UNIVERSITY OF IOANNINA
SCHOOL OF SCIENCES
DEPARTMENT OF MATHEMATICS

COURSES OUTLINE

GRADUATE STUDIES

COURSE OUTLINE
AN2 – GENERAL TOPOLOGY

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**AN2**	**SEMESTER**	1st
COURSE TITLE	**General Topology**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Language of Instruction (lectures): Greek Language of Instruction (activities other than lectures): Greek and English Language of Examinations: Greek and English		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)	Course description: http://math.uoi.gr (go to: Studies -> PostGraduate Studies -> Courses) Learning Management System (e.g.: Moodle): http://users.uoi.gr/kmavridi (go to: Courses)		

LEARNING OUTCOMES

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

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

Learning outcomes according to Bloom Taxonomy:
Remembering:

1. Topological spaces, open and closed sets, interior and closure of sets.

2. Continuous functions in topological spaces.
3. Axioms of separation.
4. Convergence in topological spaces.
5. Metric spaces and metrizable spaces.
6. Dimension of topological spaces. Dimension of metrizable space.

Comprehension:

1. Methods of generating topologies.
2. Homeomorphisms.
3. Frechet spaces.
4. Operations on topological spaces. Functions spaces.
5. Compact spaces, locally compact spaces, compactifications, countably compact spaces, pseudocompact spaces, sequentially compact spaces.
6. Totally bounded and complete metric spaces.
7. Paracompact spaces, countably paracompact spaces.
8. Connected spaces, kinds of disconnectedness.
9. Uniform spaces, totally bounded, complete and compact uniform spaces, proximity spaces.

Applying:

1. Thorough study of topological spaces.
2. Thorough study of continuous functions in topological spaces.

Evaluating: Teaching undergraduate courses.

General Competences

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

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

- Production of free, analytic and inductive thinking.
- Required for the production of new ideas.
- Working independently.
- Team work.
- Decision making.

SYLLABUS

Topological spaces, methods of generating topologies, continuous mappings, axioms of separation, Frechet spaces, subspaces, Cartesian products, quotient spaces, function spaces, compact spaces, locally compact spaces, compactifications, countably compact spaces,

pseudocompact spaces, sequentially compact spaces, totally bounded and complete metric spaces, paracompact spaces, countably paracompact spaces, connected spaces, kinds of disconnectedness, dimension of topological spaces and its basic properties, uniform spaces, totally bounded, complete and compact uniform spaces, proximity spaces.

TEACHING and LEARNING METHODS – EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance earning, etc.</td><td>• Lectures in class.
• Learning Management System (e.g.: Moodle).</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>1. Use of Learning Management System (e.g.: Moodle), combined with File Sharing and Communication Platform (e.g.: NextCloud) for
• distributing teaching material,
• submission of assignments,
• course announcements,
• gradebook keeping for all students evaluation procedures,
• communicating with students.
2. Use of Web Appointment Scheduling System (e.g.: Easy!Appointments) for organising office appointments.
3. Use of Google services for submitting anonymous evaluations regarding the teacher.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>39</td></tr><tr><td>Study and analysis of bibliography</td><td>78</td></tr><tr><td>Preparation of assignments and interactive teaching</td><td>70.5</td></tr><tr><td>Course total</td><td>187.5</td></tr></table></td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure
Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-</td><td>Language of evaluation: Greek and English.

Methods of evaluation:
• Weekly presentations – oral exams, combined with weekly written assignments.
• In any case, all students can participate in written exams at the end of the semester.</td></tr>
</table>

ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	The aforementioned information along with all the required details are available through the course's website. The information is explained in detail at the beginning of the semester, as well as, throughout the semester, during the lectures. Reminders are also posted at the beginning of the semester and throughout the semester, through the course's website. Upon request, all the information is provided using email or social networks.

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Ryszard Engelking - General Topology
- James Munkres - Topology
- John Kelley - General Topology

- *Related academic journals:* Variety of international, peer-reviewed journals, with related content.

