Program of the course

Principles of Mathematics 1 & 2

Prof. Renato Bruni

Part 1
1. Sets of numbers: Natural, Integer, Rational and Irrational numbers, Real numbers, intervals.
2. What is a function, graph of a function, mathematical model of a real-world phenomenon.
3. Different types of functions: linear functions, piecewise functions, polynomial functions, power functions, trigonometric functions, exponential functions, logarithmic functions.
4. Limits of sequences, limits of functions: finite and infinite limits, limits from right and from left.
5. How to compute a limit, limits laws, geometric view of limits, continuity of a function, asymptotes, Intermediate Value theorem, Bolzano's theorem.
6. Derivatives: the concept of derivative, the tangent problem, derivative as a rate of change, differentiability, right and left derivatives, higher derivatives, properties of derivatives, computation of derivatives, derivative of a product, the chain rule, examples of derivative in sciences.
7. Study of functions using derivatives, minimum and maximum, Fermat Theorem on minimum and maximum, Weierstrass theorem, Rolle theorem, Mean-value theorem, first derivative test, second derivative test, indeterminate forms, l'Hôpital rule, guidelines for sketching a curve, antiderivatives.
8. Integrals: the concept of integrals, the area problem, definite integrals, properties of definite integrals, the Fundamental Theorem of Calculus, indefinite integrals. computation of integrals. Integration by substitution, Integration by parts.

Part 2
9. Differential equations: types of differential equations. Pure-time, Autonomous, and Non-autonomous differential equations. Examples. Equilibria and Stability. Direction Field. Euler method. Systems of Differential Equations. Examples in biologic sciences.
10. Vectors and Matrices: coordinates in 2, 3 and n dimensions, what is a vector, dot product, what is a matrix, what is a tensor. Operations with matrices: sum, multiplication. Identity, inverse matrix, determinant, solving systems of linear equations, Eigenvectors and Eigenvalues.
11. Multivariate calculus: functions of 2 variables, level curves, functions of 3 or n variables, limits and continuity, partial derivatives, higher derivatives, directional derivatives, gradient vector, maximum and minimum.

Material of the course
-Books for extensive study, they contain more than the program of this course:
1 Biocalculus: Calculus for Life Sciences, authors J. Stewart, T. Day -Cengage Learning 2015
2 Calculus For Biology and Medicine, author Claudia Neuhauser -Pearson 2014
- Slides of the course, available from the home page of the professor
(http://www.diag.uniroma1.it//~bruni/)

Exam
There will be a written exam at the end of the course, with possible subsequent oral questions if needed for the evaluation.

Contact
To contact Renato Bruni, use bruni@diag.uniroma1.it and ALWAYS insert the subject Principles of Maths. Emails not using this subject may remain unseen and/or go into the spam folder.