1 MA221. Numerical Analysis I

This course introduces fundamental numerical methods for solving mathematical problems through computational algorithms. It develops skills for implementing and analyzing numerical methods in linear algebra, nonlinear equations, and interpolation, with emphasis on error analysis and numerical stability.

5.2 MA222. Real Analysis I

This course introduces the fundamentals of real mathematical analysis, providing rigorous foundations for differential and integral calculus. It develops logical reasoning and mathematical proof skills through the study of real numbers, sequences, series, and continuity, establishing theoretical foundations for advanced areas of mathematics.

5.3 MA223. Graph Theory

This course introduces the fundamentals of graph theory, providing mathematical foundations for the study of discrete structures and their applications in computing, networks, and optimization. It develops skills for modeling real-world problems using graphs and applying algorithms to solve connectivity, traversal, and optimization problems in networks.

5.4 ID203. Technical and professional English V

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Chapter 6

Sixth Semester

6.1 MA321. Abstract algebra

This course introduces the fundamental concepts of abstract algebra, providing foundations for the study of algebraic structures such as groups, rings, and fields. It develops abstract thinking and mathematical proof skills through the analysis of algebraic properties and their applications in number theory, cryptography, and geometry.

6.2 MA325. Numerical Analysis II

This course advances the study of numerical methods for advanced mathematical problems, focusing on differential equations, numerical integration, and eigenvalue problems. It develops skills for implementing and analyzing sophisticated numerical algorithms with applications in engineering and computational sciences, with emphasis on stability and computational efficiency.

6.3 MA352. Stochastic processes

This course introduces the theory of stochastic processes, providing mathematical foundations for the study of systems that evolve randomly over time. It develops skills for modeling random phenomena in finance, engineering, and sciences through Markov chains, Poisson processes, and Brownian motion, with applications in simulation and analysis of stochastic systems.

Chapter 7

Seventh Semester

7.1 MA322. Computational Number Theory

This course introduces the fundamentals of computational number theory, integrating advanced mathematical concepts with algorithmic methods to solve problems in cryptography, computer security, and digital communications. It develops skills for implementing modular arithmetic, primality, and factorization algorithms with applications in modern cryptographic systems.

7.2 MA341. Optimization I

This course introduces the mathematical foundations of optimization, covering both unconstrained and constrained problems. Classical methods of continuous optimization, optimality conditions, numerical algorithms, and applications in various fields are studied. The course provides the theoretical and computational foundations for formulating and solving optimization problems in science, engineering, and economics, developing analytical skills to characterize and find optimal solutions.

7.3 MA361. Mathematical Modeling

This course introduces the fundamental principles of mathematical modeling to represent, analyze, and predict the behavior of systems in various areas such as science, engineering, and business. It emphasizes the formulation of models from real-world problems, their solution using mathematical and computational tools, and the critical interpretation of results. The course develops abstraction skills and the application of advanced mathematics to solve complex real-world problems.

Chapter 8

Eighth Semester

8.1 MA331. Scientific Computing

This course provides the foundations of modern scientific computing, integrating numerical methods, algorithm analysis, and efficient programming to solve complex mathematical problems. It focuses on the practical implementation of numerical algorithms, error analysis, and computational optimization. The course develops skills to select, implement, and validate appropriate numerical methods for different types of scientific and engineering problems.

8.2 MA332. Fourier and Wavelet Analysis

This course introduces the theories and applications of Fourier analysis and wavelets for signal processing and analysis. It covers from the fundamentals of Fourier series to modern wavelet transforms, providing the mathematical tools to analyze signals in time and frequency domains. The course emphasizes both theoretical aspects and practical applications in signal processing, data compression, and image analysis.

8.3 MA355. Statistical Learning Theory

This course provides the theoretical foundations of statistical learning, covering the mathematical principles that support machine learning algorithms. It focuses on the theoretical analysis of generalization capability, model complexity, and performance guarantees for various learning methods. The course connects theory with practice through the study of generalization bounds, bias-variance tradeoff, and foundations of computational learning theory.

Chapter 9

Ninth Semester

9.1 MA401. Capstone Project I

This course represents the first semester of the capstone project in computational mathematics. Students develop an applied research project or technological development that integrates and applies the knowledge acquired during the degree program. The course emphasizes problem formulation, literature review, methodological design, and initial development of computational solutions under the supervision of a faculty advisor. Projects must demonstrate research capability, innovation, and application of computational mathematics to real-world problems.

Chapter 10

Tenth Semester

10.1 MA402. Capstone Project II

This course constitutes the final phase of the capstone project in computational mathematics, where students complete, validate, and present an applied research project or technological development. It emphasizes the complete implementation of computational solutions, rigorous analysis of results, methodological validation, and professional communication of findings. The project must demonstrate mastery of computational mathematics, innovation capability, and contribution to knowledge or solution of real-world problems, culminating in professional-quality work and a public defense before a specialized jury.