COURSE OUTLINE
AN4 – FUNCTIONAL ANALYSIS

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**AN4**	**SEMESTER**	1st
COURSE TITLE	**Functional Analysis**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General Background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The objectives of the course are: The acquisition of background from the students on the basic structures and techniques of Functional Analysis, as independent knowledge as well as a tool for the other branches of Analysis, so that they will have the potential to apply the knowledge they get in applications.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the*

course aim?	
Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment*	*Production of new research ideas* *Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…*
The course aims to give the postgraduate student the ability to analyse and synthesize advanced concepts of Functional Analysis. The goal is to acquire the skills for autonomous work and teamwork in an interdisciplinary environment and to able to produce new research ideas.	

SYLLABUS

- Normes spaces, Banach spaces and Hilbert spaces, classical examples (sequence spaces and function spaces). Basic theorems.
- General theory of topological vector spaces, locally convex spaces, separation theorems.
- Weak topologies, theorems of Mazur, Alaoglu and Goldstine, weak compactness.
- Schauder bases and basic sequences.
- Extreme points, Krein Milman theorem.
- Riesz representation theorem, L_p spaces.
- Fixed point theorems.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for*	

Activity	***Semester workload***
Lectures	39
Study at home	78
Resolving exercises-assignments	70.5
Course total	**187.5**

each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written examination at the end of the semester.

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Habala, Hajek, Zizler, Introduction to Banach Spaces I and II.
- W. Rudin, Functional Analysis.
- J. Lindenstrauss, L. Tzafriri, Banach spaces I.
- F. Albiac, N. Kalton, Topics in Banach Space theory.
- Νεγρεπόντης, Ζαχαριάδης, Καλαμίδας, Φαρμάκη, Γενική Τοπολογία και Συναρτησιακή Ανάλυση.

COURSE OUTLINE
AN7 – MEASURE THEORY

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**AN7**	**SEMESTER**	2nd
COURSE TITLE	**Measure Theory**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The objectives of the course are: The acquisition of background for the students on the basic structures and the main theorems of Measure Theory (measure, Lebesgue integral) and their potential to use them in applications.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the*

course aim?	
Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment*	*Production of new research ideas* *Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…*
The course aims at enabling the postgraduate student to acquire the ability to analyse and synthesize basic knowledge of advanced Measure Theory. With these supplies he will be able to work in a multidisciplinary environment.	

SYLLABUS

Measure spaces, Lebesgue measure, measurable functions and Lebesgue integral, Monotone convergence Theorem and Dominated convergence Theorem, relation between Riemann and Lebesgue integral. Product measures, Fubini's Theorem. L^p spaces. Signed measures, Hahn decomposition, Radon-Nikodym Theorem. Convergence of sequences of measurable functions.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Teaching on the blackboard.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Communication with the students by e-mail.
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-*	

Activity	***Semester workload***
Lectures	39
Study at home	78
Resolving exercises-assignments	70.5
Course total	**187.5**

directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written examination at the end of semester (obligatory), delivery of work and exercises during the semester (obligatory), lecture-presentation in the class by the student (optional).

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Γ. Κουμουλλής και Στ. Νεγρεπόντης Θεωρία Μέτρου. Εκδόσεις Συμμετρία, 2005
- D. Cohn Measure Theory, Birkhauser, Boston 1988
- P. Halmos, Measure Theory, Springer Verlag.

COURSE OUTLINE
ΑΛ1 – ALGEBRA I

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΑΛ1**	**SEMESTER**	1st
COURSE TITLE	**Algebra I**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The aims of the course are: The postgraduate student to reach a good level of theoretical background on topics related to the theory of group actions, the Sylow theorems and the general theory of modules over associative rings.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the*

course aim?	
Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment*	*Production of new research ideas* *Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…*
The aim of the course is to enpower the postgraduate student to analyse and compose basic notions of advanced Algebra. This will allow him to work in an international interdisciplinary environment.	

SYLLABUS

Group actions on a set, Sylow theorems and applications, Direct and semidirect products, Finitely generated abelian groups, Free groups, Amalgamated free product of groups, Jordan-Hoelder theorem, Modules and homomorphisms between modules, Free modules, Direct sum and product of modules, Exact sequences and functors, Noetherian rings and modules, Semisimple rings and modules, Elements of multilinear and tensor algebra.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given*	

Activity	***Semester workload***
Lectures	39
Study of theory and solving of exercises	148.5
Course total	**187.5**

as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written exam at the end of semester (obligatory), problem solving or/and intermediate exams (optional).

