
**UNIVERSITY OF WESTERN MACEDONIA**
**SCHOOL OF EXACT SCIENCES**
**DEPARTMENT OF MATHEMATICS**

# COURSE OUTLINES
# DEPARTMENT OF MATHEMATICS

## ACADEMIC YEAR
## 2023-2024

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# 1st SEMESTER

## ■ CC11 - Infinite Calculus I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC11 | **SEMESTER** | A |
| **COURSE TITLE** | INFINITE CALCULUS I | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 5 | 8 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| After the successful completion of the course, the students:<br>• will know the basic properties of the natural and real numbers,<br>• will be able to decide on the convergence of series,<br>• will be able to study the continuity and the differentiation of functions of one |

variable,
- will be able to do calculations and draw the graph of a function of one variable.

**General Competencies**

- Individual work.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Natural and real numbers, the principle of mathematical induction, classical inequalities.
Sequences of real numbers: definition, monotonicity of sequence, bounded sequence, Cauchy sequence, convergence of sequence.
The meaning of series, basic properties of series, criteria for convergence.
Functions of a single real variable: limits, continuity, uniform continuity, differentation and reversibility.
Rules of differentation, intermediate value theorem, Bolzano theorem, Rolle theorem,
Monotonicity, extreme values, convexity, asymptotes, graphs of functions.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |
| **STUDENT EVALUATION** | Written final examination 100%. |

| Activity | Semester Workload |
|---|---|
| Lectures | 65 hours |
| Projects | 45 hours |
| Individual Study | 90 hours |
| Course Total (25 hours per ECTS) | 200 hours |

**RECOMMENDED BIBLIOGRAPHY**


1. Spivak M, Differential and Integral Calculus, Crete Un. Press, 2010. (Greek)
2. Ntougias S, Calculus vol A, Leader Books, 2007. (Greek)
3. Apostol T, Differential and Integral Calculus, Atlantis Press, 2007. (Greek)


## ■ CC12 - Linear Algebra I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC12 | **SEMESTER** | A |
| **COURSE TITLE** | LINEAR ALGEBRA I | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 7 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|

After the successful completion of the course, the students:

- will know the calculus of matrices,
- will be able to calculate the determinant of a square matrix,
- will be able to apply the Gauss method in order to solve linear systems,
- will understand the meaning of a vector space and the properties of subspaces,
- will be able to recognize if a mapping is linear and to find its basic characteristics (kernel, image, representation matrix).

**General Competencies**

- Familiarity with the use of aggregation indices.
- Connecting prior knowledge to Linear Algebra concepts.
- Promotion of inductive thinking.

## CONTENT OF THE COURSE

Matrices. Special types of matrices. Operations with matrices. Inverse matrix.
Calculation of the determinant of a square matrix, properties of determinants.
Linear systems of equations, the Gauss method of elimination.
Vector spaces, subspaces, linear span. Linear Independence and Dependence. Bases and dimension.
Linear transformations. Kernel, image, matrix of linear mapping
Isomorphic vector spaces.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |
| **STUDENT** | Project 20%. |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 43 hours |
| Individual Study | 80 hours |
| Course Total (25 hours per ECTS) | 175 hours |

| | |
|---|---|
| **EVALUATION** | Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Linear Algebra, Theochari-Apostolidi Theodora, Charalambous Chara, Vavatsoulas Charilaos, Publications Tziola & Sons S.A. (2017). (Greek)
2. An Introduction to Linear Algebra, Varsos Dimitris, Deriziotis Dimitris, Emmanouil Giannis, Maliakas Michalis, Melas Antonis, Talelli Olympia, Publications Sophia (2012). (Greek)
3. Linear algebra, Donatos Georgios, Adam Maria., Publications G. Dardanos-K. Dardanos O.E. (2008). (Greek)
4. Linear Algebra and Applications, Gilbert Strang, Publications University Publications of Crete (2021). (Greek)
5. Introduction to Linear Algebra, Papistas Athanasios, Publications Tziola & Sons S.A. (2019). (Greek)


## ■ CC13 - Introduction to Computers

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC13 | **SEMESTER** | A |
| **COURSE TITLE** | INTRODUCTION TO COMPUTERS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 2 | 7 |
| Computer-Lab | 2 | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

After the successful completion of the course, the students:

- will be able to know the basic notions of computers,
- will be able to recognize and evaluate the technical characteristics of devices,
- will be able to compute various quantities related to memory capacity, data transfer speed and other technical quantities,
- will be able to evaluate and conclude the appropriateness of certain provisions and applications,
- will be able to organize and recommend effective computing systems, applications and network systems,
- will be able to compare and evaluate devices and various software,
- will be able to build a PC using the basic building blocks that make it up,
- will be able to install various operating systems on a PC,
- will be able to to compose small local computer network.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Individual work.
- Promotion of free, creative and inductive thinking.
- Generating new research ideas.

## CONTENT OF THE COURSE

Basic notions, the meaning of information, calculations and auxiliary means, historical development of Computer Science, numbering systems, coding of information, introduction to algebra Boole and basic logic circuits, the computer hardware, description and analysis of various structural elements that make up a computer, computer peripherals, computer organization, computer arithmetic, processor structure and function, computer memory and its organization. Algorithms, programs and programming, operating systems, data processing, computer networks, internet, information systems and applications. In detail, the sections are:

- Introduction to numerical systems.
- Number representation and codes.
- Arithmetic on the computer.
- Boolean algebra, logic gates.
- Functional structure of computer, basic unit.

- Memory in the computer, memory organization, peripheral memory.
- Computer assembly.
- Peripheral devices.
- Software, Operating systems.
- Installation of operating systems on PCs.
- Digitalization. The concept of file, types of files.
- Computer networks and communications.
- Internet.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom and computer-lab. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Laboratory teaching. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 26 hours |
| Individual Study | 123 hours |
| Laboratory Exercise | 26 hours |
| Course Total (25 hours per ECTS) | 175 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Approximately in the middle of the semester, an intermediate exam (progress) will take place, which will participate with a percentage of 30% in the formation of the final grade.<br><br>The exam at the end of the semester will contribute 40% to the final grade.<br><br>In the laboratory part of the course there will be an exam using a specialized software which will participate with a percentage of around 20% in the formation of the final grade, while there will also be a written exam, with multiple choice questions, which will participate with a percentage of 10% in the formation of the final grade. |

**RECOMMENDED BIBLIOGRAPHY**

-Recommended Bibliography:


1. Garmpis Aristogiannis & Fotiadis Dimitrios. (2015). Introduction to Computers and Informatics. Publications Arakynthos. (Greek)
2. Evans, Alan, & Kendall, Martin & Poatsy, Mary Anne. (2018). Introduction to Informatics (2nd edition). Publications Kritiki S.A. (Greek)


- Additional Bibliography:


1. Beekman, B. & Beekman, G. (2015). Introduction to Informatics (10th edition). Publications H. Gkiourda & Co EE. (Greek)
2. Forouzan, Behrouz A.. (2015). Introduction to Computers (3rd edition). Publications Kleidarithmos. (Greek)
3. Brookshear, Glenn J. (2009). The science of Computers: A complete presentation (10th edition). Publications Kleidarithmos. (Greek)
4. Tsouroplis A. & Klimopoulos St.(2005). Introduction to Informatics. Publications New Technologies. (Greek)
5. Foropoulos Leonidas (2004). Technology of Computers. European Technological Publications. (Greek)


## ■ CC14 - Fundamental Notions of Mathematics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC14 | **SEMESTER** | A |
| **COURSE TITLE** | FUNDAMENTAL NOTIONS OF MATHEMATICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 5 | 8 |
| | | |
| **COURSE TYPE** | General Background | |

| | |
|---|---|
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, the students will be in position to:

- know the basic notions of set theory (operation of sets and properties), along with the concepts of Cartesian product, set of sets, cover and partition,
- know the concept of relations and their properties, the concept of composition of relations, along with the notions of equivalencies, orders and bounded sets (supremum, infimum),
- know the basic notions of functions, one-to-one, on to, and bijective functions, inverse functions, composite functions, the concepts of image inverse image of a set through a function, and also the relation between functions and ordered sets, (bounds, monotonicity),
- know the basic notions of propositional calculus and mathematical induction,
- know about the set theoretical construction of the natural numbers and integers, dividability, and the construction of rational numbers and through these of real numbers (Dedekind cuts),
- know the basic notions of complex numbers, their trigonometric form and also know how to apply these in solving equations in the set of complex numbers.

**General Competencies**

- Analysis and synthesis of data and information.
- Working independently.
- Decision making.
- Creation of new research ideas.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

- Elementary set theory. Union, intersection,. difference, symmetric difference of sets and related properties. Powerset and complement of a set, Cartesian product, set of sets. cover and partition of a set.
- Relations and their properties. Composition of relations. Equivalencies, classes of equivalence. Orders. Bounds and bounded sets. Supremum, infimum. Well

ordered sets.

- Functions, basic concepts. One-to-one, onto, bijective functions. Inverse function. Composite function. Image and inverse image of a set through a function. Functions and ordered sets. Bounds. Monotonicity.
- Elementary notions of propositional calculus. Logical operations. Tautologies.
- Mathematical induction. Mathematical induction and well ordering. Full induction.
- The sets of natural numbers and integers. Dividability. The set of of rational numbers. Construction of real numbers through Dedekind cuts. The set of of irrational numbers. Completeness theorem in the set of real numbers.
- Complex numbers. Second degree equations in the set of complex numbers. Trigonometric form. Equation de Moivre. ν-th roots of a complex number. Fundamental Theorem of Algebra. Triangular inequality.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | LATEX and Scientific Workplace to prepare the course material.<br>Powerpoint presentations.<br>Use of the e-class platform to share notes-exercises-projects, and for communication through e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 65 hours |
| Individual Study | 100 hours |
| Solving exercises and projects | 35 hours |
| Course Total (25 hours per ECTS) | 200 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Solving exercises and problems 25%.<br>Written final examination 75%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Tsolomitis A., Sets and Numbers, Publications Leader Books, 2004. (Greek)
2. Tsamatos P., Fundamental Notions of Mathematical Analysis, Publications Tziola, 2009. (Greek)

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|---|
| 3. Stewart I., Tall I., The Foundations of Mathematics, Oxford Univ. Press, 2015. |

# 2nd SEMESTER

## ■ CC21 - Infinite Calculus II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC21 | **SEMESTER** | B |
| **COURSE TITLE** | INFINITE CALCULUS II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 5 | 8 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Infinite Calculus II |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| After the successful completion of the course, the students:<br>• will know the indefinite integral and its basic calculation techniques, |

- will know the definition of the definite integral (according to Riemann),
- will apply the Fundamental Theorem of Integral Calculus for the calculation of the definite integral as well as the basic methods of substitution and factorial integration.
- will apply the definite integral to calculate flat areas, and volumes of solids from rotation,
- will know the generalized integral and the basic convergence criteria of generalized integrals.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Making decisions.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Factor and indefinite integral. Definition of indefinite integral, basic properties, integration by change of variable, integration by factors, integration of explicit functions, integration of basic types of functions.
Definite integral (Riemann integral). Definition, properties, integrability criteria, mean value theorem for definite integrals, inequalities between definite integrals, Fundamental Theorem of Infinite Calculus for computing definite integral, change of variable in definite integral. Applications of definite integrals. Calculation of the area of a region, the volume of a solid by rotation and the length of an arc.
Generalized integrals. Types of generalized integrals and their calculation, basic properties, convergence criteria of generalized integrals of non-negative functions (comparison criterion, limit criterion, etc.), absolute convergence of generalized integrals, change of variable in the generalized integral.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software GEOGEBRA.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 65 hours |

| | |
|---|---|
| | Individual Study: 135 hours<br>Course Total (25 hours per ECTS): 200 hours |
| **STUDENT EVALUATION** | 1. Written exam (progress) in the calculation of indefinite and definite integrals 30%.<br>2. Written final exam on all material 70%. |

**RECOMMENDED BIBLIOGRAPHY**

1. THOMAS INFINITE CALCULUS, [George B. Thomas], Jr., Joel Hass, Christopher Heil, Maurice D. Weir. (Greek)
2. DIFFERENTIAL AND INTEGRAL CALCULUS, SPIVAK MICHAEL. (Greek)
3. General Mathematics - Infinite Calculus, volume I, Athanasiadis Ch. E. Giannakoulias E. Giotopoulos S. Ch. (Greek)
4. Infinite calculus, Briggs William, Cochran Lyle, Gillett Bernard. (Greek)
5. Mathematics I, Petrakis L. Andreas, Petraki A. Dorothea, Petrakis A. Leonidas. (Greek)

## ■ CC22 - Linear Algebra II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC22 | **SEMESTER** | B |
| **COURSE TITLE** | LINEAR ALGEBRA II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 7 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Linear Algebra I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, students will be in position to:

- compute eigenvalues and eigenvectors of a matrix,
- know the Cayley-Hamilton theorem,
- apply the diagonalization criterion of a matrix,
- diagonalize symmetric matrices using rectangular matrices,
- calculate the invariants of quadratic forms.

**General Competencies**

- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Eigenvalues. Eigenvectors. Eigenspaces. Diagonalization. Cayley-Hamilton theorem.
Euclidean spaces. Orthogonality. Gram-Schmidt normalization.
Orthogonal matrices.
Endomorphisms. Symmetric matrices. Spectral theorem.
Isometries. Quadratic forms. Main axes. Measure of a matrix.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of the e-class platform to share notes-exercises-projects and for communication through e-mails. |
| **TEACHING ORGANIZATION** | **Activity** \| **Semester Workload** |

| | |
|---|---|
| | Lectures: 52 hours<br>Individual Study: 123 hours<br>Course Total (25 hours per ECTS): 175 hours |
| **STUDENT EVALUATION** | 1. Written exam (progress) by completing 6 teaching weeks 30%.<br>2. Final written exam on all material 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Papistas A., Introduction to Linear Algebra, Tziola Publications, 2019. (Greek)
2. Donatos G., Adam M., Linear Algebra, Gutenberg Publications, 2008. (Greek)
3. Theohari Th., et.al, Linear Algebra, Tziola Publications, 2017. (Greek)
4. Varsos D., et.al, An Introduction to Algebra, 3rd edition, Sofia Publications, 2020. (Greek)
5. Linear Algebra and Analytic Geometry, Mylonas N.-Papadopoulos V. (Greek)
6. Linear Algebra and Applications, Gilbert Strang Approach, Prentice Hall. (Greek)


## ■ CC23 - Analytic Geometry

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC23 | **SEMESTER** | B |
| **COURSE TITLE** | ANALYTIC GEOMETRY | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 7 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |

| | |
|---|---|
| **PREREQUISITE COURSES** | Linear Algebra I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

After the successful completion of the course, the students:

- will be able to use matrices and determinants and solve linear systems,
- will be able to use basic vector algebra (inner product, outer product, mixed product) in order to solve problems in the plane and space,
- will be able to find equations of lines and planes and to be able to comfortably manage the Cartesian coordinate system in solving basic geometric problems,
- will be able to use transformations of coordinate systems in the plane and in space,
- wil be familiar with basic curves and surfaces defined by quadratic polynomials.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Adapting to new situations.
- Working in an interdisciplinary environment.
- Individual work.
- Team work.
- Generation of new research ideas.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Vector Calculus: Vectors and operations, linear independence, bases, coordinates, inner, outer, mixed and double outer product. Geometric Interpretation of the products. Coordinate systems in the plane and in space (general, orthonormal and polar). Coordinate system transformations.
Analytic geometry in space: Lines and planes in space (parametric equations, vector equation, Cartesian plane equation). Distance of a point from a line and plane. Relative positions of lines and planes in space.
Quadratic curves and surfaces in space.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Individual Study — 110 hours<br>Course Total (25 hours per ECTS) — 175 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Ch. Stefanidis, Introduction to Geometry, Publications Ziti. (Greek)
2. Th. Chrisakis, Linear Algebra and Analytic Geometry, Publications Tsotras. (Greek)
3. D. Georgiou, S. Iliadis, Analytic Geometry with elements of Linear Algebra, Publications Tziola. (Greek)
4. Linear Algebra and Analytic Geometry, 2nd edition, Mylonas N.-Papadopoulos V. (Greek)
5. N. Kadianakis, S. Karanasios, Linear Algebra, Analytic Geometry and Applications, Publications Tsotras, 2017. (Greek)
6. A. Petrakis, D. Petrakis, L. Petrakis, Analytic Geometry with elements of matrix theory, Publications Thalis. (Greek)


## ■ CC24 - Introduction to Programming

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |
| **DEPARTMENT** | MATHEMATICS |

| | | | |
|---|---|---|---|
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC24 | **SEMESTER** | B |
| **COURSE TITLE** | INTRODUCTION TO PROGRAMMING | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 8 |
| | | | |
| **COURSE TYPE** | General Background | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| Upon successful completion of the course students will have been taught the basic programming concepts and skills required to solve basic problems. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Making decisions.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

Algorithmic problem solving and programming with MATLAB.
Basic concepts of computers and algorithms.
Computational representation of numbers.
Variables, operators/expressions, assignments, input/output.

Check and repeat commands.
Arrays and vectors and basic data structures. Search/Sort.
Introduction to LaTeX.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom and computer-lab. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Programming tasks in MATLAB — 45 hours<br>Individual Study — 90 hours<br>Course Total (25 hours per ECTS) — 200 hours |
| **STUDENT EVALUATION** | Programming tasks 30%.<br>Written final examination in theory 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Stormy Attaway, MATLAB: a practical introduction to programming and problem solving, Publications Kleidarithmos. (Greek)
2. Charles F. Van Loan & K-Y Daisy Fan, The MATLAB in the Computing Science and Technology, DA VINCI M.E.Π.Ε. (Greek)
3. D. Higham, N. Higham, Matlab Guide, SIAM.
4. Van Loan, Introduction to Scientific Computing, A Vector, Matrix Approach, Prentice Hall.

# 3rd SEMESTER

## ■ CC31 - Infinite Calculus III

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC31 | **SEMESTER** | C |
| **COURSE TITLE** | INFINITE CALCULUS III | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 5 | 8 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Infinite Calculus I-II |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| After the successful completion of the course, the students will be able to:<br>• find the domain of functions of several variables, |

- calculate partial derivatives of functions of several variables as well as find their total differential,
- find the extrema of functions of several variables,
- find the limits of functions of several variables,
- check the continuity of functions of several variables,
- make approximations to functions of several variables with the help of the Taylor formula,
- use Mathematica to verify the existence of extremes, continuity, etc.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Making decisions.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Calculus of many variables. Limits, Continuity, Partial derivatives and geometric interpretation. Formulas and theorems of partial derivatives. Extrema of functions of many variables. Limits of functions of several variables with constraints. The concept of Total Differential. Partial higher order derivatives. Distance of points, open and closed sets of $R^n$, boundary of a set.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software Mathematica.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 65 hours |
| Projects | 47 hours |
| Individual Study | 88 hours |

| | | |
|---|---|---|
| | Course Total<br>(25 hours per ECTS) | 200 hours |
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-Exams 20%.<br>Written final examination 70%. | |

**RECOMMENDED BIBLIOGRAPHY**


1. H. Edwards, D. Penney, Infinite Calculus-Volume II, Publications Ion. (Greek)
2. R.L. Finney, M.D. Weir, F.R.Giordano, Infinite Calculus, University Publications of Crete. (Greek)
3. Chatziafratis T, Calculus of Functions of Many Variables, Symmetria Press (Greek).
4. W. Briggs, L. Cochran, B. Gillett, Infinite Calculus, Publications Kritiki.
5. L. Tsitsas, Applied Vector Infinite Calculus, Publications Symmetria. (Greek)
6. A. Panagiotopoulos, A. Sapounakis, Infinite Calculus, Volume II, Publications Stamouli S.A. (Greek)
7. A. Kyriazis, V. Sevroglou, Infinite Calculus II, Publications Enastron. (Greek)


## ■ CC32 - Introduction to Numerical Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC32 | **SEMESTER** | C |
| **COURSE TITLE** | INTRODUCTION TO NUMERICAL ANALYSIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 7 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |

| | |
|---|---|
| **PREREQUISITE COURSES** | Introduction to Programming |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, the students will be able to:

- know computer arithmetic,
- know how to approximate functions with polynomial interpolation,
- apply numerical integration formulas for the approximation of integrals,
- know and apply the basic methods for solving non-linear equations,
- study their convergence and distinguish them in terms of speed,
- know and apply the basic direct and iterative methods for the solution of linear systems,
- implement the above methods with programs in MATLAB.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Making decisions.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Computer arithmetic. Polynomial interpolation. Lagrange interference. Difference theory. Divided and Finite Differences. Interference against Newton. Hermite interference.
Numerical derivation. Numerical integration. Simple and complex types of rectangle, trapezium, Simpson, 3/8. Custom numerical integration. Gaussian integration.
Numerical solution of non-linear equations. Bisection methods and regula falsi. Iterative fixed point methods, convergence. The Newton-Raphson method, the intersection method, the Halley method.
Numerical solution of Linear Systems: Direct methods (Gauss Elimination, LU factorization), Iterative methods (Jacobi, Gauss-Seidel).

