Università degli Studi della Basilicata
Scuola di Ingegneria

COURSE: MATHEMATICAL ANALYSIS (CALCULUS I)

ACADEMIC YEAR: 2016/2017

TYPE OF EDUCATIONAL ACTIVITY: BASIC

PROFESSOR: ELISABETTA BARLETTA

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Language: ITALIAN

ECTS: (lessons e tutorials/practice)	n. of hours: (lessons e tutorials/practice)	Campus: POTENZA Dept./School: SCUOLA DI INGEGNERIA Program: ENVIRONMENTAL AND CIVIL ENGINEERING; INGEGNERIA MECCANICA	Semester:
12	120		ANNUAL

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

Knowledge: Developing a good knowledge of the basic mathematical language together with abilities of differentiable and integral calculus in one real variable. The aim is to provide a tool for comprehending successive lessons in Mathematics (e.g. Mathematical Analysis II, Mathematical Physics), Physics and Engineering. In particular the course will concern:

- basic knowledge of Euclidean topology;
- complex numbers and their main properties;
- sequences and series of real numbers;
- scalar functions in one real variable: limits, Infinities and infinitesimals, continuity and differentiability of a function;
- some consequences of the infinitesimal calculus (e.g. L'Hôspital's theorems, Taylor's formula, Mac Laurin's formula);
- indefinite integration and Riemann integral; improper integrals and the relation with the numerical series;
- first order differential equations and higher order differential equations with constant coefficients.

Particular attention will be given to the foundations and the main theorems of the above arguments.

Learning ability: Attending the lessons will give a better comprehension of the arguments and will make easy the individual preparation of the final examination. The student should gradually become independent by the teacher and try to learn more by reading other textbooks, preferably those appearing in the proposed list.

Skills: Analyzing a mathematical analysis problem in one real variable and finding the solution by evaluating the suitable solving method and by using the theoretical notions learned through the course.

PRE-REQUIREMENTS

Elementary algebra (factorization of polynomials, first and second order equations, radicals, logarithms, inequalities), plane analytic geometry and trigonometry.

SYLLABUS

1 – Sequences and series of real numbers (25 hours): The field of real numbers with the Euclidean topology. Convergent sequences. Divergent sequences. Monotone sequences. Cauchy sequences. Operations with limits of sequences. Sequences and topology of $\mathbb{R}$. Numerical series with nonnegative terms. Convergence criteria for numerical series. Absolutely convergent series.

2 - Functions in one real variable (15 hours): The domain, range and graph of a function. Composition of functions. Inverse of a function. Extremes of a function. Monotone functions. Limits of a function. Relation between the sign of the limit and the sign of the function. Operations with limits. Some remarkable limits. One-sided limits. Limits of monotone functions. Infinities and infinitesimals.

3 – Continuous functions (5 hours): Definition of a continuous function. Discontinuity points. Theorem on the permanence of the sign of a continuous function. Functions continuous on sets. The mean value theorem. Weierstrass' theorem. Uniform continuity. Cantor's theorem. Invertible continuous functions.

4- Differentiability of functions (10 hours) : Derivative of a function. Relation between the differentiability and the continuity of a function. Differentiation rules. Rolle's Theorem. Lagrange's (or mean value) Theorem. Cauchy's Theorem. Determination of local and global extremes of a function of one real variable.

5 - Consequences of infinitesimal calculus (10 hours): L'Hôspital Theorems. Higher-order derivatives. C^k and C^∞ functions. Convex (concave) functions. Some properties of differentiable convex (concave) functions. Determination of the graph of a function in one real variable.

6 – Taylor's formula of a function (10 hours) : Taylor's polynomial. Taylor's expansion with a reminder. Representations of Taylor's reminder. Relation between Taylor's formula and the local extreme points of a function. Mac Laurin's formula. Mac Laurin's expansion of elementary functions.

7 – Integration of a function (20 hours): Primitive of a function. Determination of primitives of elementary functions. The formulae of integration by parts and by substitution. Integration of rational functions. Abelian integrals. Trigonometric integrals. Integration of binomial differentials. Riemann integral. Integral mean value theorem. Fundamental theorem of calculus. Integrals and Taylor's reminder. Mac Laurin's formula for the functions $\log(1-x)$, $\arctan x$, $\arcsin x$.

8 – Improper Integrals (8 hours): Convergence criteria for improper integrals. Euler integral of the first and second kind. Improper integrals and numeric series.

9 – Complex numbers (6 hours): The construction of the complex field $\mathbb{C}$. Polar form of a complex number. The n-th power and the rational power of a complex number. $\mathbb{C}$ as a metric space. Sequences and series of complex numbers. Complex logarithm and complex powers of a complex number.

10 – Differential equations (11 hours): First order ordinary differential equations (ODEs). Separation of variables. Linear first order ODEs. Classes of first order nonlinear ODEs: Bernoulli's equation, Riccati's equation, equations of the form $y' = f((ax+by+c)/(a'x+b'y+c'))$, Manfredi's equation. Higher order ODEs with constant coefficients.

TEACHING METHODS

Theoretical lessons (80 hours) in which the entire content of the course will be tought and classroom tutorials (40 hours).

EVALUATION METHODS

Written examination and oral examination (in case of a close to sufficient result obtained in the written examination).

To verify the educational goals and expected learning outcomes, a mid term homework is assigned. A positive evaluation of this test contributes to the final grade.

The arguments of the written examination (as well as the arguments of the oral examination) include all the contents of the course and they are chosen so that to ensure either the study and understanding of the material of the course either the ability of using the knowledge and methods acquired for learning the contents of the successively taught mathematics, physics and engineering disciplines.

The written test is distributed in three separate versions each containing three blocks divided into exercises/questions: one of the three blocks consists of theory questions.

The answer to each block is evaluated 10/30, if complete and error-free. The score 10/30 is reached by the partial evaluation of individual exercises/questions that make up the block.

The available time for the written test is 2 hours. Consultation of tables and formulas is permitted, but consultation of textbooks, manuals, exercise books, lecture notes, as well as the use of personal computers, smartphones and similar tools (that enable connection to the Internet or other forms of communication) are not allowed.

A passing grade requires a score of at least 18/30.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

E. Giusti, Analisi Matematica I, Bollati Boringhieri.

E. Giusti, Esercizi e Complementi di Analisi Matematica, vol. I, Bollati Boringhieri.

S. Salsa, A. Squellati, Esercizi di Matematica, vol. I, Zanichelli.

R.A. Adams, Calcolo differenziale 1, Casa Editrice Ambrosiana.

B.P. Demidovic, Esercizi e problemi di Analisi Matematica, Editori Riuniti.

INTERACTION WITH STUDENTS

Lecture notes written by the professor will be available in pdf format at the beginning of the course and by requiring them directly to the professor through the institutional email.

Further information about the course may be requested to the professor by the institutional email.

Office hours:

Tuesday and Thursday from 15:00 to 17:00 at Dipartimento di Matematica, Informatica ed Economia.

EXAMINATION SESSIONS (FORECAST)

Tuesday January 31, 2017; Friday April 21, 2017; Tuesday June 27, 2017; Tuesday September 19, 2017; Friday November 10, 2017.

SEMINARS BY EXTERNAL EXPERTS YES □ NO X

FURTHER INFORMATION

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