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Marmaridis Nikos, Introduction to Group Theory (Greek), Leipsoi 2013
- Dummit, David, Foote, Richard M., Abstract algebra.
- Third edition. John Wiley & Sons, Inc., Hoboken, NJ, 2004

COURSE OUTLINE
ΓΕ2 – DIFFERENTIAL GEOMETRY

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΓΕ2**	**SEMESTER**	1st
COURSE TITLE	**Differential Geometry**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES	Linear Algebra, Topology, Elementary differential geometry, Calculus, Analysis of several variables.		
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

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

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

This course introduces the basic notions of differential and Riemannian geometry.

General Competences
Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?
Search for, analysis and synthesis of data *Production of new research ideas*

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

- Work autonomously
- Work in teams
- Develop critical thinking skills.

SYLLABUS

Differentiable manifolds, immersions, embeddings, submanifolds, vector fields, orientation covering spaces, partition of unity, Riemannian manifolds, Levi-Civita connection, curvature tensor, geodesics, exponential map. Isometric immersions, second fundamental form, hypersurfaces, Gauss, Codazzi and Ricci equations, applications.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Direct
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	

Activity	***Semester workload***
Lectures	39
Autonomous study	148.5
Course total	**187.5**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written final examination.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Manfredo do Carmo, Riemannian geometry, Birkauser, 1992
- John M. Lee, Introduction to smooth manifolds, Springer, 2013
- M. Spivak, A comprehensive introduction to differential geometry, Publish or Perish, 1979.

COURSE OUTLINE
AA3A – NUMERICAL LINEAR ALGEBRA I

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**AA3A**	**SEMESTER**	1st
COURSE TITLE	**Numerical Linear Algebra I**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

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

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

After successful end of this course, students will be able to:

- know and understand the Perron-Frobenius Theory,
- know the differences of Perron-Frobenius Theory as applied to different classes of matrices (irreducible, cyclic, primitive and reducible),
- know the efficiency of the Perron-Frobenius Theory in applications,
- know and understand the theory of Krylov subspace methods,
- know error analysis,

- know the preconditioned techniques and the necessity of preconditioning,
- implement the above methods with programs on a computer.

General Competences

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

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

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Criticism and self-criticism
- Production of free, creative and inductive thinking

SYLLABUS

Perron-Frobenius Theory of Nonnegative Matrices: Irreducible Matrices, Cyclic and Primitive Matrices, Reducible Matrices. Extension of the Perron-Frobenius Theory, M-matrices, Applications of the Perron-Frobenius Theory. Minimization methods for the Solution of Linear Systems: Conjugate Gradient Method, Convergence Theory, Error Analysis, Preconditioning Techniques, Preconditioned Conjugate Gradient Methods, Applications.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In the class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and*	

Activity	***Semester workload***
Lectures	39
Study and analysis of bibliografy	78
Exercises-Homeworks	70.5
Course total	**187.5**

analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Written examination – Oral Examination.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Numerical Linear Algebra, Dougalis V., Noutsos D., Hadjidimos A., University of Ioannina Press.
- Personal Transparencies.

COURSE OUTLINE
EM1A – METHODS OF APPLIED MATHEMATICS

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**EM1A**	**SEMESTER**	1st
COURSE TITLE	**Methods of Applied Mathematics**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

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

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

The course is an introduction to the basic analytical and numerical methods of applied mathematics. The objectives of the course are:

- Development of the theoretical background of the postgraduate student in matters relating to Applied Mathematics
- Ability of the student to apply analytical, approximate and numerical methods in problems of Mathematics, Physics and Engineering.
- Upon completion of the course the graduate student will be able to solve problems with

analytical, approximate or numerical methods and further deepen the understanding of such methods.

General Competences

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

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

- Adapting to new situations
- Decision-making
- Working independently
- Team work

SYLLABUS

Dimensional analysis and normalization, Perturbation theory for algebraic equations, integral and differential equations, Physical models described by partial differential equations (PDEs), Wave phenomena in continuous media, The course includes training in computational methods in the computer laboratory (Mechanics lab).