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Programming Tasks — 48 hours<br>Individual Study — 75 hours<br>Course Total (25 hours per ECTS) — 175 hours |
| **STUDENT EVALUATION** | Programming tasks (MATLAB) 30%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. G. Papageorgiou, Ch. Tsitouras, Numerical Analysis with applications to MATLAB and MATHEMATICA, Publications Symeon. (Greek)
2. A. Petrakis, D. Petraki, L. Petrakis, Numerical Analysis, Publications THALIS. (Greek)
3. G. Avdelas, Th. Simos, Numerical Analysis, Publications Symeon. (Greek)
4. G.D. Akrivis-V.A. Dougalis, Introduction to numerical analysis, University Publications of Crete.
5. M.N. Vrachatis, Numerical Analysis, Publications Greek Letters. (Greek)
6. G.E. Forsythe, M.A.Malcolm, C.B. Moler, Numerical Analysis and software for mathematical computations, University Publications of Crete.
7. D. Higham, N. Higham, Matlab Guide, SIAM, 2000.
8. C.F. Van Loan, Introduction to Scientific Computing, A Vector, Matrix Approach, Prentice Hall.
9. G.A. Evans, Practical Numerical Analysis, Wiley.


## ■ CC33 - Ordinary Differential Equations

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC33 | **SEMESTER** | C |
| **COURSE TITLE** | ORDINARY DIFFERENTIAL EQUATIONS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 7 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, the students:

- will be able to know the classification of Ordinary Differential Equations,
- will be able to solve special forms of 1st and 2nd order differential equations,
- will be able to apply an approximate method for solving 1st order differential equations that do not have an analytical solution,
- will have understood the matrix method for solving systems of differential equations,
- will have come into contact with problems of other scientific fields, the processing of which depends on the construction and solution of appropriate differential equations.

**General Competencies**

- Familiarity with the use of the differential function.
- Understanding the need to use numerical methods.
- Promotion of inductive thinking.

## CONTENT OF THE COURSE

Classification of Ordinary Differential Equations (ODE). Separable variable ODE, homogeneous ODE. Complete ODE, Euler multipliers. 1st order linears, Bernoulli and Riccati ODE. Picard theorem. Linear ODE of order n>1 - Basic Theorems.
Solving linear homogeneous ODE with fixed coefficients. Methods of finding a solution of non-homogeneous ODE. Euler's ODE. Solving techniques for 2nd order linear ODE with non-constant coefficients. ODE systems.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | E-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 43 hours |
| Indivisual Study | 80 hours |
| Course Total (25 hours per ECTS) | 175 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

## RECOMMENDED BIBLIOGRAPHY


1. Differential Equations, Transformations and Complex Functions, Mylonas Nikos - Schinas Christos.Publications GIOLA & SONS S.A. (2015). (Greek)
2. Differential Equations, Kyventidis Thomas A. Publications ZITI (2012). (Greek)
3. Elementary Differential Equations and Boundary Value Problems, W.E. Boyce -

R.C. Di Prima. Publications NATIONAL TECHNICAL UNIVERSITY OF ATHENS OE (2015). (Greek)
4. Introduction to Differential Equations, Logan David. LIBERAL BOOKS Publications (2014). (Greek)
5. Ordinary differential equations (2nd edition), Nikolaos Alikakos, Grigoris Kalogeropoulos. Publications SYCHRONI EDTOTIKI (2019). (Greek)

## ■ CC34 - Propabilities I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC34 | **SEMESTER** | C |
| **COURSE TITLE** | PROPABILITIES I | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| | Lectures | 5 | 8 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|

Upon successful completion of the course, the students:

- will be able to use the basic rules of probability calculus,
- will be familiarized with the notion of the univariate random variable,
- will be able to gauge several parameters (mean value, covariance etc.) of probability distributions of discrete and continuous random variables,
- will have consolidated the definitions of some basic univariate discrete and continuous probability distributions.

**General Competencies**

- Search for, analysis and synthesis of data and information, by use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Random phenomena. Sample space- event space- event operations. Classical probability definition, statistical regularity, geometric probability, axiomatic definition.
Conditional probability. Total probability theorem- Bayes formula, independence.
Basic combinatorial analysis, Permutations, Combinations. Stirling formula. Discrete and continuous random variables. Probability distribution function. Properties of probability distribution function. Functions of random variables.
Mean value, variance, standard deviation, moments, probability generating functions, moment generating functions.
Basic univariate discrete probability distributions (uniform, Bernoulli, binomial, geometric, hyper-geometric, Poisson, negative binomial).
Basic univariate continuous probability distributions (uniform, exponential, normal, Gamma).
Multi-dimensional random variables- multi-dimensional probability distributions.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 65 hours |

| | |
|---|---|
| | <table><tr><td>Projects</td><td>45 hours</td></tr><tr><td>Individual Study</td><td>90 hours</td></tr><tr><td>Course Total<br>(25 hours per ECTS)</td><td>200 hours</td></tr></table> |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Kounias E. and Moysiadis P., Probability theory I , Ziti Publications 1995. (Greek)
2. Haralampidis C. A., Probability theory and applications, S. Athanasopoulos Publications, 2009. (Greek)
3. BASIC PRINCIPLES OF PROBABILITY THEORY, SHELDON ROSS, Publications KLEIDARITMOS 2011.
4. Introduction to Probability Theory and Applications, Koutras M., TSIOTRAS Publications ATH. 2018.

# 4th SEMESTER

## ■ CC41 - Infinite Calculus IV

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC41 | **SEMESTER** | D |
| **COURSE TITLE** | INFINITE CALCULUS IV | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 8 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Infinite Calculus III | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students:<br>• will know the definition of the integral of a scalar function of several variables,<br>• will be able to decide whether a subset of Euclidean space is of measure or content zero,<br>• will be familiar with the properties of the Riemann integral over orthogonal sections and be able to calculate such integrals using the Fubini theorem,<br>• will be able to compute integrals over any Jordan measurable section,<br>• will be familiar with the definitions and properties of epicurves and surface integrals,<br>• will be able to calculate curves and surface integrals, either directly, or by making use of the Green-Gauss-Stokes theorems. |
| **General Competencies** |
| • Indivisual work.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

Multiple Integrals: integration over closed rectangles, definition and examples. Integrality criteria, integral properties. Integration over measurable passages. Mean Value Theorem, Fubini's Theorem. Changing variables to integrals. Calculations in examples.
Curved Integrals: definition and first examples of integrals of the first and second kind. Properties. Vortex vector fields and gradient fields. Computation of potential as a circumscribed integral. Green's theorem. Calculations.
Surface Integrals: Surfaces and vertical vectors. Surface integrals of the first and second kind, definition and examples. Surface area and vector field flux. Gauss theorem and Stokes theorem. Calculations.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** \| **Semester Workload** |

| | |
|---|---|
| | Lectures: 65 hours<br>Projects: 45 hours<br>Individual Study: 90 hours<br>Course Total (25 hours per ECTS): 200 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Marsden J and Tromba A, Vector Calculus, Crete Un.Press. (Greek)
2. Thomas G, Finney R, Vector Calculus, Crete Un.Press. (Greek)


## ■ CC42 - Real Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC42 | **SEMESTER** | D |
| **COURSE TITLE** | REAL ANALYSIS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 7 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Infinite Calculus I | | |
| **LANGUAGE OF TEACHING** | Greek/English | | |

| | |
|---|---|
| **AND EXAMINATIONS** | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

With this course, the students will have the chance to study the theory of Real Analysis. Especially, with the successful attendance of the course, the students:

- will be able to analyze the theory of metric spaces and their topological notions,
- will be able to study sequences and continuous mappings in metric spaces,
- will understand the notions of completeness, compactness, connectedness and separability of metric spaces,
- will study main theorems of Real Analysis.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

**CONTENT OF THE COURSE**

- Basic notions of Set Theory: countable and non-countable sets, examples, the countability of the set of rational numbers and the non-countability of the set of real numbers.
- Metric spaces: notions, examples, basic properties, topological notions, equivalent metrics.
- Sequences: convergence and Cauchy sequences.
- Continuous mappings in metric spaces: pointed (local) continuous mappings, continuous mapping in the whole space, properties, homeomorphisms, isometries.
- Compete metric spaces: notion, basic properties, examples, theorems of fixed points, Cantor and Baire theorem, applications.
- Compactness: notions (through open covers), basic properties, continuous mappings and compactness, characterizations of compactness through the Bolzano-Weierstrass property and the meaning of bounded set, finite (Cartesian) product of compact metric spaces.
- Separable metric spaces.
- Connectedness: Connected subsets of metric spaces, images through continuous

mappings, characterizations of connected subsets of the set of real numbers.
- Study of the main theorems and applications that are related to Real Analysis.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Individual Study — 110 hours<br>Course Total (25 hours per ECTS) — 175 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. D. Georgiou, S. Iliadis, General Topology, Publications Tziola, 2017 (Greek).
2. M. Anousis, A. Tsolomytis, V. Felouzis, Real Analysis, Publications Symmetria, 2014 (Greek).
3. W. Rudin, Principles of Mathematical Analysis, Second version, Publications LIBERAL BOOKS, 2014 (Greek).
4. S. Negrepontis, Th.. Zachariadis, N. Kalamidas, V. Farmaki, General Topology and Function Analysis, Publications Symmetria, 1997 (Greek).


## ■ CC43 - Algebra I

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |
| **DEPARTMENT** | MATHEMATICS |
| **LEVEL OF STUDIES** | UNDERGRADUATE |

| | | | |
|---|---|---|---|
| **COURSE CODE** | CC43 | **SEMESTER** | D |
| **COURSE TITLE** | ALGEBRA I | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 8 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Fundamental Notions of Mathematics | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students:<br>• will be able to use sets and operations between sets, equivalence and order relations and functions,<br>• will understand the notion of countable sets,<br>• will understand the notions of group, subgroup, cycle group, symmetric groups and will be able to compute the order of elements,<br>• will understand the notions of the ring and field and their basic properties. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Working independently for the enhancement of their self-esteem.<br>• Creation of new research ideas.<br>• Production of free, creative and inductive thinking, which is based on mathematical processes. |

**CONTENT OF THE COURSE**

- Set, subset, powerset, operations between sets, Cartesian product, equivalence relations, equivalence classes, partitions, quotient-set, order relations, functions, the notion of countable set and the set of real numbers as a non-countable set.
- Groups, subgroups, normal subgroups, symmetric groups, cycle groups, order of an element, homomorphisms and isomorphisms, kernel and image of a homomorphism, basic theorems of isomorphism in Algebra.
- Rings and fields: notions and basic properties.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Individual Study — 135 hours<br>Course Total (25 hours per ECTS) — 200 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. John B. Fraleigh, Introduction to Algebra, University Publications Crete. (Greek)
2. Mark Antony Amstrong, Groups and Symmetry, Publications Leader Books. (Greek)
3. D. Georgiou, S. Iliadis, Set Theory, Second version, Publications Tziola, 2017. (Greek)
4. D. Stratigopoulos, Modern Algebra, Publications Symmetria, 1997. (Greek)


## ■ CC44 - Statistics I

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |
| **DEPARTMENT** | MATHEMATICS |

| | | | |
|---|---|---|---|
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC44 | **SEMESTER** | D |
| **COURSE TITLE** | STATISTICS I | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 5 | 7 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With this course, the students:

- will consolidate the basic notions of Statistics,
- will be able to process and analyze a data set,
- will be evaluate the results of a survey.

**General Competencies**

- Application of knowledge in practice
- Search for, analysis and synthesis of data and information, by use of the necessary technology.
- Decision making.

## CONTENT OF THE COURSE

Population, sample. Types of variables, frequency distribution, grouping data.
Graphs (bar charts, histograms, pie charts, stem and leaf plot, boxplot, time series

chart, variance chart).
Measures of location and dispersion, calculations from simple or grouped frequency tables.
Use of R programming language for data representation.
Sampling distributions, distribution of random variable sums, the central limit theorem and its consequences in statistics.
Point and interval estimators, unbiasedness and efficiency. Unbiased minimum variance estimators, moment and maximum likelihood methods.
Confidence intervals and hypothesis testing for one and two samples (independent or paired) for the mean value and the variance. Confidence intervals and hypothesis tests for proportions. $X^2$ test (goodness of fit, independence and homogeneity).
Simple linear regression and correlation.
Non-parametric tests (runs test, randomization test, Kolmogorov-Smirnov test, Mann-Whitney test, Wilcoxon test, McNemar test, Kruskal-Wallis test, Friedman test, median test), Spearman correlation coefficient.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Projects — 35 hours<br>Individual Study — 75 hours<br>Course Total (25 hours per ECTS) — 175 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

## RECOMMENDED BIBLIOGRAPHY


1. Kolyva-Mahera F., Mpora-Senta E., Mpratsas H., Statistics, Ziti Publications, 2018 (Greek).
2. Papaioannou T., Loukas S. B., Introduction to Statistics, Stamouli Publications, 2002 (Greek).

3. Kounias E., Kolyva-Mahera F., Mpagiatis K., Mpora-Senta E.,Introduction to Statistics, Kyriakidis bros Publications, 2016 (Greek).
4. Damianou C., Koutras M., Introduction to Statistics, Vol. I, Tsiotras Athanasios Publications, 2021 (Greek).

# 5th SEMESTER

## ■ CC51 - Algebra II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC51 | **SEMESTER** | E |
| **COURSE TITLE** | ALGEBRA II | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| | Lectures | 5 | 8 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Fundamental Notions of Mathematics<br>Algebra I | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students:<br>• will know the basic concepts of the Theory of Rings and Fields,<br>• will be able to do calculations with ideals and apply isomorphism theorems,<br>• will be able to study factorization problems in integral domains,<br>• will be able to do simple calculations about body extensions. |
| **General Competencies** |
| • Indivisual work.<br>• Promotion of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

Rings and fields, integral domains, homomorphisms-isomorphisms of rings. The body of fractions of an integral domain. Rings of polynomials. Analysis of polynomials over a field, reduced polynomials. First, maximal and main ideals. Quotient-Rings. Extensions of fields and classical geometric constructions. Major rings and rings of unique analysis. Euclidean rings.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 65 hours |
| Projects | 45 hours |
| Individual Study | 90 hours |

| | | |
|---|---|---|
| | Course Total<br>(25 hours per ECTS) | 200 hours |
| **STUDENT EVALUATION** | Written final examination 100%. | |

**RECOMMENDED BIBLIOGRAPHY**


1. Varsos Dimitrios A., Deriziotis Dimitrios I., Emmanuel Ioannis P., Maliakas Michael P. and Talelli Olympia P., An Introduction to Algebra, 3rd Edition, Sofia Publications, 2011.
2. Fraleigh John, Introduction to Algebra, ITE Publications - University Press of Crete, 2010.


## ■ CC52 - Operational Research

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC52 | **SEMESTER** | E |
| **COURSE TITLE** | OPERATIONAL RESEARCH | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| | Lectures | 4 | 7 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will be able to:<br>• recognize and model real problems as linear programming models,<br>• use the graphical method to solve linear programming problems,<br>• solve linear programming problems with Simplex method,<br>• use software to solve linear programming problems,<br>• interpret the results ensuing from linear programming problem solutions,<br>• solve special cases of problems: the transportation, transshipment and assignment problems. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking, which is based on mathematical processes. |

**CONTENT OF THE COURSE**

Linear programming problem modelling. Basic notions of Linear Programming. Graphical solution of linear programming problems in the two-dimensional space. Graphical sensitivity analysis of the linear model. Simplex algorithm. Big M method. Duality theory. Sensitivity analysis. The transportation problem. The assignment problem.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 52 hours |

| | |
|---|---|
| | Projects: 20 hours<br>Individual Study: 103 hours<br>Course Total (25 hours per ECTS): 175 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Vassiliou P. and Tsantas N., Introduction to operational research, Ziti publications, 2000 (Greek).
2. Koletsos I. and Stogiannis D., Operational Research, Symeon publications, Athens, 2021 (Greek).
3. Kounias S. and Fakinos D., Linear Programming, Ziti publications, Thessaloniki, 1999 (Greek).
4. Siskos G., Linear Programming, New Technologies Publications, Athens, 1998 (Greek).
5. Taha H., Operational research An introduction, Pearson, (10th ed), 2017.
6. Bertsimas D. and Tsitsiklis J. N., Introduction to Linear Optimization, Athena Scientific 1997.


## ■ CE51 - Numerical Linear Algebra

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE51 | **SEMESTER** | E |
| **COURSE TITLE** | NUMERICAL LINEAR ALGEBRA | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Introduction to Numerical Analysis |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, the students:

- will be able to understand the basic matrix theory,
- will know methods for solving linear systems,
- will know methods for finding eigenvalues and eigenvectors,
- will be able to choose the appropriate method taking into account the stability and speed of the algorithm, as well as the state of the system,
- will be able to apply MATLAB functions for linear algebra,
- will be able to implement the above methods with their own functions in MATLAB.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Making decisions.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Numerical Solution of Linear Systems.
Direct Methods: Elimination Method of Gauss, LU factorization, LDM, LDLT and Cholesky factorizations.
Managing sparse arrays. Solving Systems with a sparse coefficient matrix.
Iterative methods: Jacobi method, Gauss-Seidel method, SOR method.
Minimization methods for solving linear systems: Steep Descent Method, Conjugate

Slopes method.
The linear problem of least squares: System of Normal Equations, QR method.
Numerical finding of Eigenvalues and Eigenvectors: Method of Powers, inverse Powers method, QR method.
Implementation with MATLAB.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 39 hours<br>Programming Tasks in MATLAB — 13 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Programming Tasks in MATLAB 30%.<br>Written final examination 70%. |

## RECOMMENDED BIBLIOGRAPHY


1. G Papageorgiou, X. Tsitouras, Numerical Analysis with applications in MATLAB and MATHEMATICA, Symeon Publications. (Greek)
2. A. Petrakis, D. Petrakis, L. Petrakis, Numerical Analysis, THALIS Publications. (Greek)
3. G. Avdelas, Th. Simos, Arithmetic Linear Algebra Simeon Publications. (Greek)
4. G.E. Forsythe, M.A. Malcolm, C.B. Moler, Numerical Analysis and programs for mathematical calculations, University Publications of Crete. (Greek)
5. D. Higham, N. Higham, Matlab Guide, SIAM, 2000.
6. C.F. Van Loan, Introduction to Scientific Computing, A Vector, Matrix Approach, Prentice Hall.

## ■ CE52 - Number Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE52 | **SEMESTER** | E |
| **COURSE TITLE** | NUMBER THEORY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will learn the basic Number Theory and some of their subfields: the classical Number Theory, the Diofantic equations, the numerical functions and numbers modulo n.<br>In particular, they will learn to use issues of divisibility and factorization in the set of integers numbers and issues of finding integer solutions of types of Diofantic equations. Also, they will learn the theory of prime numbers.<br>With the successful attendance of the course, the students will have the basic mathematical background in Number Theory. The last will give them the tools to |

study topics of Algebra, Geometry and Analysis.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

- The notion of divisibility in the set of integers numbers, highest common factor and least common multiple, Euclidean division.
- Prime numbers, Fundamental Theorem of Arithmetic.
- Arithmetic modulo n.
- Diofantic equations.
- Numerical functions.
- Fermat and Euler Theorems.
- Polynomial and linear congruences.
- Quadratic residue, quadratic fields of numbers, solving quadratic congruences, Quadratic Reciprocity Law, symbols of Legendre and Jacobi.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Individual Study | 73 hours |
| Course Total (25 hours per ECTS) | 125 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Deriziotis D., An introduction to Number Theory, Publications Sophia, second version, 2012 (Grrek).
2. Tsagaris P. G., Number Theory, Publications Symmetria, third version, 2010 (Greek).
3. Poulakis D. M., Number Theory, Publications Ziti, 1997 (Greek).
4. Tzanakis N.K., Fundamental Number Theory, Department of Mathematics, University of Crete, 2019 (Greek).


