COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	A.1	SEMESTER	A
COURSE TITLE	MATHEMATICAL ANALYSIS I		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	WEEKLY TEACHING HOURS	CREDITS
	4	5
Total	4	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	GENERAL BACKGROUND
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (IN ENGLISH)
COURSE WEBSITE (URL)	ECLASS

LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The 1st Semester of 1st Mathematical Analysis extends and combines the students' existing knowledge on the calculation of functions of one variable with the applications. Also, provides them the tools to effectively address and solve suitable scientific problems.
On the other hand it includes new fields such as complex numbers, series, dynamics in vector analysis, plane vector functions, differential equations, etc, which are essential in engineering mathematical courses. Mathematical Analysis I, aims in the advancement of mathematical literacy and analytical mathematical thinking of the student as any Mathematic course and lesson must do.

Upon successful completion of this course module students possess advanced knowledge, skills and competences in the subject of Mathematics that enable them to:

- Work with the field of complex numbers, representing them in trigonometric and exponential form and calculating roots and powers of complex numbers

- Able to find - examine convergence, continuity and calculate limits for functions, sequences and series.
- Able to recognize known curves of the plane.
- Know how to apply the derivatives to its various applications and develop functions in Taylor series.
- Study the basic integration techniques.
- Understand the physical point of view for the derivates and for the integrals and how to use them in order to solve engineering and mechanics problems.
- Apply taught methods to calculate integrals (indefinite, definite and generalized integrals).
- Apply taught methodology in problem solving of other fields of science and technology, in real life contexts.
- Use vector analysis and its basic operations (inner product, angle, external product, etc) in analyzing problems and synthesizing solutions.
- Assess different methods for the synthesis of solutions to real-life problems and select the appropriate for the problem at hand.
- Study first order ordinary differential equations, for example Differential Equations of Separated Variables and able to study their applications in many fields of science and engineering.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

Analytical and synthetic work using mathematical concepts, and problems solving in key fields of science and engineering.
Autonomous work.
Ability to convert basic physical problems into mathematics-computing problems.
Promote free, creative and inductive thinking.
Adequacy in applying computer software for the practical implementation of mathematical procedures.
Working in an interdisciplinary environment.
Making decisions according to the solution of the Mathematical Problem.

(2) SYLLABUS

The lesson is organized in 26 two-hour lectures.

Section 1 "Complex Numbers"

• **Lecture 1**: Introduction to Complex Numbers, Definition of Complex Numbers, Complex Algebra, Complex Conjugate, Magnitude and Argument of Complex numbers.

• **Lecture 2**: Geometric Representation, Trigonometric Form, Exponential Form, Polar Form and Logarithmic Form of Complex Numbers. Euler's Type, De Moivre Theorem, Complex Roots and Powers.

Section 2 "Sequences-Series"

• **Lecture 3**: Sequences, Functions, Series, Examples and Exercises.

• **Lecture 4**: Power-Series, Convergence Theorem, Convergence radius

• **Lecture 5**: Limits: Definitions, Basic Boundary Theory and Boundary Convergence Theory, Continuity, Properties, Exercises.

• **Lecture 6**: Applications, Exercises and Examples in different types of series.

Section 3 "Level Curves"

• **Lecture 7**: Curves, Analytical Equations (line, ellipse, circle, etc), Cartesian's Coordinate System, Parallel Shift, Examples.

• **Lecture 8**: Known Curves from the analysis (exponential, trigonometric and their inverse functions, also logarithmic and hyperbolic functions), Even and Odd Functions, Exponential Growth Model, Examples- Applications.

Section 4 "Differential Calculus"

• **Lecture 9:** Functional Derivative, Geometric Interpretation, Derivation, Basic Laws of Derivatives, Derivative Calculations (logarithmic derivation, chain rule, inverse function derivative, etc).

• **Lecture 10**: Applications: The Derivative as a Gradient of the Tangent, The Derivative as a Rate of Change, Minimum -Maximum Problems.

• **Lecture 11**: Linearization, Differential Operator, Taylor Expansions, Errors and their limits-Applications

Section 5 "Integral Calculus"

• **Lecture 12**: Indefinite Integral, Definition of Anti-Derivative Function, Properties and Basic Integration Rules.

• **Lecture 13** Integration Techniques: Integration with Replacement, Factorial Integration.