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In the class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of computer (Mechanics) lab
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching,*	

Activity	***Semester workload***
Lectures	39
Self-study	78
Homework-Projects	70.5
Course total	**187.5**

educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	• Weekly assignments • Final project • Written examination at the end of the semester

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Applied Mathematics, Logan D.J., 1st Edition, 2010 (in Greek).
- Perturbation Methods, A.H. Nayfeh, 1η έκδοση, Willey-VCH, 2000.

COURSE OUTLINE
EM4A – FLUID MECHANICS

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**EM4A**	**SEMESTER**	2nd
COURSE TITLE	**Fluid Mechanics**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

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

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

The course is an introduction to the analytical and numerical methods of Fluid Mechanics. The objectives of the course are:

- Development of the theoretical background of the postgraduate student in matters relating to Fluid Mechanics and ability of the student to apply analytical, approximate and numerical methods in Fluid Mechanics problems.
- Upon completion of the course the graduate student will be able to solve problems with analytical, approximate or numerical methods and further deepen the understanding of such methods.

General Competences

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

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

The course aims to enable the postgraduate student to:

- Develop the ability to analyse and synthesize basic knowledge of Fluid Mechanics.
- Adapt to new situations
- Decision-making
- Working independently
- Team work

All the above will give to the students the opportunity to work in an international multidisciplinary environment.

SYLLABUS

Kinematics of Fluids, Fluid flow analysis, Equation of continuity and stream function, motion equations for Ideal and real fluids, laminar and turbulent flow, Boundary layer flows with adverse pressure gradient, Numerical Methods in Fluid Mechanics, Classification of fluid dynamics problems and relevant equations that describe basic numerical schemes, method of finite differences, compatibility, stability and convergence of numerical schemes, finite volume method, Introduction to the method of weighted residues, finite element method. The course includes training in computational methods in the computer laboratory (Mechanics lab).

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	In the class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of computer (Mechanics) lab

<table>
<tr>
<td>TEACHING METHODS
The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td>
<td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td>Self study</td><td>78</td></tr>
<tr><td>Homework-Projects</td><td>70.5</td></tr>
<tr><td>Course total</td><td>187.5</td></tr>
</table>
</td>
</tr>
<tr>
<td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure
Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other
Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td>
<td>

Weekly assignments
Final project
Written examination at the end of the semester

</td>
</tr>
</table>

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Fluid Mechanics, Volume 1, A. Papaioanou, 2nd Edition, 2001 (in Greek).
- Computational Fluid Mechanics, I. Soulis, 1st Edition, 2008 (in Greek).
- Numerical heat transfer and fluid flow, S.V. Patankar, McGraw-Hill, New York, 1980.
- The Finite Element Method, Vol. 1, The Basis, O.C. Zienkiewicz, R.L. Taylor, 5th Ed., Butterworth-Heinemann, Oxford, 2000.
- Computational Techniques for fluid Dynamics, C.A.J. Fletcher Volumes I and II, 2nd Ed. Springer-Verlag, Berlin, 1991.

COURSE OUTLINE
ΠΛ4Α – ALGORITHMIC GRAPH THEORY

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΠΛ4Α**	**SEMESTER**	2nd
COURSE TITLE	**Algorithmic Graph Theory**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes

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

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

This course aims at introducing to students fundamental algorithmic techniques for solving problems related and modeled by graphs.

After successfully passing this course the students will be able to:

- Understand graph theory
- Design and analyze algorithms for graph problems
- Understand difficult problems on graph classes.

General Competences

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

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

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Working independently
- Team work
- Project planning and management.