## ■ CE53 - Propabilities II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE53 | **SEMESTER** | E |
| **COURSE TITLE** | PROPABILITIES II | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 5 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Propabilities I | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students:<br>• will be familiarized with the notion of multi-dimensional random variable,<br>• will be able to study the marginal random variables of a multi-dimensional random variable,<br>• will be able to gauge moments of multi-dimensional random variables,<br>• will be able to study conditional random variables of a multi-dimensional random variable,<br>• will be able to handle moment generating functions of multi-dimensional random variables,<br>• will be able to apply the central limit theorem. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, by use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking, which is based on mathematical processes. |

**CONTENT OF THE COURSE**

Axiomatic definition of probabilities. Definition of a random variable and a random vector. Probability distribution and density functions. Multi-dimensional random variables (discrete and continuous ones). Multi-dimensional distributions. Radon-Nikodym theorem. Useful multi-dimensional distributions. Properties of multi-dimensional random variables (multi-dimensional mean values, variance-covariance matrices etc.). Conditional probability distributions. Ordered random variables. Characteristic functions of multi-dimensional random variables. Moment and probability generating functions of multi-dimensional random variables. Applications of multi-dimensional random variables, Convergence of sequences of random variables- convergence classification. Limit Theorems (laws of large numbers, Central limit theorems etc.)

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** \| **Semester Workload** |

| | |
|---|---|
| | Lectures: 52 hours<br>Projects: 20 hours<br>Individual Study: 53 hours<br>Course Total (25 hours per ECTS): 125 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Kounias E. and Kalpazidou S., Probabilities II Theory and Exercises, Ziti Publications 1991 (Greek).
2. Charalampidis C. A., Probability theory and applications, S. Athanasopoulos Publications, 2009 (Greek).
3. Sheldon R., A first course in probability, Pearson Prentice Hall.
4. Feller W. An Introduction to Probability Theory and its applications, Vol. 1, John Wiley & Sons Inc.


## ■ CE54 - Classical Mechanics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE54 | **SEMESTER** | E |
| **COURSE TITLE** | CLASICAL MECHANICS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 5 |
| | | | |
| **COURSE TYPE** | General Knowledge | | |

| | |
|---|---|
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With the completion of the learning process, the students will be able to:

- know basic categories of mechanical systems and their fundamental principles (laws of conservation and principles of minimum action)
- analyze with systematic and documented mathematical methodologies, fundamental classes of mechanical systems,
- apply basic methods of the calculus to basic engineering problems, having acquired a valuable background in the relevant mathematical theories,
- apply modern methods based on the theory of dynamical systems, for the analysis of flows defined by systems of classical mechanics, having been introduced to basic concepts of dynamics.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Making decisions.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Newton's equation for point mass system, conservative forces, conservation laws (energy, angular momentum, linear momentum) and Galilean transformations. Elements of theory of variations. Lagrange Mechanics: Generalized positions and velocities, Lagrangian function and integral of action, D'Alembert's principle, Hamilton's principle, Euler-Lagrange equations.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS** | e-Lectures.<br>Use of e-class. |

| | |
|---|---|
| **TECHNOLOGY** | Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 42 hours<br>Individual Study — 31 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-Exam 20%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Modern Theoretical Mechanics, K. Tsiganos, Stamouli Publications. (Greek)
2. Classical Mechanics, S. Pnevmatikos, Scientific and Technological Publications A.G. Pnevmatikos. (Greek)
3. Theoretical Mechanics, Petros Ioannou, Theoharis Apostolatos, University of Athens Property Development and Management Company. (Greek)


## ■ CE55 - Computer Programming with C

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE55 | **SEMESTER** | E |
| **COURSE TITLE** | COMPUTER PROGRAMMING WITH C | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** | |

| | | | |
|---|---|---|---|
| | Lectures | 4 | 5 |
| | | | |
| **COURSE TYPE** | Skills Development | | |
| **PREREQUISITE COURSES** | Introduction to Programming | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| The course aims to familiarize the students with the basic concepts of computer programming with the C language. Upon successful completion of the course, the student will be able to:<br>• understand the basic structure of a program with C,<br>• understand the concept of variables and different categories of data types,<br>• become familiar with the properties and value ranges of different types of variables,<br>• create new, complex data types,<br>• become familiar with the selection structures and their variations,<br>• become familiar with repetition structures and their variations,<br>• understand the concept of functions, their gradient and their implementation (as sub-programs),<br>• become familiar with how to pass parameters to functions, and output values from functions via return value and parameters,<br>• know how to declare and use pointers to each type of data (ready or complex),<br>• understand the concept of stack and heap,<br>• create statically declared and dynamic arrays, by committing memory on the stack and on the heap, respectively,<br>• pass arrays to functions, either for input or output,<br>• use appropriate repetition structures and functions to solve basic mathematical problems,<br>• apply C programming in practice to solve complex problems,<br>• know introductory concepts of programming in C++,<br>• collaborate, where appropriate, with fellow students to create and present simple applications that demonstrate the concepts of each module. |

**General Competencies**

- Indivisual work.
- Team work.
- Project Planning and Management.
- Exercise criticism and self-criticism.

**CONTENT OF THE COURSE**

The course introduces the fundamental concepts of computer programming with the C language. An industrial-scale compiler and development environment (IDE) are used to familiarize the students with professional tools. Basic concepts of basic variables, their types, capabilities and usage are covered. Furthermore, the creation of complex programmer-defined types is described in detail. Also, all selection and repetition structures are studied, with characteristic examples of conversion between them (depending on the category and the requirements). Memory management, both static and dynamic, is discussed in detail, along with pointers, dynamically allocating and freeing memory on/from the heap, and using it as one-dimensional or multi-dimensional, dynamically mutable arrays. Functions, input and output of values to/from them, and demonstration of them in common math problems are presented. These are applied to mathematical algorithms of various objects, such as e.g. numerical analysis, geometry, etc.

More specifically, the content of the course covers the following:

Section 1: The basic structure of a program in C. Introduction to the development environment of Visual Studio 2019. Introduction to the concept of variables of various types and classes. Limits and capabilities of ready-made data types. Operations with variables.

Section 2: Creating new, complex data types. Accessing the variable fields of complex types. Location of fields and/or sub-fields in memory.

Section 3: Selection structures (if and switch), as well as a comparison between them. Extensive examples of their use.

Section 4: Repetition structures (for, while, do-while), as well as a comparison between them. A summary description of them, with the aim of making the best choice for the student, depending on each case. Convert between them, as well as referencing the basic iteration loop.

Section 5: Introduction to functions, using their parameters for input and output, and the optional return value.

Section 6: Static (stack) and dynamic memory (heap). Pointer declaration, dynamic memory allocation for ready or complex types.

Section 7: Statically and dynamically declared 1, 2, 3, 4 and 5 dimensional arrays. Passing arrays to functions for input and output.

Section 8: Use appropriate recurrence structures and functions to solve various basic mathematical problems. Practical application of C programming to solve complex problems.

Section 9: Demonstration of the use of the material of the previous sections in iterative methods (Conjugate Gradient and Jacobi-Accelerated Preconditioned

Conjugate Gradient) of solving large-scale numerical systems. Solving integrals with the trapezium method, matrix operations, problems limited by memory or processor. Accurate timing of the above. Examples of parallel code in math problems.
Section 10: Introduction to basic concepts of object oriented programming with C++.
Section 11: Standard functions.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 18 hours<br>Individual Study — 55 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Written final exam (100%) in the Greek language, which includes:<br>- Short answer questions<br>- Problem solving<br>- Optional exercises and tasks, individual or group<br>- Comparative assessment of theory.<br>During the semester, the students are given individual assignments or group exercises and assignments, as well as a larger optional group assignment covering several subject areas simultaneously. |

## RECOMMENDED BIBLIOGRAPHY


1. Cheng H. (2012) C for scientists and engineers. 1st Edition. Tziola Publications. (Greek)
2. Tan H and D' Orazio T. (2000) C for engineers. 1st Edition. Tziola

Publications.(Greek)
3. Tselikis GS and Tselikas ND. (2016) C: From theory to practice. 3rd Edition. Publisher: Tselikis Georgios.(Greek)
4. Hanly Jeri R. and Koffman Elliot B. (2021) Principles and Techniques of Programming with the C Language. 1st Edition. Kritiki Publications S.A. (Greek)
5. Hatzigiannakis NM. (2017) The C language in depth. 5th Edition. Kleidaritmos S.A. Publications.(Greek)
6. Paul Deitel, Harvey Deitel. (2014) A Programmer's Guide to C. 1st Edition. Ch Giourda & Co Publications S.A. (Greek)
7. Abbey Deitel, Harvey Deitel. (2014) C Programming. 7th Edition. Ch Giourda & Co Publications SA. (Greek)
8. Karolidis Dimitrios A. (2021) Learn C easily. 2nd Edition. Pinelopi Xarhakou Publications. (Greek)

## ■ CE56 - Fourier Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE56 | **SEMESTER** | E |
| **COURSE TITLE** | FOURIER ANALYSIS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 5 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students will be able to:<br>• know the measure and the Lebesgue integral,<br>• have understood trigonometric polynomials,<br>• recognize Fourier series and apply the convergence criteria of their partial sums,<br>• solve Sturm-Liouville problems using integral calculus,<br>• know the integral transforms (Laplace and Fourier) and use them in solving differential and integral equations. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Adapting to new situations, making decisions.<br>• Work in a team.<br>• Promotion of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

Calculus of variations: Euler's differential equation. Problems of variations in conditions. Hamilton's principle. Lagrange's equations. Sturm-Liouville problems. Rayleigh-Ritz method. Laplace transformation: Properties- Inverse transformation- Applications to ordinary differential equations- Applications to partial differential equations. Fourier analysis: Orthogonal functions-Fourier series-Fourier integrals. Fourier transformation-Applications to partial differential equations. Bessel's functions-Legendre's functions. Integral Equations: Connection to Differential Equations.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | | |
|---|---|---|
| **TEACHING METHOD** | In the classroom. | |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. | |
| **TEACHING ORGANIZATION** | **Activity** | **Semester Workload** |

| | |
|---|---|
| | Lectures: 52 hours<br>Individual Study: 73 hours<br>Course Total (25 hours per ECTS): 125 hours |
| **STUDENT EVALUATION** | Progress-exam (calculation of indefinite and definite integrals) 30%<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**

1. FOURIER ANALYSIS, Kolountzakis M., Papachristodoulos X., Kallipos. (Greek)
2. APPLIED MATHEMATICS, Mylonas N., Hatzarakis G. Tziola Publications. (Greek)

## ■ CE57 - Topology

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE57 | **SEMESTER** | E |
| **COURSE TITLE** | TOPOLOGY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Real Analysis |

| | |
|---|---|
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

With the successful attendance of the course, the students:

- will understand basic notions of General Topology such as the notions of topological space, subspace, base and subbase,
- will define topologies on a set,
- will recognize various sets of a topological space like the open, closed, dense and nowhere dense sets,
- will categorize the topological spaces under the view of separation axioms,
- will be able to use mappings between topological spaces like the continuous mappings, the open and closed mappings and the homeomorphisms,
- will understand the meaning of the Moore-Smith convergence and the necessity to generalize the notion of sequence in topological spaces,
- will understand the product of topological spaces,
- will understand the notions of compactness, local compactness and compactification,
- will understand the notions of connectedness, local connectedness and path connectedness,
- will understand the importance of Topology through its applications in various branches of Mathematics.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

**CONTENT OF THE COURSE**

Metric spaces: Notion of metric space, examples of metric spaces, basic notions of metric spaces such as open and closed sets, closure, interior and boundary of a set.
Topological spaces: Notion of topology and examples of topological spaces,basic notions of topological spaces like open and closed sets, closure, interior, boundary,

subspace, base and subbase of topology.
Separation axioms: $T_0$-space, $T_1$-space, $T_2$-space (or Hausdorff space), regular spaces, completely regular spaces, normal spaces.
Mappings and Moore-Smoth sequences: Continuous mappings, homeomorphisms, open and closed mappings, examples of mappings between topological spaces, Moore-Smith sequences.
Product of topological spaces: Product of finite and infinite family of topological spaces, properties of the product of topological spaces.
Compact topological spaces: The meaning of the compact topological space, examples of compact topological spaces, continuous mappings and compact topological spaces, local compact topological spaces, compactification.
Connected topological spaces: The meaning of the connected topological space, examples of connected topological spaces, continuous mappings and connected topological spaces, connected components, local connected topological spaces, path connected topological spaces.
Applications of Topology in branches of Mathematics.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class,.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. D. Georgiou, S. Iliadis, General Topology, Publications Tziola, 2017 (Greek).
2. S. Negrepontis, Th.. Zachariadis, N. Kalamidas, V. Farmaki, General Topology and Function Analysis, Publications Symmetria, 1997 (Greek).

## ■ CE58 - Discrete Mathematics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE58 | **SEMESTER** | E |
| **COURSE TITLE** | DISCRETE MATHEMATICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students will be able to:<br>• compose mathematical arguments using mathematical logic,<br>• use evidential procedures, such as that of mathematical induction,<br>• apply combinatorial analysis to solve enumeration problems,<br>• know the concept of graphs and use them in simplifying and solving complex problems. |
| **General Competencies** |

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Adapting to new situations, making decisions.
- Work in a team.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Sets and operations.
Propositional Logic and equivalences.
Proof methods (mathematical induction) and proof strategy.
Complexity of algorithms.
Relations and properties. Equivalence relation and classes, partial ordering relation.
Presentation of relations.
Integers and division. Elements of number theory.
Enumeration. Combinations, permutations.
Graphs and terminology. Graph representation. Subgraphs and isomorphisms. Coherence. Trees. Binary graphs. Matching in bipartite graphs. Maximum matches. Euler and Hamiltonian paths and circuits.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Progress-exam (calculation of indefinite and definite integrals) 30%<br>Written final examination 70%. |

## RECOMMENDED BIBLIOGRAPHY

1. DISCRETE MATHEMATICS & Their Applications., Kenneth H. Rosen, Tziola

Publications. (Greek)
2. DISCRETE MATHEMATICS & Their Applications, Susana S. Epp, Publications Kleidarithmos. (Greek)
3. DISCRETE MATHEMATICS, Kolountzakis M., Papachristodoulos C., Kallipos. (Greek)

## ■ CE59 - Partial Differential Equations

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE59 | **SEMESTER** | E |
| **COURSE TITLE** | PARTIAL DIFFERENTIAL EQUATIONS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Infinite Calculus II-III-IV<br>Ordinary Differential Equations |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the successful completion of the course, the student will be able to: |

- understand the concept of a partial differential equation, its difference compared to an ordinary differential equation both in the form of its solutions and its solution techniques,
- understand concepts such as initial conditions-boundary conditions,
- recognize the type of a partial differential equation and be able, in any case, to apply specific techniques for solving differential equations with partial first and second order derivatives in initial and boundary value problems,
- be able to examine the form of the solutions by drawing conclusions about the model under consideration and trying to apply knowledge from theoretical mathematics.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Adapting to new situations.
- Working in an interdisciplinary environment.
- Indivisual work.
- Team work.
- Creation of new research ideas.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

POE of first order, linear and almost-linear equations, Cauchy's problem, Monge cones-characteristic strips, Solving linear POE of α order with the method of transformations, total differential equations, Charpit method. Classification of second-order differential equations, normal forms, D' Alembert-type wave equation, propagation of discontinuities, wave reflections, separation of variables method, wave equation, diffusion equation, Laplace equation, initial and boundary value problems of Dirichlet, Neumann, Robin types, Fourier series, orthogonal functions, Sturm-Liouville eigenvalue problems, generalized functions or distributions, finding fundamental solutions with Fourier and Laplace transforms.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lecture.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** \| **Semester Workload** |

| | |
|---|---|
| | <table><tr><td>Lectures</td><td>40 hours</td></tr><tr><td>Teaching Exercises</td><td>20 hours</td></tr><tr><td>Solving Selected Exercises</td><td>25 hours</td></tr><tr><td>Individual Study</td><td>40 hours</td></tr><tr><td>Course Total (25 hours per ECTS)</td><td>125 hours</td></tr></table> |
| **STUDENT EVALUATION** | Written final examination 100% whcich includes:<br>- Theory<br>- Solving Exercises<br>- Applications to Mathematical Physics. |

**RECOMMENDED BIBLIOGRAPHY**


1. Partial Differential Equations, Trachanas S. (Greek)
2. Partial Differential Equations, Akrivis G., Alikakos N. (Greek)
3. Partial Differential Equations, Skoutaris N. (Greek)
4. Partial Differential Equations, Vol. A, Tsoumpelis D. (Greek)
5. Partial Differential Equations, Volume 1, Kyventidis Th. (Greek)
6. Walter A. Strauss, Partial Differential Equations: An Introduction, 2nd edition, Wiley, 2008.
7. Fritz John, Partial Differential Equations, 4th edition, Springer, 1982.
8. Stanley J. Farlow, Partial Differential Equations for Scientists and Engineers, 2nd edition, Dover Pub. Inc., 1993.
9. J. David Logan, Applied Partial Differential Equations, 2nd edition, Springer, 2000.
10. Paul W. Berg and James. L. McGregor, Elementary Partial Differential Equations, Holden-Day, 1980.
11. Lawrence C. Evans, Partial Differential Equations, 2nd edition, AMS, 2010.
12. Gerald B. Folland, Introduction to Partial Differential Equations, 2nd edition, Princeton University Press, 1995.

# 6th SEMESTER

## ■ CC61 - Complex Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC61 | **SEMESTER** | F |
| **COURSE TITLE** | COMPLEX ANALYSIS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 5 | 8 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | Real Analysis | | |
| **LANGUAGE OF TEACHING** | Greek/English | | |

| | |
|---|---|
| **AND EXAMINATIONS** | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With this course, the students:

- will be familiar with the fundamental notions of topology for the complex plane,
- will be able to understand the definition of the branches of the logarithmic function at the complex plane,
- will be able to calculate by definition the complex derivative of basic functions, as well as use the Cauchy-Riemann conditions,
- will be able to calculate simple complex integrals with both the definition and the Cauchy integral formula,
- will be able to use the theorems of Liouville and analytic continuation expansion, as well as the maximum/minimum principles, to solve exercises,
- will be able to classify specific points of complex functions and calculate Taylor or Laurent expansions at these points,
- will be able to use the theorem of integral balances to calculate complex integrals, but also real integrals of a specific form.

**General Competencies**

- Individual work.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Complex plane and operations with complex numbers. N-th root, definition of exponential function and branches of logarithm. Topology of the complex plane (open, closed, coherent and simply coherent sets, sequences, series).
Continuous and uniform functions. Complex integration: definition, Cauchy's theorem for triangles, Cauchy's formula for simple closed curves. Taylor expansion, calculus of integrals. Liouville theorem, maximum/minimum principles. Cauchy's formula on a ring. Laurent development. Theorem of integral balances, calculation of curves and real integrals.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |

| | |
|---|---|
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 65 hours<br>Projects — 45 hours<br>Individual Study — 90 hours<br>Course Total (25 hours per ECTS) — 200 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Negrepontis S, Theory of Functions of a Complex Variable, Symmetria Press (Greek).
2. Merkourakis S and Chatziafratis T, Introduction to Complex Analysis, Symmetria Press (Greek).
3. Marsden J, Hoffman M, Basic Complex Analysis, Symmetria Press (Greek).


## ■ CC62 - Differential Geometry I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CC62 | **SEMESTER** | F |
| **COURSE TITLE** | DIFFERENTIAL GEOMETRY I | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** | |

| | | | |
|---|---|---|---|
| | Lectures | 4 | 7 |
| | | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Linear Algebra I-II<br>Infinite Calculus III-IV |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon successful completion of the course, the students will be able to:

- find the Frenet trihedron of a curve in space with parameterization along an arc and calculate its curvature and torsion,
- check if a surface is regular and find the tangent plane of a regular surface,
- calculate the first and second fundamental form and the various curvatures of a surface,
- formulate and understand the meaning of Gauss' Theorema Egregium.

**General Competencies**

- Individual work.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Curves in the plane and in space: tangent of a normal curve, arc length-physical parameter, accompanying Frenet trihedron, curvature and torsion, fundamental theorem of curves, the isoperimetric inequality.
Normal Surfaces: Complex Function Theorem and normal surfaces, tangent plane, first and second fundamental form, Gauss mapping, shape operator, vertical and mean curvature, principal curvatures, Gauss curvature, the “Marvelous” Theorem (Theorema Egregium).

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |

| | |
|---|---|
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 50 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 175 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Barett O'Neil, Elementary Differential Geometry, Crete Un. Press (Greek).
2. Pressley A, Elementary Differential Geometry, Crete Un. Press (Greek).
3. Arvanitogeorgos A, Elementary Differential Geometry, e-book, Kallipos Repository (Greek).