• **Lecture 14**: Integrals of Trigonometric functions, Integrals of Rational functions, Other Categories of Integrals.

• **Lecture 15:** Definite Integral: Definitions, Riemman's Sum, Basic Properties, Theorems of Definite Integrals, Exercises and Examples in special type of Integrals.

• **Lecture 16:** Area calculations, Length of curve section, Rotational volume calculations, Approximate calculation of integral with Taylor extensions.

Section 6 "Generalized Integrals"

•**Lecture 17**: Definitions, Several types of Generalized Integrals, Calculations and Exercises.

• **Lecture 18**: Geometric Interpretation of Generalized Integrals, Functions Defined from Generalized Integrals e.g. gamma function, Applications and Examples.

Section 7 "Vector Calculus"

• **Lecture 19**: Vector Calculation (definitions, vector algebra, vector measure, projection, vector angle, inner product, external product).

• **Lecture 20**: Cartesian and Polar Coordinates, Integration Using Polar Coordinates-Applications and Exercises.

• **Lecture 21**: Definition of Vector Functions, Continuity, Limit, Differentiability, Derivatives and their Geometric Interpretation.

• **Lecture 22**: Indefinite and Definite Integrals for Vector Functions, Applications, Exercises and Examples.

Section 8 " First Order Ordinary Differential Equations "

• **Lecture 23**: Introduction, Definitions, Existence of Solutions, Geometry of Solutions, First Order Ordinary Differential Equations.

• **Lecture 24**: Directly integral Differential equations, Differential Equations of Separated Variables, Exercises and Examples.

• **Lecture 25**: Engineering Applications (e.g. circuits), Interpretation of solutions of differential equations.

Section 8th "Summary and Revision"

• **Lecture 26**: Revision of the Basic Course Concepts with Examples and Exercises.

(3) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lectures are offered in class using primarily the blackboard. ICT technologies (slide presentations) are used to emphasize key topics in theory. Problems solution using Modern mathematical tools (Matlab, Mathematica, Wolfram Alpha) corroborate theory and reinforce the learning process.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	

Activity	*Semester workload*
Lectures	52
Course material study.	52
Exams preparation, Exercises solutions, Bibliographic research	43
Final exams	3
Course total	*150*

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Students' performance evaluation is based mainly on the final written exam which is in the form of solving problems. The exam is given twice a year in the Greek Language.

(4) ATTACHED BIBLIOGRAPHY

Greek:

- **Infinite Calculus**, Briggs, Cochran and Gillett, *University of Crete Publications, 2018*.
- **Advanced Mathematics for Engineers**, Erwin Kreyszig, *Tziolas Publications*.
- **Mathematics I**, Rassias Th., Tsotras, 2017.
- **Differential and Integral Calculus-Theory and Applications**, Goldstein Larry, Lay David, Broken Hill Publishers, 2020.
- **General Mathematics**, Vrizidis, Makrigiannis, Sassalos, *Singhroni Ekdotiki Publications, 2106.*
- **General Mathematics**, Masouros, Tsitouras, *Tsotras Publications*.
- **Advanced Mathematics**, Milonas N, *Tziolas Publications*.
- **Infinite Calculus I**, Finney R.L., Weir M.D., Giordano F.R., *University of Crete Publications.*

Foreign Language:

- **Handbook of Mathematical Functions**, M. Abramowitz and I. Stegun, *Dover, New York*.
- **Ordinary Differential Equations**, V. Arnold, *Springer-Verlag, Berlin*.
- **Ordinary Differential Equations** (4th Edition), G. Birkhoff and G-C. Rota, *John Wiley and Sons, New York.*
- **Elementary Differential Equations and Boundary Value Problems** (6th Edition), *W.E. Boyce and R. C. DiPrima, John Wiley and Sons, New York.*
- **Introduction to Calculus and Analysis** (volume I and II), R. Courant and F. John, *Wiley International Editions, New York.*
- **Elementary Differential Equations with Boundary Value Problems**, C.H. Edwards and D.E. Penney, *Prentice Hall, Inc., New Jersey.*
- **Engineering Mathematics**, K.A. Stroud, D. Booth, *Macmillan.*
- **Calculus for Scientists and Engineers**, W. Briggs, L. Cochran, B. Gillet, *Pearson Higher Education.*

Related Scientific Journals:

- Journal of Engineering Mathematics
- Journal of Differential Equations
- Electronic Journal of Differential Equations