SYLLABUS

- Fundamental Graph Theory
- Algorithmic and Combinatorial Graph Problems
- Complexity Classes and Parameterized Algorithms
- Chordal graphs, Comparability graphs, Split graphs
- Permutation graphs, Interval graphs, Cographs, Threshold graphs
- Algorithmic problems and width parameters.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	In the class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of projector and interactive board during lectures.
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical*	

Activity	***Semester workload***
Lectures	39
Working independently	78
Exercises – Homework	70.5
Course total	**187.5**

practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	• Written work (50%) • Essay / report (20%) • Public presentation (30%)

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- [Go2004] M. Golumbic, Algorithmic Graph Theory and Perfect Graphs, NORTH-HOLLAND, 2004
- [BSL99] A. Brandstädt, J. Spinrad, and V. Lee, Graph Classes: A Survey, SIAM Monographs on Discrete Math. and Applications, 1999.
- [NPG15] Nikolopoulos, S., Georgiadis, L., Palios, L., Algorithmic Graph Theory. Kallipos, 2015

COURSE OUTLINE
ΣΕΕ1 – MATHEMATICAL STATISTICS

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΣΕΕ1**	**SEMESTER**	1st
COURSE TITLE	**Mathematical Statistics**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures-Laboratory		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English, reading Course)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The course aims to extend the knowledge which the students have obtained during their undergraduate studies on several themes of Mathematical Statistics and to present some special topics of Mathematical Statistics.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?*

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

- Working independently
- Decision-making
- Production of free, creative and inductive thinking
- Criticism and self-criticism.

SYLLABUS

Extensions of the following subjects: Unbiasdness, Sufficient, Minimal Sufficient, Completeness, Consistency, Theorem of: Rao-Blackwell, Lehmann-Scheffé, Basu. Maximum Likelihood Estimators: Properties-Asymptotic Properties. Decision Theory: minimax, Bayes estimators. Modified Likelihood, EM algorithm, Numerical methods of finding estimators. Confidence intervals: pivotal quantity, Asymptotic method etc. Delta Method- Asymptotic statistics.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Classroom (face-to-face)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in communication with students
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given*	

Activity	***Semester workload***
Lectures	39
Working independently	78
Exercises – Homework	70.5
Course total	**187.5**

as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written exam in Greek (in case of Erasmus students in English).

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Books in English

- Casella, G. and Berger, R.L. (2002). *Statistical Inference*. Duxbury Press; 2nd edition.
- Mood A. et al. (1974). Introduction to the theory of Statistics. McGraw-Hill.
- Roussas G. (1997). A course in Mathematical Statistics. Academic Press.
- Hogg, R and Craig, A. (1978). Introduction to Mathematical Statistics.
- Lehmann, E.L. and Casella, G. (1998). *Theory of point estimation*. Springer; 2nd edition
- Bickel, P.J. and Doksum, K.A. (1977). *Mathematical Statistics, Basic Ideas and Selected Topics, Vol. 1*. Holden-Day.
- Rohatgi, V.K. (1976). *An Introduction to Probability Theory and Mathematical Statistics*. John Wiley and Sons, New York.
- Rao, C. R. (1973). *Linear Statistical Inference and its Applications*. Wiley: 2nd edition.
- Lehmann, E.L. and Romano, J.P. (2005). *Testing statistical hypotheses*. Springer; Third edition, New York.
- Van der Vaart (1998). Asymptotic Statistics. Cambridge University Press.

Books in Greek

- Τ. ΠΑΠΑΙΩΑΝΝΟΥ-Κ. ΦΕΡΕΝΤΙΝΟΥ: Μαθηματική Στατιστική Εκδόσεις Σταμούλη.
- Ηλιόπουλος, Γ. (2013). *Βασικές Μέθοδοι Εκτίμησης Παραμέτρων*. Εκδόσεις Σταμούλη; 2η έκδοση

COURSE OUTLINE
ΣΕΕ2 – LINEAR MODELS

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΣΕΕ2**	**SEMESTER**	1st
COURSE TITLE	**Linear Models**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English, reading Course)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The purpose of the course is: • the deepening of knowledge of linear models acquired during undergraduate studies • the extension of these concepts • the presentation of specialized knowledge of Linear Models with applications in statistical data analysis.
General Competences *Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the*

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

- Working independently
- Decision-making
- Adapting to new situations
- Production of free, creative and inductive thinking
- Synthesis of data and information, with the use of the necessary technology
- Working in an interdisciplinary environment.