## ■ CE61 - Numerical Solving of Differential Equations I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE61 | **SEMESTER** | F |
| **COURSE TITLE** | NUMERICAL SOLVING OF DIFFERENTIAL EQUATIONS I | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Introduction to Numerical Analysis |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| With the successful completion of the course, the students will be able to:<br>• know methods of solving simple step differential equations,<br>• know multi-step methods for solving differential equations,<br>• implement the above methods with their own functions in MATLAB. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Making decisions.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

Numerical Solving of Differential Equations.
Introduction to the numerical solving of differential equations, the Euler, Heun, Numerov methods.
Single step methods. Runge-Kutta, Runge-Kutta-Nystrom methods.
Class conditions, method construction.
Adams-Multon Multistep Methods, Adams Bashforth.
Implementation with MATLAB.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION** | Software MATLAB. |

| | |
|---|---|
| **AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Programming Tasks in MATLAB — 31 hours<br>Individual Study — 42 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Programming tasks in MATLAB 30%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**

1. M.N. Vrachatis, Numerical Solution of Differential Equations, Greek Letters Publications. (Greek)

## ■ CE62 - Stochastic Processes

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE62 | **SEMESTER** | F |
| **COURSE TITLE** | STOCHASTIC PROCESSES | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With this course, the students:

- will be familiarized with the concept of stochastic processes,
- will be able to recognize basic stochastic models,
- will be able to model real problems by use of stochastic processes,
- will be able to study the asymptotic behaviour of a Markov process.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Introduction to Stochastic Processes, discrete-time Markov Chains, Chapman-Kolmogorov equations. Classification of states. Description of the evolution of a Markov Chain. Hitting time. Distributions of sojourn time. Asymptotic results, stationary distribution. Continuous-time Markov Chains. Poisson process and generalizations. Introduction to Queuing Theory.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |

| | |
|---|---|
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 26 hours<br>Individual Study — 47 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Vassiliou P.-C., Stochastic Methods in Operations research, Publications Ziti, 2000 (Greek).
2. Fakinos D., Stochastic models in Operations research: Theory and applications, Symmetria, 2007 (Greek).
3. Daras T. and Sypsas P., Stochastic processes, Theory and applications, Publications Ziti, 2003 (Greek).
4. Loulakis M., Stochastic processes, Hellenic Academic EBooks-"Kallipos" repository, 2016 (Greek).


## ■ CE63 - Data Bases

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE63 | **SEMESTER** | F |
| **COURSE TITLE** | DATA BASES | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** | |

| | | | |
|---|---|---|---|
| | Lectures | 4 | 5 |
| | | | |
| **COURSE TYPE** | Skills Development | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

## LEARNING OUTCOMES

**Learning Outcomes**

The purpose of the course is to introduce students to relational databases, emphasizing how to design and implement databases using the SQL relational language.
Upon successful completion of the course, the students should:

- get to know the basic concepts and terms of DBMS, the relational data model and how to design them by applying the principles of the entity-relationship model,
- understand the capabilities and advantages of relational databases,
- design efficient and functional N.D. systems,
- implement simple database applications with SQL.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Introduction to the basic concepts of data storage and management using DBMS (Data Base Management Systems).
Comparison of Relational Data Storage Model with traditional file organization.
Refer to database models.
Introduction to relational database systems.
Design relational databases applying the principles of the entity-relationship model.
The SQL relational language.
Relational algebra.

## TEACHING AND LEARNING METHODS - EVALUATION

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Power point presentations of theory.<br>Online self-assessment exercises.<br>Learning process support through the moodle online platform.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>26 hours</td></tr>
<tr><td>Exercises</td><td>13 hours</td></tr>
<tr><td>Laboratory Exercises</td><td>26 hours</td></tr>
<tr><td>Semester Project</td><td>7 hours</td></tr>
<tr><td>Individual Study</td><td>53 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>125 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Written final exam (50%) and examination of the laboratory exercises (50%).<br>The written final exam includes:<br>-multiple choice questions,<br>-solving problems of applying the acquired knowledge,<br>-comparative evaluation of theory elements.<br>The examination of the laboratory exercises includes:<br>-the evaluation of the student's written laboratory reports,<br>-the assessment of laboratory skills acquired through an examination in which laboratory equipment is used.</td></tr>
</table>

## RECOMMENDED BIBLIOGRAPHY


1. Database Systems, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, X. GKIOURDA & Co EE. (Greek)
2. Fundamentals of Database Systems, Elmasri Ramez, Navathe Shamkant B.
3. INTRODUCTION TO DATABASE SYSTEMS, VOLUME A DATE C. J., Kleidaritmos Publications.

4. Database System Concepts, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill Science/Engineering/Math Publishing.

## ■ CE64 - Data Structures

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE64 | **SEMESTER** | F |
| **COURSE TITLE** | DATA STRUCTURES | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| When the student successfully completes the course he will be able to:<br>• describe the Data Structures (D.D.) that he/she uses,<br>• assess the possibilities (advantages-limitations) of a specific D.D.,<br>• examine the respective problem in relation to the available D.D.,<br>• plan the appropriate D.D. in each case, |

- create-implement the selected D.D. in C programming language,
- compare and evaluate the performance of D.D.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Adapting to new situations.
- Making decisions.
- Independent work.
- Team work.
- Criticism and self-criticism.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Introduction to Data Structures Necessity-Usefulness.
The table structure. Evaluation of the array structure.
The structure of the Stack (Static and dynamic).
The structure of the Queue (Static and dynamic).
The structure of the Priority List and Queue.
The Linked List structure single & double.
The structure of the Tree. Binary Search Tree.
The structure of the red-black Tree. 2-3-4 Tree.
The structure of the Hash Table.
The Heap structure.
The structure of the Scripture.
The classification algorithms.
Recap and compare structures.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom and lab. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Learning process support through the Moodle electronic platform.<br>Laboratory training. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 39 hours |
| Individual Study | 60 hours |
| Laboratory Exercise | 26 hours |

| | |
|---|---|
| | Course Total (25 hours per ECTS) \| 125 hours |
| **STUDENT EVALUATION** | For the successful examination of the course, the student must be successfully examined independently in both parts of the course, theory and laboratory.<br>The evaluation in the theoretical part results from:<br>1. 35% the performance in individual assignments-online tests with multiple choice questions through the course page will be graded,<br>2. 65% of the final exams of the course with a comparative evaluation of theory elements.<br>The assessment in the laboratory part results in:<br>1. active participation during the student's presence and work in the laboratory by 30%,<br>2. his/her final exam by 70%.<br>The overall grade of the course is the weighted average of 60% the grade of the theoretical part and 40% of the laboratory. |

**RECOMMENDED BIBLIOGRAPHY**


1. Data Structures & Algorithms in Java, Lafore Robert EDITIONS CH. GKIOURDA & Co EE. (Greek)
2. Data structures, algorithms and C++ applications, Sahnii Sartaj PUBLICATIONS A. TZIOLA & SONS S.A. (Greek)
3. DATA STRUCTURES, GEORGAKOPOULOS G.F. TECHNOLOGY & RESEARCH INSTITUTE PUBLICATIONS - UNIVERSITY PUBLICATIONS OF CRETE. (Greek)
4. Data structures & file organizations Ch. Koilias Publications of New Technologies. (Greek)
5. Data structures, Bozanis Panagiotis D. EDITIONS A. TZIOLA & SONS S.A. (Greek)


## ■ CE65 - Computational Statistics

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |
| **DEPARTMENT** | MATHEMATICS |
| **LEVEL OF STUDIES** | UNDERGRADUATE |

| | | | |
|---|---|---|---|
| **COURSE CODE** | CE65 | **SEMESTER** | F |
| **COURSE TITLE** | COMPUTATIONAL STATISTICS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 5 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

**Learning Outcomes**

The purpose of the course is the familiarity of the students with the use of statistical software and introduced in the principles of Computational Statistics.
With this course, the students will be able to:

- apply the most common methods of computational statistics,
- use R programming language and SPSS statistical package for the above reason,
- generate random numbers from both discrete and continuous distributions.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

**CONTENT OF THE COURSE**

R language is used. Introduction to R software environment. Variables-data. Data

base connections. Programming with R language. Descriptive Statistics. Graphical Methods for data presentation. Hypothesis testing by use of R. Simulations. Generations of random numbers from discrete and continuous probability distributions. Monte Carlo integration. Visualization of classical results of statistical inference through simulating samples (e.g. asymptotic normality of sample mean, (1-α)100% CI, significance and p-value of a statistical test).

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 20 hours<br>Individual Study — 53 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Ntzoufras I., Karlis D., Introduction to programming and statistical analysis with R, Hellenic Academi EBooks-"Kallipos" repository, 2015 (Greek). Available at: http://hdl.handle.net/11419/2601
2. Fouskakis D., Data analysis by use of R, Tsotras publications, 2013 (Greek).
3. Tsantas N., Moysiadis P. Mpagiatis K., Xantzipantelis T., Data analysis with the help of statistical software, Ziti publications, 1999 (Greek).


## ■ CE66 - Astronomy I

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |

| | | | |
|---|---|---|---|
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE66 | **SEMESTER** | F |
| **COURSE TITLE** | ASTRONOMY I | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

With the successful completion of the course the students will be able to:

- know the basic tools, physical quantities as well as standard magnitude classes of astronomy,
- know the radiation mechanism of celestrial bodies,
- understand the basic physics of the Sun,
- know the stellar structure, evolution and fate of stars,
- know basic concepts of astronomy such as the movements of the Earth, spherical trigonometry, time, calendars, etc.
- study problems of Celestial Mechanics such as: Newtonian force fields, problem of two, three and N bodies,
- know how the Lagrange-Hamilton theory is applied to the problems of Celestial Mechanics.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Basic concepts of Astronomy. Movements of the Earth-planets. Astronomical coordinate systems, Stellar magnitudes and distances. Elements of Spherical Trigonometry. Time (counting and calendars). Solar system. Kepler's Laws, N-body Problems in Dynamical Astronomy and especially in Celestial Mechanics. Problems of Dynamical Astronomy. Final stages: white dwarfs, neutron stars and black holes. Overview of the Sun. Solar system. Variable and idiosyncratic stars. Star groups and clusters. Interstellar matter. Our galaxy. The other galaxies. Cosmology.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 42 hours |
| Individual Study | 31 hours |
| Course Total (25 hours per ECTS) | 125 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-exam 20%.<br>Written final examination 70%. |

## RECOMMENDED BIBLIOGRAPHY

1. The universe that I loved, S. Theodosiou, Em. Danezis, Diavlos Publications. (Greek)

2. Introduction to modern astronomy, Ch. Varvoglis, I. Seiradakis, Agis-Savvas Gartaganis Publications. (Greek)
3. Astrophysics, Volumes I and II, F. Shu, Foundation for Technology and Research University Press of Crete. (Greek)

## ■ CE67 - Measure Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE67 | **SEMESTER** | F |
| **COURSE TITLE** | MEASURE THEORY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Infinite Calculus I-II-III-IV<br>Real Analysis |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the successful attendance of the course the students: |

- will be familiar with the notion of measure and its basic properties,
- will be able to characterize basic sets as measurable or non measurable,
- will be familiar with the notion of measurable function,
- will understand the Lebesgue integral and will be able to compute it through a direct integration or the Riemann integral,
- will learn the basic properties of the spaces $L_p$.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

- Algebra and σ-Algebra, measure (definition, properties, completion).
- Outer measures, Lebesgue measure, measurable and non measurable sets, Lebesgue measure and transformations, the Cantor set.
- Measurable functions and operations between them.
- Integral functions, Luzin Theorem, criteria of integration, comparison with Riemann integral.
- Spaces with measures. Tonelli and Fubini Theorems.
- Riesz Representation Theorem.
- Spaces $L_p$, (definition and properties).

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Individual Study | 73 hours |
| Course Total (25 hours per ECTS) | 125 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Measure Theory, Koumoullis G. Negrepontis S., Publications Symmetria, 2005 (Greek).
2. Real Analysis, Xenikakis P., Publications Ziti, 1996 (Greek).


## ■ CE68 - Galois Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE68 | **SEMESTER** | F |
| **COURSE TITLE** | GALOIS THEORY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Algebra I<br>Algebra II |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will understand the theory of the rings of polynomials and their ideals. They will be able to use irreducible polynomials. They will understand the theory of fields, their extensions and the algebraic approach of geometric constructions. They will understand the Galois group, the Fundamental Theorem of Galois Theory, the solvable groups, the field of roots of polynomials and will study the solving of equations using radicals. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Working independently for the enhancement of their self-esteem.<br>• Creation of new research ideas.<br>• Production of free, creative and inductive thinking, which is based on mathematical processes. |

**CONTENT OF THE COURSE**

Rings, ideals, rings of polynomials, irreducible polynomials, Lemma of Gauss, criteria of irreducible polynomials. Fields, extensions of fields, simple extensions, algebraic and transcendental extensions, constructions using ruler and compasses. Galois group, field of roots of polynomials, finite extensions and isomorphisms, Fundamental Theorem of Galois Theory. Cyclotomic polynomials, solvable groups, solving equations with radicals, regular polygons, Fundamental Theorem of Algebra.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class,.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 52 hours |

| | | |
|---|---|---|
| | Individual Study | 73 hours |
| | Course Total (25 hours per ECTS) | 125 hours |
| **STUDENT EVALUATION** | Written final examination 100%. | |

**RECOMMENDED BIBLIOGRAPHY**


1. John B. Fraleigh, Introduction to Algebra, University Publications Crete (Greek).
2. Rotman J., Galois Theory, Publications Leader Books, 2000 (Greek).
3. Andreadakis S., Galois Theory, Publications Symmetria, 1999 (Greek).


## ■ CE69 - Combinational and Graph Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE69 | **SEMESTER** | F |
| **COURSE TITLE** | COMBINATIONAL AND GRAPH THEORY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 5 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

Upon successful completion of the course, the students will be able to:

- use special methods of Enumeration, Distribution, Divisions and Divisions,
- use the properties of Graphs and Random Graphs to represent complex systems.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Indivisual work.
- Production of free, creative and inductive thinking.
- Work in an interdisciplinary environment.

**CONTENT OF THE COURSE**

ENUMERATION TECHNIQUES: Fundamental Principle of Enumeration, Permutations-Arrangements-Combinations, Binomial coefficients, Principle of Inclusion Exclusion, Perturbations, Principle of Pigeon or Dirichlet, Principle of Reflection, Movement in Networks, Lexicographic method of recording permutations.
SPECIAL SUBJECTS OF ENUMERATION: Pascal's triangle and Fibonacci numbers, Diophant equations and Partitions, Sorting problems (balls in cells, Stirling, Bell, Catalan numbers), Generating Functions.
GRAPHS: Basic Concepts (order, magnitude, connectivity, direction, neighbors, walk, path, circle, complement, bipartite, operations, degree, geodesic, distance, diameter, radius), Properties-Characteristic Tables (Theorems about degrees, isomorphism, connection tables, correspondences, gramogram), Subgraphs, paths, trees, factors, intersections, bridges, Theorems of Kirchoff, Dirac, Menger, Special Graphs (Planes, Euler, Hamilton, n-cubes, Gray codes, Ramsey numbers ), Colorings (basic theorems, coloring polynomials, coloring algorithms).
INTRODUCTION TO RANDOM GRAPHS: Erdös-Rényi Networks (degree distribution, mean degree, the giant component, mean distance, clustering index, transitivity), Introduction to small world and scale free networks, Introduction to Real Networks, Centrality Indices (Degree, Eigencentricity, Intermediacy, Proximity), Examples using the R language (Collaboration networks, social, financial, online etc.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


-Suggested Bibliography:

1. Mousiadis Pol. (2001): Applied Combinatorial. The art of counting without counting, Ed. ZITI, Thessaloniki. (Greek)
2. Charalambidis, Ch (1990). Combined issues 1 and 2, University of Athens. (Greek)

- Additional Bibliography for study:

1. Béla Bollobás (2002). Modern Graph Theory. Springer.
2. West B.D. (2002). Introduction to Graph Theory.
3. Bondy J.A., Murty U.S.S.R. (2008). Graph Theory. Springer.
4. Diestel R. (2005). Graph Theory. Springer, NY.
5. Maarten van Steen (2010). Graph Theory and Complex Networks An Introduction. Maarten van Steen.

# Free Elective Course (Institutional Course Catalog)

## ■ II-F-09 Topics of Numerical Analysis

(Department of Informatics-University of Western Macedonia)

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | II-F-09 | **SEMESTER** | F |
| **COURSE TITLE** | TOPICS OF NUMERICAL ANALYSIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |

| | |
|---|---|
| **PREREQUISITE COURSES** | Infinite Calculus I-II<br>Linear Algebra I-II<br>Computer Programming with C |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

The course is a continuation of the course Introduction to Numerical Analysis of the third semester.
The implementation of numerical methods is done in MATLAB where students learn to use MATLAB functions. They also write their own functions to implement the methods developed in the theoretical part. The students are also taught Mathematica. Finally, the students deal with a variety of problems modeled with differential equations, such as oscillations, Kepler's two-body problem, the pendulum, solving the one-dimensional Schrodinger equation, mathematical biology, and Lotka-Voltera models.
Upon successful completion of the course, the students will have acquired a very good knowledge of numerical methods for solving problems that appear in sciences such as Celestial Mechanics, Quantum Mechanics, Mathematical Biology, etc.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Solving linear systems.
Direct methods. LU matrix factorization. Special factorizations of LDM, LDLT. Band factorization of diagonal matrices.
Iterative methods. Jacobi, Gauss, SOR methods.
Finding matrix eigenvalues.
Representation and manipulation of sparse matrices in MATLAB. Special functions.
The algebraic eigenvalue problem.
Managing sparse arrays.

## TEACHING AND LEARNING METHODS - EVALUATION

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Software Matlab and Mathematica.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>26 hours</td></tr>
<tr><td>Implementation of numerical methods in MATLAB</td><td>26 hours</td></tr>
<tr><td>Projects</td><td>26 hours</td></tr>
<tr><td>Individual Study</td><td>72 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Programming tasks in MATLAB 50%.<br>Written final examination 50%.</td></tr>
</table>

## RECOMMENDED BIBLIOGRAPHY


- Suggested Bibliography:

1. Famelis Ioannis Th. (2021). Computational Mathematics. KRITIKI Publications S.A. (Greek)
2. Sifaleras Angelos, Stefanidis Georgios (2021). Linear Algebra with MATLAB and SageMath (2nd ed.). A. Tziola & Sons Publications S.A. (Greek)
3. Golub Gene H., Van Loan, Charles F. (ed. Emiris G.) (2015). Register Theory and Calculations. PEDIO Publications S.A. (Greek)
4. Moller Cleve B. (2010). Numerical Methods with MATLAB. Kleidarithms Publications Ltd. (Greek)
5. Vrachatis Michael N. (2012). Numerical Analysis: Ordinary Differential Equations. Kleidarithms Publications Ltd. (Greek)

- Additional Bibliography:

1. Papageorgiou G.S., Tsitouras H.G., Famelis I.T. (2008). Modern Mathematical

Software Matlab & Mathematica. Symeon Publications. (Greek)
2. Higham Desmond J., Higham Nickolas J. (2016). Matlab Guide (3rd ed.). Society of Industrial and Applied Mathematics. Philadelphia, PA, USA.
3. Shampine L.F., Gladwell I., Thompson S. (2003). Solving ODEs with MATLAB. Cambridge University Press, UK.
4. Dormand J.R. (1996). Numerical Methods for Differential Equations: A computational approach. CRC Press LLC.
5. Butcher J. (2008). Numerical Methods for Ordinary Differential Equations. Wiley & Sons Publications, USA.
6. Golub Gene H., Van Loan (2013). Matrix Computations. The John Hopkins University Press, USA.

