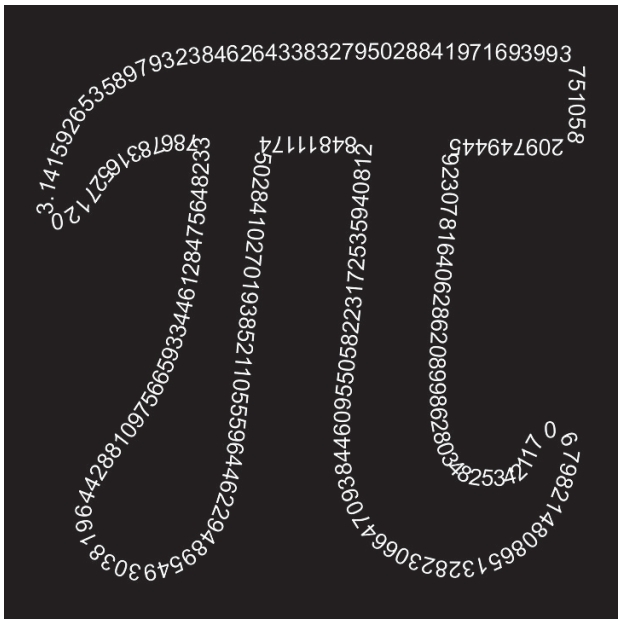
MATHS BASIC COURSE FOR UNDERGRADUATES



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Maths Basic Course for Undergraduates

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INTRODUCTION (JUSTIFICATION) and ADDRESSEE:

Maths Basic Course for Undergraduates is designed for Undergraduates in the first year of a degree in Science, especially in the first year of the degree in Mathematics. This course will teach the elementary and necessary skills to work with algebraic expressions, equations, and in general with mathematical rules. It aims to teach students the connection between the developed topics in this course and the subjects involved in other courses of the degree in Science, and how to manage them jointly.
Nowadays the amount of international students is increasing more and more. Although the vast majority of them sign up for a course after the first year, this material could be a resource to attach better the elementary subjects taught in the previous academic years, and it could be used as a positive feedback in the student's learning process, as well.

PREREQUISITES:

There is no compulsory prerequisite for this course. However, it is highly recommended that the student has passed courses of Mathematics in the High School. Since the course surveys many topics, a good math background is always a plus.

COURSE OBJECTIVES:

The main objective of this course is to understand and use abstract language and mathematical structures. The student will learn the basic elements and tools of algebraic structures and how to use the mathematical language involved in them as well as the techniques for proving and solving problems. The learning activities to reach these objectives are precisely: self-study and exercise and problem solving.

This course is divided into eight main chapters and a preliminary section, as follows:

PROGRAM:

Preliminary Section: **Mathematical language**. First concepts. Some useful symbols in Mathematics. Mathematical proofs.

1. Chapter: **Set theory.** Sets. Sets of numbers. Equivalence and order relations.
2. Chapter: **Complex numbers**. Operations. Conjugate. Polar form. Solutions of polynomial equations. Fundamental theorem of Algebra.
3. Chapter: **Functions**. Examples. Types of functions. Inverse function. Composition of functions.
4. Chapter: **Divisibility**. Integer numbers. Division algorithm. Numeral systems. Greatest common divisor. Euclidean algorithm. Prime numbers and Sieve of Eratosthenes. Fundamental theorem of arithmetic.
5. Chapter: **Congruences**. Congruences. Divisibility criteria. Linear congruences. Euler's φ function. Chinese remainder theorem.
6. Chapter: **Polynomials**. Divisibility and Euclidean algorithm. Factorization. Roots and multiplicities. Factorization of rational functions.
7. Chapter: **Polynomial inequations.** Definitions. Polynomial inequations. Some classical inequalities.
8. Chapter: **Elementary Linear Algebra**. Matrices. Addition and scalar multiplication of matrices. Matrix multiplication. Invertible matrices. Rank of a matrix. Determinant of a matrix. Systems of linear equations.

DESCRIPTION OF THE COURSE:

The available material of the course is entirely self-contained and it is presented in the OCW platform in different sections, such as, lecture materials, recommendable readings, resources, assignments and exercises sets. It is expected that the students dedicate an average of 4 hours in understanding the theory involved in each subject, except to the preliminary section, for which 2 hours is enough, and an average of 4 hours for each excercise set. In order to encourage students to follow the course in a guided way, the teacher team offers also the students the possibility of asking them any help via email. The teacher team is formed by three experienced teachers, whose email addresses are available at the section "Teachers" of the OCW platform.

COURSE SPECIFIC COMPETENCIES:

- To understand and apply the main types of mathematical proof and the techniques of solving problems (observation-conjecture-proof).
- To think abstractly and use properly induction and deduction.
- To be acquainted with set theory, functions and with elementary linear algebra.
- To know the concepts, techniques and basic results of divisibility and congruence theory.
- To manage suitably algebraic expressions in order to work with polynomials and solve equations and inequations.
- To solve mathematical problems using basic skills in calculus and others, planing their resolution according to the tools available and of any restrictions in terms of time and resources.
- To find information and develop critical thinking.
- To use tools for searching for bibliographic resources in mathematics.
- To gather and interpret data, information and relevant results on problems of a scientific and technological nature, or in other fields that require the use of mathematical tools.

METHODOLOGY:

Since the course is mainly based on self-learning and self-study, the best itinerary to propose the students would be: read carefully several times all the concepts included in each subject, and try to reproduce by themselves the proofs of all the theorems and propositions involved in each subject. Once the lecture material becomes easy to understand by the students, they should perform the proposed exercises sets, and create new analogous exercises solving them as well. This would convince themselves that the underlying concepts in each subject are now much more familiar. The students will have the opportunity of verifying some of the results obtained in some exercises using the "solved exercises sets", as well.

BIBLIOGRAPHY:

- J.P. D'Angelo and D.B. West. Mathematical Thinking: Problem Solving and Proofs, Prentice Hall, 2000
- T.S. Blyth and E.F. Robertson, Sets, Relations and Mappings, Cambridge Univ. Press, 1984.
- K.H. Rosen, Matemática discreta y sus aplicaciones, McGraw-Hill, 2004.
- M. Liebeck, A concise introduction to Pure Mathematics, Chapman & Hall, 2006.

TIMELINE:

Order to study	SUBJECTS	SELF-STUDY (time)	EXERCISES SET and solved exercises set	OTHER READINGS
1st	MATHEMATICAL LANGUAGE	X	Both	
		2 h	1h	
2nd	1. SUBJECT: SET THEORY	X	Both	x
		4h	4h	
At any time	2. SUBJECT: COMPLEX NUMBERS	X	Both	
		4h	4h	
3rd	3. SUBJECT: FUNCTIONS	X	Both	x
		4h	4 h	
At any time	4. SUBJECT: DIVISIBILITY	X	Both	
		4h	4h	
After subj-4	5. SUBJECT: CONGRUENCES	X	Both	x
		4h	4h	
At any time	6. SUBJECT: POLYNOMIALS	X	Both	x
		4h	4h	
After subj-6	7. SUBJECT: POLYNOMIAL INEQUATIONS	X	Both	
		4h	4h	
At any time	8. SUBJECT: ELEMENTARY LINEAR ALGEBRA	X	Both	x
		4-5h	4-5h	