SYLLABUS

General Linear Model of full Rank, Multiple Regression Analysis, Analysis of residuals-Diagnostics, Selection of Variables, Two way analysis of variance with equal and unequal numbers per cell. Models of non full rank.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in communication with students
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for*	

Activity	***Semester workload***
Lectures	39
Independent study	78
Study and analysis of bibliography, Fieldwork	70.5
Course total	**187.5**

each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Final written exam in Greek (in case of Erasmus students in English).

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

In Greek

- Καρακώστας, Κ. (1993). Παλινδρόμηση και Ανάλυση της Διακύμανσης. Πανεπιστήμιο Ιωαννίνων
- Λουκάς, Σ. (2014). Γενικό Γραμμικό Μοντέλο. Πανεπιστήμιο Ιωαννίνων

In English

- Draper , N. R. and Smith, H. (1981). Applied Regression Analysis. John Wiley & Sons, Inc., N.Y.
- Searle, S. R. (1971). Linear Models. John Wiley & Sons, Inc, N. Y., London
- Seber, G. A. F. (1977). Linear Regression Analysis. John Wiley & Sons, Inc, N.Y.

COURSE OUTLINE
ΣΕΕ7 – NON LINEAR PROGRAMING

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΣΕΕ7**	**SEMESTER**	2nd
COURSE TITLE	**Non Linear Programing**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The course aims to introduce students to the fundamentals of non-linear optimization. Upon successful completion of the course the student will be able to: • understand the basic principles of nonlinear optimization problems. • use some of the commonly used algorithms for nonlinear optimization (unconstrained and constrained) • select the appropriate algorithm for a particular optimization problem.

General Competences

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

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

- Working independently
- Decision-making
- Adapting to new situations
- Production of free, creative and inductive thinking
- Synthesis of data and information, with the use of the necessary technology.

SYLLABUS

Introduction to unconstrained and constrained optimization, Lagrange Multipliers, Karush-Kuhn-Tucker conditions, Line Search, Trust Region, Conjugate Gradient, Newton, Quasi-Newton methods, Quadratic Programming, Penalty Barrier and Augmented Lagrangian Methods.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lindo/Lingo Software, Mathematica, Email, class web
TEACHING METHODS *The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching,*	

Activity	***Semester workload***
Lectures	39
Independent study	78
Study and analysis of bibliography, Fieldwork	70.5
Course total	**187.5**

educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	LANGUAGE OF EVALUATION: Greek METHODS OF EVALUATION: • Written work (30%) • Final exam (70%)

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Bazarra, Sherali, and Shetty Nonlinear Programming: Theory and Algorithms, 3rd Edition, John Wiley & Sons, 2006
- Bertsekas D. Nonlinear Programming, Athena Scientic, 2004
- Luenberger, David G.; Ye, Yinyu (2008). Linear and nonlinear programming. (Fourth ed). New York: Springer
- Γεωργίου Α. Βασιλείου Π.-Χ. Μη γραμμικές μέθοδοι βελτιστοποίησης, Εκδόσεις Ζήτη, 1996
- Παπαγεωργίου Μ. Μη γραμμικός προγραμματισμός. Ηλεκτρονικό σύγγραμμα.

- Related academic journals:

- Computational Optimization and Applications
- Journal of Global Optimization
- Journal of Optimization Theory and Applications
- Optimal Control Applications and Methods
- Optimization
- SIAM Journal on Optimization (SIOPT).

COURSE OUTLINE
ΣΕΕ3 – MATHEMATICAL PROGRAMING

GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Department of Mathematics		
LEVEL OF STUDIES	Graduate		
COURSE CODE	**ΣΕΕ3**	**SEMESTER**	1st
COURSE TITLE	**Mathematical Programing**		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures		3	7.5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d)			
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES			
LANGUAGE OF INSTRUCTION and EXAMINATIONS	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)		
COURSE WEBSITE (URL)			

LEARNING OUTCOMES

Learning outcomes *The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.* • *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area* • *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B* • *Guidelines for writing Learning Outcomes*
The course learning outcomes are: the presentation of mathematical programming problems, the presentation of their solution techniques and their applications in several areas such as production, distribution, routing, etc. Upon successful completion of the course the student will be able to: • model complex systems • comprehend the mathematical foundation of the Simplex method and the dual theory