## 7th SEMESTER

### ■ CE71 - Mathematical Physics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE71 | **SEMESTER** | G |
| **COURSE TITLE** | MATHEMATICAL PHYSICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |

| | |
|---|---|
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| The students who successfully complete this course will be able to:<br>• understand basic mathematical theories and tools that are used in the study of differential equations in various branches of physics,<br>• know modern-day techniques of symbolic computation to analytical approaches of physical problems,<br>• handle problems with new data (various physical states, boundary conditions, etc.),<br>• synthesize or find solution methods in new physical applications. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

Basic introductory concepts in programming with symbolic programming languages. Basic operations and commands, functions, integrals, lists, diagrams. Introduction to Complex Analysis. Vector Spaces, Hilbert Spaces, Operators, Integral Transformations. Special Functions of Mathematics and Physics (Gamma function, Theta function, Zeta function). Differential Equations and their solution with a computer. Non-homogeneous Differential Equations. Green's method. Applications in Physics.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software Mathematica.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions |

| | |
|---|---|
| | and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 25 hours<br>Individual Study — 73 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-exam 20%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Vergados J., Mathematical Methods of Physics, Vol. I, Crete University Press, 2004. (Greek)
2. Chow T., Mathematical Methods for Physicists: A concise introduction, Kleidarithmos Publications, 2018. (Greek)
3. Mathematical Methods of Physics, Volume A, Complex Functions, Fourier Analysis, S. Masen, M. Grypaios, Charalambos Publications Nik. Aivazis. (Greek)


## ■ CE72 - Numerical Solving of Differential Equations II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE72 | **SEMESTER** | G |
| **COURSE TITLE** | NUMERICAL SOLVING OF DIFFERENTIAL EQUATIONS II | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** | |

| | | |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Numerical Solving of Differential Equations I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

After successful completion of the course, the students will have acquired a very good knowledge in the subject of numerical solving of differential equations. They will have known the current trends in research in this subject.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Numerical Solving of Differential Equations.
Single step methods. Runge-Kutta, Runge-Kutta-Nystrom, Partitioned Runge-Kutta methods. Butcher's theory: class conditions. trees, construction methods. Stability of methods.
Methods for solving problems with specific properties of the solution: exponentially and trigonometrically fitted methods, methods with minimum phase lag, with minimum magnification error.
Two-step hybrid methods, second derivative methods.
Implementation with MATLAB.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |

| | |
|---|---|
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 39 hours<br>Programming Tasks in MATLAB — 31 hours<br>Individual Study — 80 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Programming tasks in MATLAB 30%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**

1. M.N. Vrachatis, Numerical Solution of Differential Equations, Greek Letters Publications. (Greek)

## ■ CE73 - Mathematical Programming

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE73 | **SEMESTER** | G |
| **COURSE TITLE** | MATHEMATICAL PROGRAMMING | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** | |

| | | | |
|---|---|---|---|
| | Lectures | 4 | 6 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

## LEARNING OUTCOMES

**Learning Outcomes**

With this course, the students:

- will be able to solve integer linear programming problems,
- will be able to find the main idea of dynamic programming,
- will be able to solve classical optimization problems by use of dynamic programming,
- will be able to consolidate the notion of stochasticity in optimization and decision problems.

**General Competencies**

- Search for, analysis and synthesis of data and information, by use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Integer linear programming, integer programming problem modelling, integer programming algorithms, dynamic programming, deterministic path problems, equipment replacement, stochastic path problems, stochastic equipment replacement problems, the knapsack problem, the travelling salesperson problem.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |

| | |
|---|---|
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 26 hours<br>Individual Study — 72 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Vassiliou P.-C. G., Applied Mathematical Programming, Ziti Publications, 2001 (Greek).
2. Taha H., Operations research An introduction, Pearson, (10th ed), 2017.
3. Ypsilantis P. Operations research: Methods and techniques in decision making, Propompos publications, (5th ed), 2015 (Greek).


## ■ CE74 - Symbolic Programming Languages

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE64 | **SEMESTER** | F |
| **COURSE TITLE** | SYMBOLIC PROGRAMMING LANGUAGE | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING** | **ECTS** | |

| | HOURS | |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | Introduction to Programming |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With the successful completion of the course, the students:

- will have acquired the knowledge of basic concepts of informatics,
- will have become familiar with the use of computational algebra systems such as Mathematica to solve mathematical problems in all areas of mathematics,
- will be able to design problem-solving algorithms,
- will be able to present mathematical concepts to students in a more demonstrative way,
- will have acquired necessary teaching skills for teaching computer science in high school.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

The course is included in the section of Special Teaching of Mathematic courses. An introduction to the use of informatics concepts suitable for presentations to junior high school students. Required laboratory course of a large number of compulsory courses. Introduction to systems of symbolic mathematical manipulations. The Mathematica language. Representation of symbolic mathematical expressions. Numerical calculations. Symbolic calculations. Symbolic manipulation of

mathematical expressions. Basic functions. List and list manipulation. Functions, program flow control structures. Programming. Introduction to using additional packages. Create new packages. Study and didactic approach to the understanding of special topics from the areas of Algebra (expansion-factorization of expressions, simplification-transformation of expressions into equivalent simpler forms, tables, sets), Analysis (exact and numerical solutions of equations and systems of algebraic equations, differentiation, Taylor series, limits, integration, series) and Geometry (second order curves and surfaces, static and moving graphs). Use of other symbolic languages such as Maple, Reduce, Macsyma, Matlab. Comparison.

## TEACHING AND LEARNING METHODS - EVALUATION

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>52 hours</td></tr>
<tr><td>Individual Study</td><td>98 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Programming tasks 30%.<br>Written final examination 70%.</td></tr>
</table>

## RECOMMENDED BIBLIOGRAPHY


1. Karampetakis Nikolaos, Stamatakis Stylianos, Psomopoulos Evangelos, 2004, Mathematics and Programming in Mathematica, Ziti Publications. (Greek)
2. Papadakis Konstantinos E., 2010, Introduction to Mathematica, Tziola Publications. (Greek)
3. Stefanos Trahanas, 2004, Mathematica and applications, University Press of Crete. (Greek)
4. N. Glynou, Introduction to symbolic calculations with Mathematica, Ioannina 2002. (Greek)

5. S. Trachanas, 2001, Mathematica and Applications: For Mathematicians, Physicists and Engineers, University Press of Crete. (Greek)
6. John W. Gray, 1997, Mastering Mathematica: Programming methods and applications, Academic Press.
7. R.J. Gaylord, S.N. Kamin and P.R. Wellin, 1993, Introduction to Programming with Mathematica, Springer-Verlag.
8. Roman Maeder, 1991, Programming in Mathematica, Addison-Wesley Publishing Co., Second Edition.

## ■ CE75 - Statistical Data Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE75 | **SEMESTER** | G |
| **COURSE TITLE** | STATISTICAL DATA ANALYSIS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 6 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |

| COURSE WEBSITE (URL) | http://eclass.uowm.gr/ |
|---|---|

## LEARNING OUTCOMES

| Learning Outcomes |
|---|
| Upon completion of the course the student will be able to:<br>• enter data into the computer,<br>• conduct descriptive statistical analysis, i.e. to summarize the available data,<br>• conduct basic data analyzes (outlier testing, normality, basic hypothesis testing with dependent and independent samples, one-factor analysis of variance),<br>• adapt linear models, mainly simple regression, checking whether or not the assumptions of their application are violated,<br>• present the results of the above analyzes (reference report). |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Indivisual work.<br>• Production of free, creative and inductive thinking.<br>• Work in an interdisciplinary environment. |

## CONTENT OF THE COURSE

In this course, the statistical theory developed in "Statistics I" is applied, with the help of the computer and the use of the statistical program SPSS. More specifically, it is applied to hypothesis testing concerning the mean value of a population, the mean values of two populations with dependent and independent samples, simple and multiple linear regression, as well as analysis of variance by one factor.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Individual Study | 73 hours |
| Solving exercises- | 25 hours |

| | | |
|---|---|---|
| | Projects | |
| | Course Total (25 hours per ECTS) | 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. | |

**RECOMMENDED BIBLIOGRAPHY**

- Suggested Bibliography:
  1. Exploring Statistics Using IBM SPSS, Andy Field.
  2. A GUIDE TO DATA ANALYSIS WITH IBM SPSS 19, MARIJA J. NORUSIS.

- Additional bibliography for study:
  1. Carver and Nash (2006). Doing data analysis with SPSS version 18.0 Coakes and Steed (1999).SPSS: Analysis Without Anguish.

## ■ CE76 - Set Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE76 | **SEMESTER** | G |
| **COURSE TITLE** | SET THEORY | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| | Lectures | 4 | 5 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |

| | |
|---|---|
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With a successful attendance of the course, the students:

- will understand basic notions of Set Theory such as the notions of set, subset, powerset and operations between sets,
- will understand equivalence relations, order relations and functions between sets,
- will understand the Axiomatic Foundation of Set Theory, paying attention to the axioms of Zermelo-Fraenkel and the Axiom of Choice,
- will understand the foundation of the sets of natural numbers, integers numbers and rational numbers and also the notions of basic operations between these numbers,
- will understand the construction of the set of real numbers as Dedekinds cuts and through Cauchy sequences of rational numbers and also the notions of basic operations between these numbers,
- will understand the notion of countable set and properties of countable sets,
- will understand the notion of cardinal number, basic operations between them and their order,
- will understand the basic theory of ordinal types and ordinal numbers, studying operations between them and their order,
- will understand important subsets of the set of real numbers like the Cantor set, Borel sets and Baire sets,
- will understand the importance of Set theory through its applications in various branches of Mathematics.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

- Set, subset, powerset, operations between sets, like union and intersection,

properties of these operations.

- Equivalence relations, equivalence classes, order relations, functions.
- Axiomatic Foundation of Set Theory by Zermelo-Fraenkel.
- Foundation of natural, integers and rational numbers, operations between these numbers, the order relation on the sets of natural, integers and rational numbers.
- Study of the set of real numbers through Dedekind cuts and Cauchy sequences of rational numbers, operations between these numbers, order relation on the set of real numbers.
- Countable and non-countable sets.
- Cardinal numbers, Cantor-Berstein theorem, operations between cardinal numbers, order between cardinal numbers, the continuum hypothesis.
- Ordinal types and ordinal numbers, operations between ordinal types and ordinal numbers, order between them.
- Important subsets of the set of real numbers, like the Cantor set, Borel sets and Baire sets.
- Applications of Set Theory in branches of Mathematics.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class,.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. D. Georgiou, S. Iliadis, Set Theory, Publications Tziola, 2017 (Greek).
2. K. Kalfa, Axiomatic Set Theory, Publications Ziti, 1990 (Greek).


## ■ CE77 - Differential Geometry II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE77 | **SEMESTER** | G |
| **COURSE TITLE** | DIFFERENTIAL GEOMETRY II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Infinite Calculus I-IV<br>Linear Algebra I-II<br>Differential Geometry I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students:<br>• will be able to define maps on a differentiable surface and check whether a representation is differentiable,<br>• will be able to calculate the reciprocal derivative of a vector field,<br>• will be able to calculate the geodesic curves of simple surfaces,<br>• will be familiar with basic surfaces of constant curvature. |
| **General Competencies** |

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Indivisual work.
- Production of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

Maps, local coordinate systems and manifold atlases. Basic examples.
Differentiable mappings between manifolds, differential mapping.
Vector fields, parallel transport, reciprocal derivative.
Function of length, geodesic curves, definition and examples.
Gauss-Bonnet theorem.
Surfaces of constant curvature.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Elementary Differential Geometry, Barrett O'Neil, University Press of Crete, 2005. (Greek)
2. Elementary Differential Geometry, A Pressley, University Press of Crete, 2011. (Greek)
3. Elementary Differential Geometry, A. Arvanitogeorgos, Association of Greek Academic Libraries, 2015. (Greek)

## ■ CE78 - Function Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE78 | **SEMESTER** | G |
| **COURSE TITLE** | FUNCTION ANALYSIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Topology |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With a successful attendance of the course, the students:<br>• will understand the basic properties of the norm,<br>• will understand the meaning of the completeness,<br>• will learn for the classical (mainly, sequential) Banach spaces and their basic properties,<br>• will recognize the form of the inner product on Hilbert spaces,<br>• will learn the meaning of the bounded linear operators,<br>• will understand the meaning of the binary space and apply related techniques,<br>• will formulate problems from other fields of Mathematics using the “environment” |

of Function Analysis,
- will argue rigorously in contexts more abstract than those of Basic Analysis.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Adapting to new circumstances
- Working in an interdisciplinary environment.
- Working independently for the enhancement of their self-esteem.
- Team Working.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

## CONTENT OF THE COURSE

Spaces with norm. Basic topological notions (continuity of norm, open and closed sets, closure and interior, density of subspaces, separability, convergence of sequences), paying attention on interaction with linear structure. Completeness. Banach spaces and basic properties (completeness of closed subspaces, characterization trough series). Examples of non complete spaces with norm. Banach spaces (spaces of summable, convergent and bounded sequences, spaces of continuous functions) and basic properties (for example, separability and dense subspaces). Characterization of spaces with norm of finite dimension. Equivalence of norms. Riesz Lemma. Bounded and linear operators. Isomorphisms and isometries. Norm of operator. The space of bounded operators as a Banach space. Extension of bounded operators defined on dense subspace. Bounded linear functionals. The binary space as a Banach space. Comparison with the algebraic binary space. Comparison with the space of finite dimension.

Spaces with inner product. The notion of orthogonality. Rectangular complements. Hilbert spaces. Bounded and linear functionals on Hilbert spaces. The Riesz Representation Theorem. Orthonormal bases. Orthonormalization. Bessel inequality. Parseval identity. Abstract Fourier coefficients. The universality of the space $\ell 2(A)$. Hahn-Banach Theorem and some applications (determination of the norm of an element through functionals, separability of a space with separable binary, embedding on the second binary). Theorem of open mapping. Theorem of closed graph and Principle of uniform bound with some applications (pointwise convergence of sequences of bounded operators, inverse mapping theorem, equivalence of norms in Banach spaces).

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION** | Use of e-class. |

| | |
|---|---|
| **AND COMMUNICATIONS TECHNOLOGY** | Communication through e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 40 hours<br>Lectures of auxiliary exercises — 20 hours<br>Solving of selected exercises — 40 hours<br>Individual Study — 50 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination (theory and exercises) 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. S. Negrepontis, Th.. Zachariadis, N. Kalamidas, V. Farmaki, General Topology and Function Analysis, Publications Symmetria, 1997 (Greek).
2. E. Kreyszig. *I*ntroductory Functional Analysis. Wiley, 1989.
3. G. F. Simmons. Introduction to Topology and Modern Analysis. Krieger Publishing Company, 2003.


## ■ CE79 - Artificial Intelligence

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE79 | **SEMESTER** | G |
| **COURSE TITLE** | ARTIFICIAL INTELLIGENCE | | |

| INDEPENDENT TEACHING ACTIVITIES | WEEKLY TEACHING HOURS | ECTS |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

Upon completion of the course the student will be able to:

- know the basic structures of search algorithms,
- develop basic programming schemes of intelligent agents,
- use knowledge representation methods with propositional and categorical logic, as well as with recursive rules,
- use neural networks and evolutionary intelligence algorithms,
- know the characteristics of an expert system.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Indivisual work.
- Promotion of free, creative and inductive thinking.
- Problem solving.
- Generating new research ideas.

## CONTENT OF THE COURSE

Basic concepts. Historical data. Representation of problems. Algorithms (blind and directed) search. Knowledge, knowledge representation (logic, structured rules). Alternative reasoning (with uncertainty, with ambiguity). Knowledge systems. Action planning. Autonomous programs (agents) and distributed informatic systems.

Non-symbolic logic (genetic algorithms, neural networks). Applications (natural language processing, machine vision, robotics).

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 73 hours<br>Soving exercises-Projects — 25 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Vlachavas I., Kefalas P., Vasiliadis N., Kokkoras F., Sakellariou H., Artificial Intelligence. (Greek)
2. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach. (Greek)


## ■ CE710 - Special Math Subjects I

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE710 | **SEMESTER** | G |

| COURSE TITLE | SPECIAL MATH SUBJECTS I | |
|---|---|---|
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | 4 | 6 |
| | | |
| **COURSE TYPE** | Scientific Field<br>Skills Development | |
| **PREREQUISITE COURSES** | - | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, students:<br>• will have delved into a subject,<br>• will have become familiar with specific scientific problems,<br>• will have gained experience in how to write a scientific paper. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

The subject of the course is the knowledge of the supervisor who undertakes to guide a student or a group of students in the preparation of an assignment. The aim is to familiarize the student with specific scientific problems and to gain experience in how to write a scientific paper.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | Face-to-Face. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Indivisual Study / 150 hours<br>Course Total (25 hours per ECTS) / 150 hours |
| **STUDENT EVALUATION** | Project 100%. |

**RECOMMENDED BIBLIOGRAPHY**

The bibliography is determined by the supervisor.

## ■ CE711 - Theory of automata and formal languages

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE711 | **SEMESTER** | G |
| **COURSE TITLE** | THEORY OF AUTOMATA AND FORMAL LANGUAGES | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |

| | |
|---|---|
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

- Introductory Concepts: Automata, Computability, Complexity, Concepts, Definitions, Theorems, Proofs and Types of Proofs.
- Abstract Machines and Languages: Introduction, the Elementary Machine (EM). Finite State Machines (FSM). Finite Automaton (FA), Causative Finite Automaton (CFA), Non-Acausative Finite Automaton (NAFA), Acceptance Trees (AT), Finite Automata with e-Transitions (FAWET), Equivalence of NAFA and FAWET, Minimization of a CFA, Repeatability Theorem,
- Finite Automata and Grammars, Chomsky Hierarchy Grammars, Regular Sets (RS), Regular Sets and Finite Automata, Finding the Regular Expression of a FA, Capabilities and Deficiencies of FAs.
- Stacked Finite Automata (SFA), Non-Acausal Finite Stacked Automata (NAFSA), Causative Finite Stacked Automata (CFSA), Acceptance with Empty Layer, Equivalence of SAF and Context-Independent Languages.
- Turing Machines (TM), Introduction, Mathematical Description, Useful Tricks for TM Construction, TM Modifications, TM as a Process.
- Unsolvability, the Church-Turing Theorem, Universal TM, the Termination Problem. Computational Complexity, NP-completeness.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Familiarity with:

- Abstract Machines and Languages: Introduction, Elementary Machine (EM), Finite State Machines (FSM). Finite Automaton (FA), Causative Finite Automaton (CFA), Non-Acausative Finite Automaton (NAFA), Acceptance Trees (AT), Finite Automata with e-Transitions (FAWET), Equivalence of NAFA and FAWET,

Minimization of a CFA, Repeatability Theorem,

- Finite Automata and Grammars, Chomsky Hierarchy Grammars, Regular Sets (RS), Regular Sets and Finite Automata, Finding the Regular Expression of a FA, Capabilities and Deficiencies of FAs,
- Stacked Finite Automata (SFA), Non-Acausative Stacked Finite Automata (NASFA), Causative Stacked Finite Automaton (CSFA), Acceptance with Empty Layer, Equivalence of SFA and Context-Independent Languages,
- Turing Machines (TM), Introduction, Mathematical Description, Useful Tricks for Constructing TM, Modifications of TM, TM as a Process,
- unsolvability, the Church-Turing Theorem, Universal TM, the Termination Problem. Computational Complexity, NP-completeness.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**

1. Elements of computation theory, Lewis Harry R., Papadimitriou Christos Ch. (Greek)
2. INTRODUCTION TO THE THEORY OF COMPUTATION, SIPSER MICHAEL.

## ■ CE712 - Econometrics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE712 | **SEMESTER** | G |
| **COURSE TITLE** | ECONOMETRICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

**Learning Outcomes**

With the successful completion of the course, the students will acquire knowledge and skills that will enable them to:

- design and estimate a linear regression model,
- use an econometric software package (e.g. E-views) in the application of econometric techniques,
- evaluate econometric models and their results,
- evaluate results of diagnostic tests.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.

- Decision making.
- Criticism exercise.
- Production of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

Econometrics as a subject is based on the sciences of Economics, Statistics and Mathematics. Its purpose is the measurement and empirical control of economic relationships. The course aims to familiarize students with the use of econometric techniques to estimate economic models using econometric software packages (eg E-Views).

