COURSE OUTLINE

1. GENERAL

SCHOOL	NATURAL SCIENCES		
DEPARTMENT	MATHEMATICS		
LEVEL OF COURSE	UNDERGRADUATE		
COURSE CODE	MAT_PM438	**SEMESTER OF STUDIES**	8th
COURSE TITLE	FUNCTIONAL ANALYSIS: SPACES AND OPERATORS		

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*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
Lectures and Tutorials	4	6
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*	Compulsory course for the specialization *Pure Mathematics & Applied Mathematics* Elective course for each of the other specializations
PREREQUISITE COURSES:	Recommended prerequisite knowledge: REAL ANALYSIS II
TEACHING AND ASSESSMENT LANGUAGE:	Greek
THE COURSE IS OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBPAGE (URL)	

2. 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*

By the end of this course the student will have developed the following skills and abilities:

- Ability to prove and understand the significance of Hölder's and Minkowski's inequalities
- Knowledge of classical Banach spaces (spaces of functions, sequences etc) and ability to determine wether a space is complete or separable.
- Ability to understand and use the theory of Banach spaces and ability to prove basic properties of finite-dimensional spaces.
- Knowledge and ability to prove basic properties of operators and ability to calculate their norm, whenever possible.
- Ability to understand dual spaces and their topology.
- Ability to understand the importance of the Hahn-Banach theorem, the open mapping theorem and the closed graph theorem
- Knowledge of basic Hilbert space theory.
- Ability to investigate and understand special types of linear operators, their properties and to find differences among them.
- Ability to understand the resolvent set and the spectrum of a linear operator and their importance for solving equations in Hilbert spaces.

A student who has successfully completed the course will be able to understand properties of classical spaces of sequences and functions, Banach spaces, spaces of finite dimension, dual spaces and Hilbert spaces. He/she will be able to prove basic properties of linear operators, to calculate their norm, whenever possible, and to find the differences among special types of operators. He/she will be able to understand the resolvent set and the spectrum of a linear operators as well as their importance in solving equations in Hilbert spaces.

General Abilities

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

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

- Decision making.
- Autonomous work.
- Teamwork.
- Production of new research ideas.
- Promotion of free, creative and inductive thinking.

3. COURSE CONTENT

Hölder's and Minkowski's inequalities. Completeness and separability of known sequence spaces and function spaces. Normed spaces. Banach spaces. Finite-dimensional spaces. Operators and functionals.
Dual Banach spaces. Reflectivity. Hahn-Banach theorem and its applications. Applications of Baire's theorem: The open mapping theorem. The uniform bound principle, the closed graph theorem.
Inner-product spaces. Hilbert spaces. Orthogonal and orthonormal systems. Orthogonal complement and projections. The Riesz representation theorem. Adjoint, self-adjoint, normal, isometry, unitary, compact and projection operators.
Resolvent set and spectrum. The spectrum of adjoint and compact operators. Solution of equations in Hilbert spaces.

4. TEACHING AND LEARNING METHODS - ASSESSMENT

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

Activity	***Semester workload***
Lectures	52
Solving suggested exercises	65
Personal study by the student	30
Final examination	3
Total number of hours for the Course (25 hours of work-load per ECTS credit)	***150***

STUDENT ASSESSEMNT *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.*	**Assessment Language:** Greek **Assessment Language for Erasmus students:** English **Assessment methods:** Written final course exam including ✓ Comprehensive questions, ✓ Sort answer questions, ✓ Exercises and problem solving. Minimum passing grade: 5 Maximum passing grade: 10

5. RECOMMENDED LITERATURE

(*in Greek*)

- Υφαντής Ευάγγελος Κ. *Θεωρία Τελεστών*. Εκδόσεις Σταμούλη, 2004.
- Κατάβολος Αριστείδης. *Εισαγωγή στη Θεωρία Τελεστών*. Εκδόσεις Συμμετρία, 2008.

(*in English*)

- Eidelman Yuli, Milman Vitali and Tsolomitis Antonis. *Functional Analysis: An Introduction*. American Mathematical Society, 2004.
- Debnath Lokenath and Mikusinski Piotr. *Hilbert Spaces with Applications*. 3rd ed., Academic Press, 2005.