- understand and apply the appropriate techniques required to solve linear optimization problems
- understand the principles of dynamic programming and apply dynamic programming solution techniques
- recognize and apply the appropriate inventory management policies (depending, each time, on underlying assumptions of the system)

General Competences

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

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

- Working independently
- Decision-making
- Adapting to new situations
- Production of free, creative and inductive thinking
- Synthesis of data and information, with the use of the necessary technology
- Project planning and management

SYLLABUS

Linear programming problems formulation. The Simplex algorithm. Big M-method. Two-Phase method. Revised Simplex method. Duality theory. Dual Simplex algorithm. Sensitivity analysis. Parametric analysis. Transportation problem. Transhipment problem. Assignment problem. Dynamic programming: Bellman principle of optimality, finite and infinite horizon problems. Applications of dynamic programming. Inventory control.

TEACHING and LEARNING METHODS – EVALUATION

DELIVERY *Face-to-face, Distance earning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lindo/Lingo Software, Email, Class Web

TEACHING METHODS

The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS

Activity	***Semester workload***
Lectures	39
Independent study	70
Study and analysis of bibliography, Fieldwork (6-7 sets of homework)	78.5
Course total	**187.5**

STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.

LANGUAGE OF EVALUATION: Greek

METHODS OF EVALUATION:

- Written work (30%)
- Final exam (70%)

ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

- Bellman, R.E.. Dynamic Programming, Princeton University Press, 1957, Princeton, NJ. Republished 2003
- Bertsekas D. P. Dynamic Programming and Optimal Control, Vols. I and II, Athena Scientific, 1995, (3rd Edition Vol. I, 2005, 4th Edition Vol. II, 2012),
- Bertsimas D. and J. N. Tsitsiklis Introduction to Linear Optimization, Athena Scientific 1997
- Gass S. Linear Programming Methods and Applications, McGraw-Hill 1985
- Hadley G. Linear Programming, Addison-Wesley Publishing Company, INC, 1965
- Taha H., Επιχειρησιακή Έρευνα Εκδόσεις Α. Τζιολα & ΥΙΟΙ Α.Ε., 2011
- Hillier F. S. and G. J. Lieberman Introduction Operations research. The McGraw-Hill Companies, 2001

- Johnson L. A. and D. C Douglas, Operations research in production planning scheduling and inventory control. John Willey and Sons, New-York, 1974
- Silver E. A., D.F. Pyke and R. Peterson, Inventory Management and Production Planning and Scheduling. John Willey and Sons, New-York, 3rd Edition, 1998
- Tersine R. J., Principles of inventory and materials management, Prentice Hall International Inc, New Jersey, 4rd Edition, 1994
- Wagner H.M and T.M Within (1958) Dynamic version of the economic lot size model. Management Science, 5(1), 89-96
- Winston W. L., Operations research (Applications and algorithms). Duxbury Press (International Thomson Publishing) 1994.
- Βασιλειου Π. και Τσαντας Ν., Εισαγωγή στην επιχειρησιακή έρευνα, Εκδόσεις ΖΗΤΗ 2000.
- Κολετσος Ι., και Στογιαννης Δ. Εισαγωγή στην επιχειρησιακή έρευνα, Εκδόσεις Συμεών, 2012
- Κουνιας Σ. και Φακινος Δ., Γραμμικός Προγραμματισμός, Εκδόσεις ΖΗΤΗ, Θεσσαλονίκη 1999.
- Λουκακης Μ. Επιχειρησιακή έρευνα γραμμικός προγραμματισμός, Εκδοτικό Κέντρο Βορείου Ελλάδας, 1994.
- Παπαρριζος Κ., Γραμμικός Προγραμματισμός. Εκδόσεις Ζυγός, Θεσσαλονίκη 1999.
- Σισκος Γ., Γραμμικός Προγραμματισμός, Εκδόσεις Νέων Τεχνολογιών, Αθήνα 1998.
- Φακινου Δ. και Οικονομου Α., Εισαγωγή στην επιχειρησιακή έρευνα- Θεωρία και Ασκήσεις, Αθήνα 2003.

- *Related academic journals:*

- Mathematical Programming Journal, Series A and Series B
- INFORMS Transactions on Education (ITE)
- Interfaces