Suggested course material:

- Introduction to econometrics.
- Single equation regression models.
  - Bi-variate regression model: Basic ideas, model estimation, the method of least squares (OLS), coefficient of determination.
  - Classical normal linear regression model (CNLRM).
  - Bi-variate regression: interval estimation and hypothesis testing.
  - Extensions of the Bi-variate Linear Regression Model.
  - Multiple regression analysis: The problem of estimation, The problem of induction.
  - The use of dummy variables.
- Violation of assumptions of the classical model and residual diagnostic tests.
  - Normality.
  - Multicollinearity.
  - Heteroscattering.
  - Autocorrelation.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | PowerPoint presentations.<br>Learning process support through the e-class electronic platform.<br>Communication via e-mail and course discussion group.<br>Use of econometric software (eg E-views). |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Individual Study | 98 hours |

| | |
|---|---|
| | Course Total (25 hours per ECTS) \| 150 hours |
| **STUDENT EVALUATION** | 1. Written final exam (50%) which includes:<br>1.1. Multiple choice questions.<br>1.2.Evaluation of theory elements.<br>1.3. Solving Exercises.<br>2. Group Laboratory work (50%)<br><br>Remarks:<br>The evaluation process and evaluation criteria will be posted on the course website in the e-class. |

**RECOMMENDED BIBLIOGRAPHY**

-Suggested Bibliography:


1. Gujarati D., (2012), Econometrics, Principles and Applications, A. TZIOLA & SONS PUBLICATIONS S.A. (Greek)
2. Dritsaki, Ch., and Dritsaki, M., (2013), Introduction to econometrics using EViews software, Publications KLEIDARITHMOS Ltd. (Greek)
3. Wooldridge J., (2011) Introduction to econometrics, A. PAPAZISIS PUBLICATIONS SOLE PRIVATE EQUITY COMPANY. (Greek)


-Indicative list of related scientific journals:

1. Econometrica
2. Journal of Econometrics
3. Econometric Reviews
4. Quantitative Finance
5. Journal of Empirical Finance
6. Econometrics Journal
7. Journal of Applied Econometrics
8. Advances in Econometrics
9. Journal of Time Series Econometrics
10. Econometrics (MDPI)
11. Foundations and Trends in Econometrics
12. International Journal of Computational Economics and Econometrics
13. Applied Financial Economics

## ■ CE713 - Introduction to Macroeconomic Theory

**GENERAL**

| | |
|---|---|
| **SCHOOL** | EXACT SCIENCES |

| | | | |
|---|---|---|---|
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE713 | **SEMESTER** | G |
| **COURSE TITLE** | INTRODUCTION TO MACROECONOMIC THEORY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| Course aim: understanding the functioning of a closed (no trade with other countries) economy. The main macroeconomic parameters are examined and the basic operating model of a closed economy is presented.<br>Aim: The tools of basic analytical techniques are given to students in order to function effectively as active participants in the ever-changing world in which we live. Economics is a way of thinking about solving problems, not a set of ready-made answers ready to be taken off the shelf. Therefore, the main objective of the course is to help students develop systematic, critical and independent thinking of today's macroeconomic problems. |
| **General Competencies** |
| Understanding and deepening the functioning of the closed economy and exercising economic policy. |

## CONTENT OF THE COURSE

- Basic concepts of macroeconomics. The aims and means of macroeconomics.
- Measurement of economic activity: gross domestic product, real and nominal GDP, price indices and inflation.
- Consumption, income, and saving. The consumption and saving functions, the marginal propensity to consume and save. The determinants of investment. The demand function for investment.
- The basic model of the income multiplier. The determination of output, with saving and investment, determination of output from consumption and investment, analysis of the income multiplier model. Fiscal policy, in the multiplier model. How government fiscal policies affect output and the fiscal policy multiplier.
- Money and interest.
- The operation of the central bank.
- The total offer.
- Inflation and unemployment.
- Macroeconomic policies.

## TEACHING AND LEARNING METHODS - EVALUATION

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>52 hours</td></tr>
<tr><td>Individual Study</td><td>98 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Optional Midterm assessment which receives 30% of the grade.<br>Written final exam including multiple choice questions.</td></tr>
</table>

## RECOMMENDED BIBLIOGRAPHY

1. Papadogonas Th., (2019), Introduction to Macroeconomic Analysis and Policy,

Athens: Tsotras. (Greek)
2. Katseli Louka T., Magoula Chara M., (2005), Macroeconomic analysis and the Greek economy, Athens: Dardanos. (Greek)

## ■ CE714 - Astronomy II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE714 | **SEMESTER** | G |
| **COURSE TITLE** | ASTRONOMY II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | Astronomy I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course the students will be able to know:<br>• the basic principles governing astronomical observations and the operating principles of telescopes (optical, infrared, ultraviolet, X-rays, radio), |

- the sources of astronomical information and observable quantities,
- the effect of the Earth's atmosphere on observations (absorption and disturbance) as well as the ways to deal with them,
- the methods of spectroscopic analysis of radiation and the relevant instruments (spectrographs, filters, etc.),
- the polarization of radiation,
- the detection of particles (neutrinos, cosmic rays, particles in interplanetary space) and gravitational radiation,
- the physical processes that shape the phenomena in our own and other galaxies as well as the study of the evolution of the large-scale structures of the universe and the universe as a whole,
- galaxy clusters and superclusters.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

Part A: Astronomical observation, Effect of atmosphere, Telescopes (Optical, Radio, Infrared, X-ray), Radiation detection methods, Charge transport systems, CCD camera, Spectral analysis of radiation, Polarization of radiation, Cosmic radiation.
Part B: Star Clusters and Stellar Evolution, Dynamical Evolution of Star Clusters, Galaxy Clusters-Large Structures, Variable Stars, Binary Star Systems, Interstellar Matter, Matter Infall and Active Galaxies.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 42 hours |
| Individual Study | 56 hours |

| | | |
|---|---|---|
| | Course Total<br>(25 hours per ECTS) | 150 hours |
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-Exam 20%.<br>Written final examination 70%. | |

**RECOMMENDED BIBLIOGRAPHY**


1. Galactic and Extragalactic Astrophysics, N. Alexandros, K. Alyssandrakis, Greek Academic Electronic Books and Aids.
2. Observational Astrophysics, K. Alyssandrakis, Greek Academic Electronic Books and Aids.
3. Astrophysics II course notes, A. Mastichiadis, M. Kontizas. (Greek)
4. Observational Astronomy, S. Avgoloupis, I. Seiradakis, D. Tsampouras Publications & Co. OE. (Greek)

# 8th SEMESTER

## ■ CE81 - Mathematical Modelling

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE81 | **SEMESTER** | H |
| **COURSE TITLE** | MATHEMATICAL MODELLING | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 4 | 6 |
| | | | |
| **COURSE TYPE** | Scientific Field | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |

| COURSE WEBSITE (URL) | http://eclass.uowm.gr/ |
|---|---|

## LEARNING OUTCOMES

| Learning Outcomes |
|---|
| Upon successful completion of the course, the students will be able to:<br>• know the basic stages for the construction of mathematical models,<br>• know the meaning and importance of fundamental laws, such as the principle of conservation of mass, energy, etc., as well as the variables that appear in them,<br>• use the fundamental laws for the production of simple mathematical models which will describe simple physical problems, e.g. one-dimensional flow in a cylindrical section, and other similar problems from chemistry, biology, etc.,<br>• know the concept of the functional, and the concept of the minimum for it, i.e. introductory concepts of calculus of variations,<br>• define a functional and produce simple academic models such as Laplace equation,<br>• distinguish the various common academic problems that they encounter, e.g., P.O.E. first, second order, if they describe transport, diffusion, wave effects, etc.,<br>• know the basic steps for building mathematical models. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Indivisual work and also team work in an interdisciplinary environment<br>• Making decisions.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

Introductory concepts, what is the mathematical model.
Iterative concepts and theorems of Infinite Calculus, eg, parametrization of particle motion, divergence theorem, concept of tensor.
Description in Euler and Lagrange coordinates.
Conservation laws in one dimension.
Conservation of mass, energy momentum.
Derivation of a quantity in a passage that varies with time.
Conservation laws in many dimensions, and with discontinuities.
Use of laws and production of simple mathematical models, examples.
What is functional, its derivatives, finding minima in simple-special cases,
Examples of mathematical models with the process of finding minima for functors.

## TEACHING AND LEARNING METHODS - EVALUATION

| TEACHING METHOD | In the classroom. |
|---|---|
| USE OF INFORMATION | Graphics and video software for representing natural |

<table>
<tr><td>AND COMMUNICATIONS TECHNOLOGY</td><td>phenomena.<br>e-Lectues.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>52 hours</td></tr>
<tr><td>Exercises, study and search for results in bibliography</td><td>35 hours</td></tr>
<tr><td>Individual Study</td><td>63 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Projects, problem solving with a related search in the bibliography 30%.<br>Written final examination 70%.</td></tr>
</table>

**RECOMMENDED BIBLIOGRAPHY**


1. Mathematical Modelling-A Study in the Natural Sciences, Stavros Komineas, Evangelos Charmandaris, Publisher: Association of Greek Academic Libraries.
2. A Primer on Mathematical Modeling, Alfio Quarteroni, Paola Gervasio Springer, freeLink.
3. Applied Mathematical Modeling of Engineering Problems, Natali Hritonenko, Yuri Yatsenko.
4. Applied mathematics, Logan David, Translation: Dougalis V., Mitsoudis D., Stratis I., Univ. Publications of Crete. (Greek)
5. Applied Numerical Methods with MATLAB for Engineers and Scientists, S. Chapra, (Awaiting Translation by G. Sisias, publications Tziola AE.). (Greek)
6. A. B. Taylor, Mathematical Models in Applied Mechanics, Oxford University Press (1984).
7. G. K. Batchelor, An Introduction to Fluid Dynamics (Cambridge University Press, Cambridge, 2000).
8. N. D. Fowkes J. J. Mahoney, An Introduction to Mathematical Modelling, John Wiley (1990).
9. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical Methods for Physics and Engineering (3rd edition, Cambridge University Press, 2006).
10. Mathematical Modeling, Christof Eck, Harald Garcke, Peter Knabner, Springer, 2017.

## ■ CE82 - Queuing Systems

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE82 | **SEMESTER** | H |
| **COURSE TITLE** | QUEUING SYSTEMS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will be able to:<br>• use Markov processes in queuing system modeling,<br>• apply Little's results,<br>• recognize and apply basic queuing system models,<br>• employ queuing system models for optimal decision making. |
| **General Competencies** |

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Application of knowledge in practice.
- Decision making.
- Production of free, creative and inductive thinking for optimal decision making.

**CONTENT OF THE COURSE**

Description of queuing systems, basic notions and general results. Simple Markov systems. M/M/1 system: System states, waiting time, busy periods, departure process. Other Markov Systems: M/M/m/k, M/M/∞/∞, Erlang systems, bulk queues. M/G/1 system: system states, waiting time, busy period. Applications for optimal decision making.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions via e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 52 hours |
| Projects | 26 hours |
| Individual Study | 72 hours |
| Course Total (25 hours per ECTS) | 150 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Fakinos D., Stochastic Models in Operations Research: Theory and Applications, Symmetria, 2007 (Greek).
2. Hillier F. S. & Lieberman G. J. Introduction to operations research (7th ed.). McGraw-Hill, 2001.
3. Stafylopatis A.-G. Performance analysis of computational systems, Hellenic

Academic Ebooks- “Kallipos” repository, 2016 (Greek).
4. Fakinos D., Queuing systems, Symmetria, 2008 (Greek).

## ■ CE83 - Statistics II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE83 | **SEMESTER** | H |
| **COURSE TITLE** | STATISTICS II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Statistics I |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will be able to:<br>• study theoretical and applied statistical problems,<br>• handle several Statistical Functions for parameter estimation,<br>• delve into the theoretical background of hypothesis testing, |

- apply the fundamental Naymann-Pearson lemma for the configuration of hypothesis tests,
- consolidate the theoretical framework on which all statistical methodologies and techniques are established.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Application of knowledge in practice.
- Decision making.

**CONTENT OF THE COURSE**

Estimation: Unbiased, efficient and consistent estimators. Exponential distribution family. Search for minimum variance estimators with Rao-Blackwell and Cramer-Rao methods. Estimation methods (maximum likelihood, moment method, Minimax and Bayes). Confidence Interval parameter estimates. Hypothesis testing: The fundamental Naymann-Pearson lemma. Simple and complex hypothesis testing, generalized likelihood ratio test.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions via e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 26 hours |
| Individual Study | 72 hours |
| Course Total (25 hours per ECTS) | 150 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Projects 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**

1. Iliopoulos G., Basic Methods of Parameter Estimation, Ath. Stamoulis Publications, 2006 (Greek).
2. Kourouklis S., Parametric statistical inference issues, Hellenic Academic EBooks- "Kallipos" repository, 2016 (Greek).
3. Papaioanou T. and Ferentinos K., Mathematical Statistics, Ath. Stamoulis Publications, 2000 (Greek).
4. Kolyva-Mahera F., Mathematical Statistics-Estimation, Ziti publications, 1998 (in Greek).
5. Kolyva-Mahera F. and Hatzopoulos S., Mathematical Statistics-Estimation, Hellenic Academic EBooks- "Kallipos" repository, 2016 (in Greek).
6. Rao, C. R. (2008). Linear Statistical Inference and its Applications, 2nd edition. Wiley Series on Probability and Statistics.
7. Rice, J. A.(1994). Mathematical Statistics and Data Analysis, 2nd edition. Duxbury Press.
8. Roussas, G. (2003). An Introduction to Probability and Statistical Inference. Academic Press. An imprint of Elsevier Science.

## ■ CE84 - Mathematical Logic

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE84 | **SEMESTER** | H |
| **COURSE TITLE** | MATHEMATICAL LOGIC | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Set Theory |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

With the successful attendance of the course the students:

- will learn the basic language of Propositional Calculus like propositions and connections,
- will be able to check the truth values of a proposition, the tautology/contradiction and the equivalence of propositions,
- will learn the regular forms,
- will study proofs in the view of typical systems,
- will understand basic theorems of Compactness, Validity and Completeness in Propositional Logic,
- will learn the meaning of Boole Algebra and its applications,
- will be able to use the language of Categorical Logic,
- will understand basic theorems of Compactness, Validity and Completeness in Categorical Logic.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Working independently for the enhancement of their self-esteem.
- Creation of new research ideas.
- Production of free, creative and inductive thinking, which is based on mathematical processes.

**CONTENT OF THE COURSE**

- The language of Propositional Logic, the truth values of propositions, corresponding truth-matrices, tautologies, contradictions, logic equivalence of propositions.
- Adequacy of logic connections, regular forms.
- Systems of typical proofs.
- Logic circuits, Algebra Boole.
- The language of Categorical Logic.
- The theorems of Compactness, Validity and Completeness in Categorical Logic.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |

| | |
|---|---|
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Margaris A. I., Introduction to Mathematical Logic, Publications Tziola, 2017 (Greek).
2. Tzouvaras Ath., Elements of Mathematical Logic, Publications Ziti, 1998 (Greek).
3. Georgiou D., Iliadis S., Set Theory, second edition, Publications Tziola, 2017 (Greek).
4. Cornelia Kalfa, Axiomatic Set Theory, Zetis Publications, 1990.
5. Enderton Herbert B., A Mathematical introduction to Logic, University Publications Crete, 2013 (Greek).


## ■ CE85 - Operation Theory

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE85 | **SEMESTER** | H |
| **COURSE TITLE** | OPERATION THEORY | | |
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING** | **ECTS** | |

| | HOURS | |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Function Analysis<br>Topology |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

**Learning Outcomes**

Upon successful completion of the course, the student will be able to:

- understand the concept of bounded and unbounded operator a space with norm and the concept of operator norm,
- prove that an operator is bounded and compute or estimate its norm,
- know various categories of operators in Hilbert spaces (autoconjugate, positive, projections, etc.) through examples and theoretical characterizations of an algebraic and geometric nature,
- distinguish between the different categories of operators, either in general or in specific areas,
- know the relationships between projections (perpendicularity, arrangement, commutativeness, pointwise convergence of sequences) and be able to use them in solving problems,
- know the concept of the operator of finite order and the compact operator and the relationship between these categories as well as their various characterizations,
- understand the Spectral Theorem for compact normal operators in Hilbert spaces and the diagonalization of such operators, as well as the general form (polar representation) of compact operators in Hilbert spaces,
- apply the spectral theory of compact operators to problem solving.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary

technologies.
- Adapting to new situations.
- Working in an interdisciplinary environment.
- Independent work.
- Team work.
- Generation of new research ideas.
- Promotion of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

Euclidean spaces, inner products in infinite-dimensional spaces. Completeness, Hilbert spaces, basic properties, Closed operators, Examples, the conjugate operator, classes of operators, projections. Operators of finite order, compact operators, integral operators, diagonalization of operators, the spectral theorem for compact normal operators, Applications.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 40 hours |
| Teaching of exercises | 20 hours |
| Solving of selected exercises | 40 hours |
| Individual Study | 50 hours |
| Course Total (25 hours per ECTS) | 150 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Written final examination (100%) which includes:<br>-Theory,<br>-Exercises. |

**RECOMMENDED BIBLIOGRAPHY**


1. Karanasios S., Theory of Operators & Applications, Publications Tsotras, 2nd ed., 2017. (Greek)
2. Katavolos A., Introduction to Operator Theory, Publications Symmetry, 2008. (Greek)
3. Ifantis E.K., Theory of Operators, Publications Stamoulis, 2004. (Greek)
4. Gohberg I., Goldberg S., Basic Operator Theory, Birkhäuser, 2001.
5. Kehe Zhu, Operator theory in Function Spaces, American Mathematical Society, 2nd edition, 2007.
6. Y. Abramovic, C. Aliprantis, An Invitation to Operator Theory, American Mathematical Society, 2002.
7. R.G. Douglas, Banach Algebra Techniques in Operator Theory, Springer- Verlag, 1998.


## ■ CE86 - Algebraic Geometry

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE86 | **SEMESTER** | H |
| **COURSE TITLE** | ALGEBRAIC GEOMETRY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field |
| **PREREQUISITE COURSES** | Algebra I-II |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |

| | |
|---|---|
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| After successful completion of the course the student:<br>• will have understood the problems with which Algebraic Geometry deals and its main goals,<br>• will have understood the geometric interpretation of algebraic concepts,<br>• will have studied and understood fundamental theorems of Algebraic Geometry. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Indivisual work.<br>• Generation of new research ideas.<br>• Promotion of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

Affine algebraic sets, the Zariski topology, ideals of affine algebraic sets.
Reducible affine algebraic sets, the resolution of an affine algebraic set into reduced affine algebraic sets.
Radical ideals, the Nullstellensatz theorem.
The projective space and the projective subspace, relations between affine and projective spaces, projective algebraic sets, ideals of projective algebraic sets.
Normal representations, coordinate rings.
Dimension of algebraic sets.
Affine, algebraic and projective varieties, the concept of dimension in affine varieties.
Tangent space and smooth points.
Bezout's Theorem and its applications.
Curves, degree and genus of projective curves.
The Riemann-Roch Theorem and its applications.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS** | Use of e-class.<br>Communication through face-to-face discussions |

| | |
|---|---|
| **TECHNOLOGY** | and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Written final examination 100%. |

**RECOMMENDED BIBLIOGRAPHY**


1. Poulakis D., Algebraic Geometry, Ziti Publications, 2018. (Greek)
2. Perrin D., Algebraic Geometry, An introduction, Springer, 2008.
3. Shafarevich, Igor R., Basic algebraic geometry 1, Varieties in Projective Space, Springer, 2013.


## ■ CE87 - Special Math Subjects II

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE87 | **SEMESTER** | H |
| **COURSE TITLE** | SPECIAL MATH SUBJECTS II | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Scientific Field<br>Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students:<br>• will have delved into a subject,<br>• will have become familiar with specific scientific problems,<br>• will have gained experience in how to write a scientific paper. |
| **General Competencies** |
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

The subject of the course is the knowledge of the supervisor who undertakes to guide a student or a group of students in the preparation of an assignment. The aim is to familiarize the student with specific scientific problems and to gain experience in how to write a scientific paper.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | | |
|---|---|---|
| **TEACHING METHOD** | Face-to-Face. | |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software MATLAB.<br>e-Lectures.<br>Use of e-class. | |
| **TEACHING ORGANIZATION** | **Activity** | **Semester Workload** |

| | | |
|---|---|---|
| | Individual Study | 150 hours |
| | Course Total (25 hours per ECTS) | 150 hours |
| **STUDENT EVALUATION** | Project 100%. | |

**RECOMMENDED BIBLIOGRAPHY**

| |
|---|
| The bibliography is determined by the supervisor. |

## ■ CE88 - Multimedia Technology

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE88 | **SEMESTER** | H |
| **COURSE TITLE** | MULTIMEDIA TECHNOLOGY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |

| COURSE WEBSITE (URL) | http://eclass.uowm.gr/ |
|---|---|

## LEARNING OUTCOMES

### Learning Outcomes

The aim of the course is to familiarize students with the basic concepts governing multimedia technologies, as well as their organized contact with techniques and tools used to create, develop and complete modern multimedia applications and digital games (video games).

With the successful completion of the course, the student will be able to:

- understand the basic concepts related to Multimedia Technologies,
- understand the special characteristics, standards and technologies related to the various means of information representation (Text, Image, Sound, Animation, Video) and become familiar with their basic coding techniques in multimedia applications,
- become familiar with the tools and special software for creating multimedia applications,
- become familiar with multimedia project management and development methodologies and how they are used to ensure the successful completion of multimedia applications,
- distinguish the key roles in a real project or multimedia application case study and appreciate the role of stakeholders in project implementation,
- identify the particular problems that arise during the development of multimedia applications and study ways of solving them,
- understand the network requirements of multimedia systems as well as the switching and playback technologies of multimedia applications on the Internet with a guaranteed quality of service,
- collaborate with fellow students to create and present a case study of an interactive multimedia application.

### General Competencies

- Independent Work.
- Team work.
- Project Planning and Management.
- Criticism and self-criticism.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

The course is an introduction to methods, tools and techniques for creating and manipulating multimedia content (text, hypertext, voice, sound, graphics, images and video), for content retrieval and for multimedia communications. It includes issues of algorithms, standards, and protocols underlying multimedia signal and multimedia information handling techniques and multimedia communications. It focuses on

presenting the concepts and characteristics of multimedia systems, describes the media that make up multimedia applications, analyzes theories and techniques for transforming media into a digital format suitable for processing, and finally lists requirements and techniques for transitioning multimedia applications to the Internet. Subsequently, methodologies for designing, developing, and implementing multimedia applications, including digital games, are taught.
Through laboratory exercises and practical exercises, as well as team work, the concepts of theory are applied in practice, which cover the material extensively.
More specifically, the content of the course covers the following topics:

- Introduction. What is multimedia? Structure, general characteristics and properties of Multimedia Systems. Classifications of Multimedia Systems and Applications. Interaction and Interactive Multimedia. Hypermedia. Structure and key features Adaptive Hypermedia Systems, Hypermedia in Education.
- Digital representation of Information. Digitization techniques.
- Basic methods of signal compression/coding. Coding principles and data compression techniques. Lossy and lossless compression algorithms. Entropy and source coding. Categories of compression methods. Text, Image, Audio, Animation and Video Compression Techniques (JPEG, MPEG).
- Digital Text. Representation, input, editing and printing of text. Markup Languages. Text and multimedia applications.
- Digital Image. Color representation and color models. Basic concepts of digital imaging. File types of bitmap images and vector graphics. Image capture and digitization. Image compression techniques. Digital image processing and vector graphics.
- Digital Audio. Sound characteristics. Audio capture and digitization. Digital Audio File Types. Coding methods and audio compression techniques. Audio and multimedia applications. MIDI. Digital audio processing. Digital Audio Sharing.
- Digital Video. Basic Video and Broadcast Video Features. Video capture and digitization. Video sampling and quantization. Digital video file types. Video file compression techniques (MPEG). Video coding standards (H.264, H.265). Video retrieval and playback. Digital video editing. Digital video sharing.
- 2-D and 3-D graphical and synthetic animation (design animation). Principles of Animation, 2-D graphic and synthetic movement (2D animation). 3-D graphic and synthetic movement (3D animation). Applications of 3D animation. Virtual Reality (Virtual Reality). Augmented Reality.
- Development of Multimedia Applications. Work phases (Analysis, Design, Production, Control/Evaluation, Distribution). Production group. Multimedia Application Development Methodology and Tools. Resource Management in Multimedia Systems.
- Multimedia and Internet. Distributed Multimedia Systems. Multicast and media streaming technology. Online distribution of multimedia content. Network services and protocols for multimedia communications. Video conference. Best effort services and guaranteed service quality. Transmission of multimedia content via 4G/5G mobile networks.

**TEACHING AND LEARNING METHODS - EVALUATION**

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom and computer lab.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Use of specialized software for editing and writing multimedia applications.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>26 hours</td></tr>
<tr><td>Laboratory Exercises</td><td>26 hours</td></tr>
<tr><td>Small indivisual works</td><td>15 hours</td></tr>
<tr><td>Team project</td><td>13 hours</td></tr>
<tr><td>Individual Study</td><td>70 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Written final exam (100%) in the Greek language, which includes:<br>-Multiple choice test,<br>-Short Answer Questions,<br>-Problem solving,<br>-Comparative evaluation of theory elements.<br>During the semester, five individual assignments, as well as a larger group case study assignment covering several subject areas simultaneously, are given to students.</td></tr>
</table>

**RECOMMENDED BIBLIOGRAPHY**


1. Multimedia Use and Programming, 3rd Edition, Yue-Ling Wong, Gkiourda Publications, Athens, 2018. (Greek)
2. Multimedia Technology: Modern Multimedia Tools, G. Styliaras, V. Dimou, D. Zeugolis, Tziola Publications, Thessaloniki, 2019. (Greek)
3. Multimedia Analytical Guide, 8th Edition, Tay Vaughan, Gkiourda Publications, Athens, 2012. (Greek)
4. Multimedia Systems, Algorithms, Standards & Applications, Parag Havaldar & Gerard Medioni, Broken Hill Publishers LTD, Nicosia, 2012.

5. Multimedia Technology: Theory and Practice, S.N. Dimitriadis, A.S. Pomportsis & E.G. Triantaphyllou, Tziola Publications, Thessaloniki, 2004. (Greek)
6. Multimedia Technology and Multimedia Communications, G.B. Xylomenos & G.K. Polyzos, Kleidarithmos Publications, Athens, 2009. (Greek)
7. Multimedia Technologies: Theory, Hardware, Software, F. Lazarinis, Kleidarithmos Publications, Athens, 2007. (Greek)

## ■ CE89 - Computer Graphics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE89 | **SEMESTER** | H |
| **COURSE TITLE** | COMPUTER GRAPHICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | Introduction to Programming<br>Linear Algebra I-II |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|

The course aims to familiarize students with the basic concepts of computational graphics, modeling of 2D and 3D objects, application of geometric algorithms/computational geometry, linear algebra and techniques in graphics, development of simple applications using basic algorithms, and using graphical programming interfaces to access the hardware.
Upon successful completion of the course, the student will be able to:

- understand the basic concepts related to Computer Graphics,
- understand the basic concepts and operations of vectors, matrices, signs and the relationships between them,
- be familiar with coordinate systems and their use in graphics, line and ellipsoid algorithms, frame and depth memories,
- understand the basics of color models and their variations, as well as the effects of different choices on each other,
- become familiar with the basic geometric transformations in 2 and 3 dimensions,
- understand and apply 2D and 3D object modeling techniques,
- be familiar with the practical use of the concepts of inner and outer products, perpendicular vectors, vector normalization, locating visible surfaces, and tilting surfaces with respect to light sources.
- understand the orthogonal, side-parallel and perspective projections of objects in space,
- become familiar with basic lighting models, camera parameters, as well as photorealistic techniques based on ray tracing and emitted radiation methods,
- collaborate, where appropriate, with fellow students to create and present simple applications that demonstrate the concepts of each module.

**General Competencies**

- Independent Work.
- Team work.
- Project Planning and Management.
- Criticism and self-criticism.
- Promotion of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

The course presents fundamental concepts of graphics, both for 2 and 3 dimensions. Basic concepts of linear algebra and computational geometry are covered for modeling objects in 2D or 3D space. There is an extensive description of the techniques of applying basic transformations, as well as calculating the necessary elements for lighting and determining the visibility of objects. Lighting models are covered, combined with the visible surfaces. The various views used in practice are analyzed. Photorealistic rendering techniques are introduced, which are used both in motion graphics and now in original real-time form. In this context the concept of energy transfer in space is covered.
More specifically, the content of the course covers the following:

Section 1: Concept of vector and point. Operations between vectors and vectors and points. Calculation of inner and outer products. Vector normalization. Vector view. Relationship of inner products and normalization with angles. Relationship of outer factors with left-handed and right-handed systems. Coordinate reference systems. 3x3 and 4x4 matrices. Actions between matrices and matrices-points.
Section 2: Basic color models and actions that reduce color depth. The effects of various options on models and color depths.
Section 3: Frame and depth memories. Mesh description of line segments and ellipsoids. Relationship between visible and active frame memories. Using depth memory to calculate the visible elements of visualizations.
Section 4: Modeling objects in 2 and 3 dimensions. Lattice model descriptions and parametrics. Description of models based on points/seats and points/sides/seats. Perpendicular vectors of vertices and bases, and use of outer products and Gouraud's method.
Section 5: Basic geometric transformations in 2 and 3 dimensions such as scaling, translation, rotation, warping. Matrix concatenation and complex geometric transformations. Orthogonal, side-parallel and perspective views of spatial objects.
Section 6: Clipping geometric descriptions outside the truncated cone of vision and non-visible seats.
Section 7: Lighting models such as ambient lighting, diffuse lighting, specular lighting, Phong model, intensity fading, spotlights. Refraction and transparent or semi-transparent materials. Surface slope and lighting.
Section 8: Photorealistic graphics with techniques based on casting and ray tracing, as well as emitted radiation.

**TEACHING AND LEARNING METHODS - EVALUATION**

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom and computer-lab.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>Use of specialized software for editing and writing computer graphics applications.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>26 hours</td></tr>
<tr><td>Laboratory Exercises</td><td>26 hours</td></tr>
<tr><td>Small Indivisual Projects</td><td>15 hours</td></tr>
<tr><td>Team Project</td><td>13 hours</td></tr>
</table>
</td></tr>
</table>

| | |
|---|---|
| | Individual Study: 70 hours<br>Course Total (25 hours per ECTS): 150 hours |
| **STUDENT EVALUATION** | Written final exam (100%) which includes:<br>-Short answer questions,<br>-Problem solving,<br>-Optional exercises and tasks, individual or group,<br>-Comparative evaluation of theory elements.<br>During the semester, individual assignments or group exercises and assignments, as well as a larger optional group assignment covering several subject areas simultaneously, are given to students. |

**RECOMMENDED BIBLIOGRAPHY**


1. Hearn D and Baker MP. 2018. Computer Graphics with OpenGL. 3rd Improved Edition. Greece, Tziola Publications.
2. Theoharis T, Papaioannou G, Platis N and Patrikalakis NM. 2015. Graphics and Visualization: Principles and Algorithms. Greece, Symmetria Publications.
3. Akenine-Möller T, Haines E, Hoffman N. 2018. Real-Time Rendering. 4th ed. USA, A K Peters/CRC Press.
4. Hughes JF, van Dam A, McGuire M, Sklar DF, Foley JD, Feiner SK and Akeley K. 2013. Computer Graphics: Principles and Practice. 3rd ed. USA, Addison-Wesley.
5. Lengyel E. 2011. Mathematics for 3D Game Programming and Computer Graphics. 3rd ed. USA, Cengage Learning PTR.
6. Dunn F and Parberry I. 2011. 3D Math for Game Development. 2nd ed. USA, A K Peters/CRC Press.
7. Kessenich J, Sellers G and Shreiner D. 2016. OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.5 with SPIR-V. USA, Addison-Wesley.
8. Luna FD. 2016. 3D Game Programming with DirectX 12. USA, Mercury Learning & Information.
9. Haines E and Akenine-Möller T. 2019. Ray Tracing Gems: High-Quality and Real-Time Rendering with DXR and Other APIs. USA, APress.
10. Pharr M, Humphreys G and Jakob W. 2016. Physically Based Rendering: From Theory to Implementation. 3rd ed. USA, Morgan Kaufmann Publishers Inc.
11. Nystrom R. 2014. Game programming patterns. UK, Genever Benning.


## ■ CE810 - Digital Signal Processing

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE810 | **SEMESTER** | H |
| **COURSE TITLE** | DIGITAL SIGNAL PROCESSING | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 2 | 6 |
| Lab | 2 | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the successful completion of the course, the student will be able to:<br>• identify and describe digital signals and systems,<br>• appreciate the advantages of digital signals over analogue ones,<br>• plan the steps of signal analysis and processing,<br>• recognize the transformations and apply them appropriately,<br>• create applications in Matlab of appropriate signal management. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies, Adaptation to new situations. |

- Making decisions.
- Independent work.
- Team work.
- Criticism and self-criticism.
- Promotion of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

- Introduction to Signals.
- Digital signal processing tools.
- Fourier series and Fourier transform.
- Discrete time systems.
- System response-convolution.
- Sampling of Continuous Time signals.
- The Shannon-Nyquist Sampling Theorem.
- Discrete Fourier Transformation.
- Fast Fourier Transformation.
- Laplace transformation.
- Z transformation.
- Analog Filters.
- Digital Filters.

In the laboratory part with the Matlab tool, the following exercises will be carried out:

- Signal creation.
- Analysis of signal peaks.
- Comparison of signals.
- Pulse analysis.
- Discrete Fourier transformation.
- Periodic signal power measurement.
- Cutoff filters.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom and computer-lab. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Learning process support through the Moodle online platform.<br>Laboratory teaching. |
| **TEACHING ORGANIZATION** | |

| **Activity** | **Semester Workload** |
|---|---|
| Lectures | 26 hours |

| | |
|---|---|
| | <table><tr><td>Laboratory Exercise</td><td>26 hours</td></tr><tr><td>Individual Study</td><td>98 hours</td></tr><tr><td>Course Total<br>(25 hours per ECTS)</td><td>150 hours</td></tr></table> |
| **STUDENT EVALUATION** | For the successful examination of the course, the student must be successfully examined independently in both parts of the course, theory and laboratory.<br><br>The evaluation in the theoretical part results from:<br>- 35% will be graded for performance in individual assignments-online tests with multiple choice questions through the course page,<br>- 65% of the final exams of the course with a comparative evaluation of theory elements.<br><br>The assessment in the laboratory part results from:<br>- active participation during the student's presence and work in the laboratory by 30%,<br>- his/her final exam by 70%.<br><br>The overall grade of the course is the weighted average of 60% the grade of the theoretical part and 40% of the laboratory. |

**RECOMMENDED BIBLIOGRAPHY**


1. Digital Signal Processing, Antoniou, A. Publications TZIOLA & SONS S.A. (Greek)
2. Digital Signal Analysis, Proakis J, Manolakis D. Ion Publications. (Greek)
3. Digital Signal Processing, A computer-based approach S.K. Mitra McGraw-Hill.
4. Theory and problems in digital signal processing, Monson H. Hayes Tziola Publications. (Greek)
5. Introduction to the theory of signals and systems, Theodoridis S. Berberidis K., Typothito Publications, Athens 2003. (Greek)
6. Introduction to digital signal processing Kogias, G. Synchroni Ekdtotiki 2010. (Greek)
7. Digital signal processing, Basic concepts and applications, Fotopoulos, Spyros Publisher Inspiration S.A. 2010. (Greek)
8. Signal Modulation and Transmission, Kottis P., Tziolas Publications, Thessaloniki 2008. (Greek)

## ■ CE811 - Time Series Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE811 | **SEMESTER** | H |
| **COURSE TITLE** | TIME SERIES ANALYSIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With this course, the students will gain knowledge and skills enabling them to:<br>• define notions such as stationarity,<br>• use econometric software packages (e.g. E-views) within the development of time series forecasting models,<br>• evaluate on time series models as well as their results,<br>• evaluate diagnostic test results,<br>• use models for time series forecasting. |
| **General Competencies** |

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Critical thinking practice.

**CONTENT OF THE COURSE**

This course focuses on time series analysis that constitute one of the important data types used in empirical analysis. The course aims to familiarize students in the Department of Economics with substantial statistical notions as well as the use of appropriate econometric techniques for the development of time series prediction models, by use of econometric software packages (e.g. E-views).
Suggested teaching sections:

- Introduction to time series
- Stochastic time series models and basic notions
- Autoregressive Models (AR)
- Moving Average Models (MA)
- ARMA Models
- ARIMA Models
- Diagnostic tests and model selection criteria
- Forecasting
- ARCH-GARCH models

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations,<br>Use of e-class.<br>Communication through face-to-face discussions via e-mails and group discussion on the subject.<br>Use of econometric sofware (e.g. E-views) |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 26 hours |
| Individual Study | 72 hours |

| | |
|---|---|
| | Course Total (25 hours per ECTS) \| 150 hours |
| **STUDENT EVALUATION** | Written final examination (50%) comprising:<br>1. Multiple choice questions<br>2. Assessment on elements of theory<br>3. Exercise solving<br>Individual laboratory project (50%).<br><br>Remarks:<br>Both the results on the assessment process and tests will be uploaded on the e-class website. |

**RECOMMENDED BIBLIOGRAPHY**


1. Dimeli S., Modern methods of time series analysis, AUEB Property Management & Development S.A., 2013. (Greek)
2. Asteriou D., Stephen H. Applied Econometrics, Propompos publications, Kimeris K. Thomas, 2018. (Greek)
3. Gujarati D., Basic econometrics, McGraw-Hill Higher Education 2003.


An indicative list of relative scientific journals:

- Econometrica
- Journal of Econometrics
- Econometric Reviews
- Journal of Time Series Analysis
- Journal of Time Series Econometrics
- Quantitative Finance
- Journal of Empirical Finance
- Econometrics Journal
- Journal of Applied Econometrics
- Advances in Econometrics
- Journal of Time Series Econometrics
- Econometrics (MDPI)
- Foundations and Trends in Econometrics
- International Journal of Computational Economics and Econometrics
- Applied Financial Economics

## ■ CE812 - Microeconomic Analysis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE812 | **SEMESTER** | H |
| **COURSE TITLE** | MICROECONOMIC ANALYSIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

## LEARNING OUTCOMES

| **Learning Outcomes** |
|---|
| Course aim: The study and understanding of economic units and how they balance in the market.<br>Aim: Microeconomic Analysis aims to acquaint the students of the Department with the functioning of economic units, consumers and businesses and the way they balance in the economic system. Effects on business profits and consumer welfare from different market formats. |
| **General Competencies** |
| Understanding and deepening the operation of businesses and consumer behavior. |

## CONTENT OF THE COURSE

Introduction-The Economic Problem. Consumer Theory: Consumer Behaviour, Consumer Equilibrium, Income and Substitution Effects-Slutsky's equation, consumer surplus, the demand curve. Production Theory: Production functions, production in the short run, break even cost curves, profit maximization of the firm, returns to scale, economies of scale, production in the long run. Cost theory: nature of cost, short-run and long-run cost curves and their relationships, cost minimization, business expansion path, sweet spot. Market Forms: perfect competition (competitive firm equilibrium, Pareto optimal and welfare analysis), monopoly (concept of Monopoly Power or Market Power, Natural Monopolies, Barriers to Entry, Price Discrimination, Social Welfare Losses due to Monopoly Power). Comparing perfect competition and monopoly in terms of social welfare.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Individual Study — 98 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Optional Midterm assessment which receives 30% of the grade.<br>Written final exam including multiple choice questions. |

**RECOMMENDED BIBLIOGRAPHY**


1. Polychronopoulos G., Tsounis. N. (2019) Microeconomic Analysis, Athens: Benou Publications. (Greek)
2. Pseiridou, A., Lianos, Th., 2015. Economic analysis & policy - Microeconomics. [elec. bibl.] Athens: Association of Greek Academic Libraries. (Greek)
3. Varian, H., (2011). Intermediate Micro-Economics, London: Norton.

## ■ CE813 - Celestial Mechanics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE813 | **SEMESTER** | H |
| **COURSE TITLE** | CELESTIAL MECHANICS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the completion of the learning process, the students will be able to know:<br>• the relationships that govern the central motion of celestial bodies,<br>• the relationships that govern the elliptical, parabolic and semi-parabolic orbits of celestial bodies,<br>• Newton's Law of Universal Gravitation and Kepler's Laws,<br>• the two-body problem, the N-body problem as well as the limited three-body problem,<br>• the Virial Theorem. |

| General Competencies |
|---|
| • Search for, analysis and synthesis of data and information, with the use of the necessary technology.<br>• Decision making.<br>• Production of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

The subject of this course is the physical laws on which the movements of celestial bodies and their orbits are based, examining their kinematics and dynamics.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 52 hours<br>Projects — 42 hours<br>Individual Study — 56 hours<br>Course Total (25 hours per ECTS) — 150 hours |
| **STUDENT EVALUATION** | Projects 10%.<br>Progress-Exam 20%.<br>Written final examination 70%. |

## RECOMMENDED BIBLIOGRAPHY


1. Celestial Mechanics and Astrodynamics: Theory and practice,Pini Gurfil P. Kenneth Seidelmann, Springer Publications.
2. Dynamical Astronomy Courses (Notes), Th.K. Papagiannopoulos, Athens 1997. (Greek)

3. Recent Advances in Celestial and Space Mechanics, Bernard Bonnard, Monique Chyba, Springer Publications.

## ■ CE814 - General Theory of Relativity

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE814 | **SEMESTER** | H |
| **COURSE TITLE** | GENERAL THEORY OF RELATIVITY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 4 | 6 |

| | |
|---|---|
| **COURSE TYPE** | General Knowledge |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the successful completion of the course, the students will be able to know:<br>• the geometry of curved spaces and make use of tensor algebra (tensors, Christofell symbols),<br>• the energy-momentum tensor and the Maxwell Equations, |

- the Principle of Equivalence,
- Einstein's field equations and their solutions,
- the classic experiments associated with the GTR such as the displacement of the perihelion of the planets and the divergence of light rays,
- the physics of gravitational waves.

**General Competencies**

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making.
- Production of free, creative and inductive thinking.

## CONTENT OF THE COURSE

The Geometry of Newtonian Gravitation and the Geometry of curved spaces. The Principle of Equivalence. Einstein's Field Equations. The Cosmological Constant. Black Holes. Solutions of Einstein's equations. The Schwarzschild solution. The Kerr solution. Consequences of GTR: Gravitational Time Dilation and change in the frequency of light. Deflection of light and gravitational time delay (Shapiro Effect). Gravitational Waves. Orbital Precession or Precession of Arcs. Orbital Attenuation. Gravitational Lenses.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Software Mathematica.<br>e-Lectures.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 52 hours |
| Projects | 42 hours |
| Individual Study | 56 hours |
| Course Total (25 hours per ECTS) | 150 hours |

| | |
|---|---|
| **STUDENT** | Projects 10%. |

| | |
|---|---|
| **EVALUATION** | Progress-Exam 20%.<br>Written final examination 70%. |

**RECOMMENDED BIBLIOGRAPHY**


1. General Theory of Relativity, Notes for Students, K. Kokkotas, (Aristotle University of Thessaloniki) 2008. (Greek)
2. General Relativity, Bernard F. Schutz, Travlos Publications & Co. OE. (Greek)
3. Special Relativity, General Relativity, J. Hartle, Tziola Publications, 2011. (Greek)


## ■ CE815 - Graduate Thesis

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CE815 | **SEMESTER** | H |
| **COURSE TITLE** | GRADUATE THESIS | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| | - | 12 |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | - |
| **COURSE WEBSITE (URL)** | - |

## LEARNING OUTCOMES

| Learning Outcomes |
| --- |
| The student who has prepared a thesis has delved into a scientific topic of his interest. His/her thesis, which may be analytical, synthetic or applied, reflects his/her theoretical knowledge and methodological skills, as well as the ability to write and comprehensively present a topic based on the commonly accepted principles governing the science of mathematics. The presentation and examination of the thesis evaluates the student's ability to present his/her work to an audience and to provide the necessary answers in order to understand the scientific topic he/she has dealt with. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Making decisions.<br>• Indivisual work.<br>• Generation of new research ideas.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

The Thesis can be an important part of the studies and special emphasis should be placed on the choice of the topic, its preparation, writing and presentation.
The Graduate Thesis can be chosen as an elective course in the 8th semester of studies, according to the conditions described in the Graduate Thesis Regulations, and is equivalent to two elective courses (12 ECTS).

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
| --- | --- |
| **TEACHING METHOD** | Face-to-Face. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | - |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
| --- | --- |
| Individual Study | 300 hours |
| Course Total (25 hours per ECTS) | 300 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Graduate Thesis 100%. |

**RECOMMENDED BIBLIOGRAPHY**

The bibliography depends on the subject of the thesis and is in Greek and/or a foreign language.

# Courses of the special study program for the acqusition of Pedagogical and Teaching Sufficiency

## ■ OP1 - Introduction to Pedagogy

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | OP1 | **SEMESTER** | C |
| **COURSE TITLE** | INTRODUCTION TO PEDAGOGY | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 3 | 5 |
| | | | |
| **COURSE TYPE** | General Background | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |

| COURSE WEBSITE (URL) | http://eclass.uowm.gr/ |
|---|---|

## LEARNING OUTCOMES

### Learning Outcomes

With the successful completion of the course, the students are expected to build knowledge, cultivate skills and develop competencies related to the subject of Pedagogical Science. In particular, students are expected to be able to:

- clarify basic pedagogical concepts,
- classify the aims and means of treatment,
- evaluate the main factors of treatment,
- monitor the emergence and development of Pedagogy as a science,
- separate research methods and provide examples for each method,
- define the scientific field of treatment,
- analyze its branches and contemporary trends,
- present the main stations of Pedagogical science,
- be aware of modern developments,
- critically reflect on various aspects and conditions of education as well as various dimensions of the educational act,
- reflect on the role of school and teachers in the modern era.

### General Competencies

- Indivisual work.
- Team work.
- Respect for diversity and multiculturalism.
- Search, analysis and synthesis of data and information, using the necessary technologies.
- Criticism and self-criticism.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

1. Clarification of basic pedagogical concepts.
2. Aims, means and factors of treatment.
3. Pedagogy as a Science (object, utility, scientific foundation).
4. Research in Pedagogical Science.
5. From Pedagogy to the Sciences of Education.
6. Branches and modern trends of the Sciences of Education.
7. Overview of the main pedagogical and educational currents from the 18th century to the middle of the 20th century.
8. The pedagogical and educational currents during the second half of the 20th century: presentation and critical analysis.
9. Modern developments (globalization, knowledge society, multiculturalism, European integration).

10. Aspects and conditions of education: Aims and Objectives, School Institution, Educational Institution, Programs and Contents, Methods and Techniques, Evaluation, School place and Time, Relationship of School, Family, Society, Pedagogical Science and Learning.
11. The Educational Practice: Fundamental Principles, Educational Relations, The Course, The School Textbooks-The Educational Material and the Pedagogy of Information. Modern Pedagogical Orientations and Applications.
12. The role of the school and teachers in the modern era.
13. Presentation of projects.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 39 hours<br>Projects — 30 hours<br>Individual Study — 56 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Projects and their presentations 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


- Suggested Bibliography:
1. Passias G., Flouris G. & Foteinos D. (2015). Pedagogy and Education. Athens: Publication Grigori. (Greek)
2. Teaching material of the teacher on the website of the course. (Greek)

- Additional Bibliography:
1. Androusou, A. & Tsafos, B. (2020). Educational Sciences: A dynamic interdisciplinary field. Athens: Gutenberg Publications. (Greek)
2. Brettos, I. (2005). Theories of Education, volume A. Athens: Gutenberg

Publications. (Greek)
3. Krivas, S. (2002). Pedagogical science. Athens: Gutenberg Publications. (Greek)
4. Mialaret, G. (2002). Introduction to Educational Sciences. Athens: Typothito. (Greek)
5. Pyrgiotakis, I. (2011). Introduction to educational science. Athens: Publications Pedio. (Greek)

## ■ OP2 - Teaching Methodology

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | OP2 | **SEMESTER** | E |
| **COURSE TITLE** | TEACHING METHODOLOGY | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 3 | 5 |
| | | | |
| **COURSE TYPE** | General Background | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

## LEARNING OUTCOMES

| Learning Outcomes |
| --- |
| Upon successful completion of the course, the students are expected to build knowledge, cultivate skills and develop competencies related to the subject of Teaching Methodology. In particular, students are expected to be able to:<br>• delineate the subject of Teaching Methodology, define teaching and its relationship with learning, critically analyze the stages of teaching. Focus on role and design models, design a teaching unit and think critically about principles of teaching,<br>• distinguish programs in terms of form, function and philosophy, examine their key features, critically approach various models of development and design, identify the relationship of the teacher with the program, understand the importance of the interdisciplinary and interdisciplinary approach to knowledge,<br>• critically examine the forms and methods of teaching as well as the characteristics of pedagogical communication,<br>• critically approach the purpose, forms and methods of assessment in learning. |
| **General Competencies** |
| • Indivisual work.<br>• Team work.<br>• Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Criticism and self-criticism.<br>• Working in an interdisciplinary environment.<br>• Promotion of free, creative and inductive thinking. |

## CONTENT OF THE COURSE

1. Teaching section.
2. Analytical Programs.
3. Social forms of teaching (face-to-face, cooperative, in groups of two, individualized).
4. Design, organization and realization of teaching. Lesson plan. Teaching principles.
5. Pedagogical relationship - pedagogical atmosphere - pedagogical interaction.
6. The Analytical Program: definitions, approaches, development models.
7. The goal-directed development model of Analytical Programs-The process model.
8. The official and the False Analytical Program (or paraprogram).
9. The teacher and the Analytical Program - The teacher as a reflective professional - Professional learning communities.
10. Teaching Methods.
11. The interdisciplinary approach to knowledge-Interdisciplinary Analytical Programs.
12. Teaching Methods (continued) - Applications.

13. Interdisciplinary and interdisciplinary approach to teaching.
14. Teaching focused on the acquisition of knowledge, the cultivation of abilities and skills, the building of metacognition.
15. Assessment in education.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |
| **TEACHING ORGANIZATION** | |

| Activity | Semester Workload |
|---|---|
| Lectures | 39 hours |
| Projects | 30 hours |
| Individual Study | 56 hours |
| Course Total (25 hours per ECTS) | 125 hours |

| | |
|---|---|
| **STUDENT EVALUATION** | Projects and their presentations 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**


- Suggested Bibliography:
1. Kapsalis, A. & Nima, E. (2015). Modern Teaching. Athens: published by Kyriakidis. (Greek)
2. Teaching material of the teacher on the website of the course. (Greek)

- Additional Bibliography:
1. Katsarou, E. (2016). Educational research-action. Athens: Publications Kritiki. (Greek)
2. Matsangouras, H. (2011). Theory & Practice of Teaching (unified). Athens: Gutenberg. (Greek)
3. Bagakis, G. (2004). The teacher and the syllabus. Athens: Metaichmio. (Greek)
4. Passias G., Flouris G. & Foteinos D. (2015). Pedagogy and Education. Athens: Publications Grigori. (Greek)
5. Frydaki, E. (2009). Teaching at the intersection of modern and postmodern

| |
|---|
| thought. Athens: Kritiki Publications S.A. (Greek) |

## ■ OP3 - Educational Psychology

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | OP3 | **SEMESTER** | D |
| **COURSE TITLE** | EDUCATIONAL PSYCHOLOGY | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
|---|---|---|
| Lectures | 3 | 5 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | General Background |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| Upon successful completion of the course, the students are expected to build knowledge, cultivate skills and develop competencies related to the subject of Teaching Methodology. In particular, students are expected to be able to:<br>• clarify the key concepts and definitions of Psychopedagogy and Educational Psychology, |

- think critically about various theories of learning and development,
- identify the characteristics of different ages,
- meet distinguished educators,
- reflect on the socio-cultural factors of education,
- distinguish the types of motivation and understand their importance in education,
- examine concepts of self and group,
- become experientially familiar with ways of cultivating communication skills and improving interpersonal relationships,
- get to know the psychopedagogical tools.

**General Competencies**

- Indivisual work.
- Team work.
- Search, analysis and synthesis of data and information, using the necessary technologies.
- Working in an interdisciplinary environment.
- Adaptation to new situations.
- Promotion of free, creative and inductive thinking.

**CONTENT OF THE COURSE**

- Psychopedagogy-Educational Psychology: Key Notions, Definitions.
- Theories of Cognitive Development and Intelligence.
- Application of Psychology in Teaching.
- Theories of Development.
- Age Characteristics.
- Behavioral Theory of Learning.
- Distinguished Teachers.
- Socio-cultural Educational Factors.
- Learning motivations.
- Concepts of Self-perception, Self-esteem and their dimensions.
- Communication skills.
- The class as a group/social whole.
- Programs to improve interpersonal relationships.
- Psychopedagogical tools.
- Elements of social development of students in education.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | Powerpoint presentations.<br>Use of e-class.<br>Communication through face-to-face discussions |

| | |
|---|---|
| | and e-mails. |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Lectures — 39 hours<br>Projects — 30 hours<br>Individual Study — 56 hours<br>Course Total (25 hours per ECTS) — 125 hours |
| **STUDENT EVALUATION** | Projects and their presentations 20%.<br>Written final examination 80%. |

**RECOMMENDED BIBLIOGRAPHY**

- Suggested Bibliography:


1. Eggen P. & Kauchak D. (2017). Educational psychology. New horizons in learning and teaching. Athens: Kritiki. (Greek)
2. Teaching material of the teacher on the website of the course. (Greek)


- Additional Bibliography:


1. Costaridou-Euklidis, A. (2011). Motivation in education. Athens: Pedio Fragos, Ch. (1984). Psychopedagogy. Athens: Gutenberg. (Greek)
2. Elliot, S., Kratochwill, T., Littlefield-Cook, J., & Traver, J. (2008). Educational psychology. Athens: Gutenberg. (Greek)
3. Foulin, J.-N., & Mouchon, S. (2002). Educational psychology. Athens: Metaichmio. (Greek)
4. Woolfolk, A. (2007). Educational psychology. Athens: Greek.


## ■ OP4 - History of Mathematics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | OP4 | **SEMESTER** | H |

| COURSE TITLE | HISTORY OF MATHEMATICS | |
|---|---|---|
| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | 3 | 5 |
| | | |
| **COURSE TYPE** | General Background | |
| **PREREQUISITE COURSES** | - | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | |

## LEARNING OUTCOMES

**Learning Outcomes**

With the successful completion of the course, the students:

- will have acquired the basic knowledge about the history and development of Mathematics,
- will have acquired a broad understanding of the evolution of mathematical ideas from antiquity to the present day,
- will be able to connect the material of school mathematics with the respective era, its ideas and concerns as well as with the people who contributed to the realization of these ideas.

**General Competencies**

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Adapting to new situations, making decisions.
- Application of knowledge in practice.
- Criticism and self-criticism.
- Respect for diversity and multiculturalism.
- Promotion of free, creative and inductive thinking.

## CONTENT OF THE COURSE

The course concerns the evolution of Mathematics from antiquity to the 19th century with a special emphasis on the evolution of both Algebra and Geometry. In this effort the following sections will be covered: Egyptian and Babylonian mathematics, the famous problems of ancient Greek mathematics, Euclid's "Elements", the role of Euclid's "5th axiom" in Euclidean Geometry and the connection with the "discovery" of Hyperbolic Geometry in the 19th century and the axiomatic foundation of Geometries by Hilbert. Reference will also be made to the work of Archimedes and its connection with integral Calculus. We will also study elements from the History of Number Theory, the search for prime numbers and their utility in problems of our time (see cryptography), the solution of the third and forth degree polynomial equation, and the unsolvability of the fifth degree polynomial equation.

## TEACHING AND LEARNING METHODS - EVALUATION

<table>
<tr><td>TEACHING METHOD</td><td>In the classroom.</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</td><td>e-Lectures.<br>Geogebra.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester Workload</th></tr>
<tr><td>Lectures</td><td>39 hours</td></tr>
<tr><td>Individual Study</td><td>86 hours</td></tr>
<tr><td>Course Total<br>(25 hours per ECTS)</td><td>125 hours</td></tr>
</table>
</td></tr>
<tr><td>STUDENT EVALUATION</td><td>Written final examination 70%.<br>Project concerning a specific discovery or the contribution of important personalities of Mathematical Science to the production of new knowledge 30%.</td></tr>
</table>

## RECOMMENDED BIBLIOGRAPHY


1. HISTORY OF MATHEMATICS. AN INTRODUCTION, V. Katz, University Publications of Crete. (Greek)
2. THE HISTORY OF MATHEMATICS, Carl B. Boyer; Uta C. Merzbach, Pnevmatikos G. A. Publications. (Greek)

3. A BRIEF HISTORY OF MATHEMATICS, Dirk Struik, Daedalos Publications. (Greek)
4. THE MATHEMATICS (volumes I,II), E.T. Bell, University Publications of Crete. (Greek)

## ■ OP5 - Teaching of Mathematics

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | OP5 | **SEMESTER** | F |
| **COURSE TITLE** | TEACHING OF MATHEMATICS | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING HOURS** | **ECTS** |
| Lectures | | 3 | 5 |
| | | | |
| **COURSE TYPE** | General Background | | |
| **PREREQUISITE COURSES** | - | | |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | Greek/English | | |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | YES | | |
| **COURSE WEBSITE (URL)** | http://eclass.uowm.gr/ | | |

**LEARNING OUTCOMES**

| Learning Outcomes |
|---|
| With the successful completion of the course, the students will be able to:<br>• have the basic knowledge and methodological tools of teaching mathematics in education,<br>• know what it means to solve a mathematical problem in education,<br>• apply a variety of mathematical methods, such as the use of counterexamples, led to a contradiction, direct proof and the method of mathematical induction in topics related to the teaching of Mathematics in education,<br>• create mathematical tools in the Geogebra environment but also to process suggested tools from the website http://photodentro.edu.gr/aggregator/ of the Ministry of Education, which will help them in live or distance teaching,<br>• teach Algebra, Geometry and Mathematical Analysis subjects in secondary education. |
| **General Competencies** |
| • Search, analysis and synthesis of data and information, using the necessary technologies.<br>• Adapting to new situations, making decisions.<br>• Application of knowledge in practice.<br>• Criticism and self-criticism.<br>• Creation of new research ideas.<br>• Respect for diversity and multiculturalism. |

**CONTENT OF THE COURSE**

Theories of learning and teaching Mathematics. Solving and creating mathematical problems (suggestions by G. Polya and A. Schoenfeld and younger researchers). Mathematical Proof (practice of using counterexamples to answer true-false questions, technique-method of a contradiction, method of proof of mathematical induction). Topics from the teaching of Algebra and Geometry (particular emphasis on elementary geometric constructions and their teaching feasibility as well as the use of geometric tools in solving geometric problems). Teaching topics of elementary Differential and Integral Calculus. Using electronic tools for teaching in the classroom. Topics from the History of Mathematics that help the teaching of Algebra, Geometry and Analysis.

**TEACHING AND LEARNING METHODS - EVALUATION**

| | |
|---|---|
| **TEACHING METHOD** | In the classroom. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | e-Lectures.<br>Geogebra.<br>Use of e-class.<br>Communication through face-to-face discussions and e-mails. |

| | |
|---|---|
| **TEACHING ORGANIZATION** | <table><tr><th>Activity</th><th>Semester Workload</th></tr><tr><td>Lectures</td><td>39 hours</td></tr><tr><td>Individual Study</td><td>86 hours</td></tr><tr><td>Course Total (25 hours per ECTS)</td><td>125 hours</td></tr></table> |
| **STUDENT EVALUATION** | Written final examination 70%.<br>Project concerning to a plan course in education and optional presentation of it in a classroom of a school 30%. |

**RECOMMENDED BIBLIOGRAPHY**


1. PROBLEM SOLVING IN MATHEMATICS. THE PROCESS OF THOUGHT WHEN SEARCHING FOR THE SOLUTION. Mamona Ioanna & Papadopoulos Ioannis (2017) . Pan. Publications of Crete. (Greek)
2. THE TEACHING OF EUCLIDEAN GEOMETRY. Thomaidis Ioannis & Poulos Andreas (2003). ZITI Publications, Thessaloniki. (Greek)
3. CONTEMPORARY TEACHING OF MATHEMATICS AND USE OF TPE IN HIGH SCHOOL AND HIGH SCHOOL. Collective project (2021). Grigoris Publications. (Greek)
4. TEACHING MATHEMATICS: TOWARD A SOUND ALTERNATIVE. Brent Davis (1996). Routledge.


## ■ CP6 - Practice

**GENERAL**

| | | | |
|---|---|---|---|
| **SCHOOL** | EXACT SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF STUDIES** | UNDERGRADUATE | | |
| **COURSE CODE** | CP6 | **SEMESTER** | E (and over) |
| **COURSE TITLE** | PRACTICE | | |
| **INDEPENDENT TEACHING ACTIVITIES** | | **WEEKLY TEACHING** | **ECTS** |

| | HOURS | |
|---|---|---|
| | - | 3 |
| | | |

| | |
|---|---|
| **COURSE TYPE** | Skills Development |
| **PREREQUISITE COURSES** | - |
| **LANGUAGE OF TEACHING AND EXAMINATIONS** | - |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | - |
| **COURSE WEBSITE (URL)** | - |

**LEARNING OUTCOMES**

| **Learning Outcomes** |
|---|
| With the Practice Program, the students:<br>• utilize the knowledge and skills acquired through relevant courses and workshops during the studies at the Department,<br>• assimilate scientific knowledge through the process of professional and scientific practice,<br>• develop professional awareness,<br>• come into contact and move smoothly from the field of studies and preparation to the field of utilizing their knowledge and skills,<br>• familiarize themselves with the work environment and the requirements of the professional field as well as with labor relations,<br>• gain teaching experience in real conditions in education,<br>• are encouraged to act independently and develop initiatives. |
| **General Competencies** |
| Application of knowledge in practice, Search, analysis and synthesis of data and information using the necessary technologies, Adaptation to new situations, Decision making, Indepedend work, Team work, Creation of new research ideas, Project planning and management, Respect for diversity and in multiculturalism, Respect for the natural environment, Demonstration of social, professional and ethical responsibility and sensitivity to gender issues, Promotion of free, creative and inductive thinking. |

**CONTENT OF THE COURSE**

Students who are in their 5th or upper semester of study can carry out a practice program according to the conditions described in the Practce Program Regulations. The practice program is an elective course, does not count towards the degree, does not replace another course, is listed in the diploma and receives 3 ECTS.

The practice takes place in classrooms of the university in the form of a laboratory practice. It includes the participation of students who attend teachings from their fellow students. The attendance of the lectures as well as the discussion with the teacher of the course aim to the better "touch" of the students with the class in which they will teach in the future and to practice the pedagogic and teaching practices as fully as possible. During the practice, students apply the pedagogical and teaching techniques they learned during their studies.

## TEACHING AND LEARNING METHODS - EVALUATION

| | |
|---|---|
| **TEACHING METHOD** | Face-to-Face. |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | - |
| **TEACHING ORGANIZATION** | **Activity** / **Semester Workload**<br>Individual Study / -<br>Course Total (25 hours per ECTS) / - |
| **STUDENT EVALUATION** | - |

## RECOMMENDED BIBLIOGRAPHY

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