# COURSE OUTLINE

## 1. GENERAL

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|---|---|---|---|
| **SCHOOL** | NATURAL SCIENCES | | |
| **DEPARTMENT** | MATHEMATICS | | |
| **LEVEL OF COURSE** | UNDERGRADUATE | | |
| **COURSE CODE** | MAT_AM464 | **SEMESTER OF STUDIES** | 7th |
| **COURSE TITLE** | SPECIAL FUNCTIONS | | |

| **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).* | | |

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|---|---|
| **COURSE TYPE** *general background, special background, specialised general knowledge, skills development* | Elective course |
| **PREREQUISITE COURSES:** | Recommended prerequisite knowledge: CALCULUS II, INTRODUCTION TO ORDINARY DIFFERENTIAL EQUATIONS |
| **TEACHING AND ASSESSMENT LANGUAGE:** | Greek |
| **THE COURSE IS OFFERED TO ERASMUS STUDENTS** | Yes |
| **COURSE WEBPAGE (URL)** | https://eclass.upatras.gr/courses/MATH938<br>https://eclass.math.upatras.gr/courses/MATH_APPL131/ |

## 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:

- to demonstrate knowledge of Gamma, Beta and Bessel functions and their properties.
- to use their properties for computating integrals and other relations involving these functions.
- to solve some types of Ordinary Differential Equations, using Bessel functions.
- to compute Fourier-Bessel series for a given function.
- to demonstrate knowledge of basic properties of orthogonal polynomials (orthogonality, three term recurrence relation, Darboux-Christofell formula, generating function).
- to use Rodrigue's formula to prove properties of orthogonal polynomials or to compute integrals involving orthogonal polynomials.

A student who has successfully completed the course will be able to use the properties of Gamma, Beta and Bessel functions for computation integrals and other relations involving them, as well as to solve some types of ODEs using Bessel functions. In addition, he will be able to prove properties of orthogonal polynomials, as orthogonality, three term recurrence relation, generating functions using several techniques.

**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

Gamma, Beta and error functions. Bessel functions of first and second kind. Linear independence and recurrence relations. Calculation of integrals involving Bessel functions. Modified Bessel functions of first and second kind. Solving some types of Ordinary Differential Equations using Bessel functions. Lommel's integrals. Some results about the zeros of Bessel functions. Fourier-Bessel series. General properties of orthogonal polynomials. Three term recurrence relation. Darboux-Christoffel formula. Rodrigue's formula. Generating functions. Applications.

## 4. TEACHING AND LEARNING METHODS - ASSESSMENT

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|---|---|
| **TEACHING METHOD**<br>*Face-to-face, Distance learning, etc.* | Lectures (face to face) |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES**<br>*Use of ICT in teaching, laboratory education, communication with students* | ✓ *eClass* platform of the Department of Mathematics, and<br>✓ *eClass* platform of the University of Patras |
| **TEACHING ORGANIZATION**<br>*The manner and methods of teaching are described in detail.*<br><br>*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.*<br><br>*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 ASSESSEMNT**<br>*Description of the evaluation procedure*<br><br>*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*<br><br>*Specifically-defined evaluation criteria are given, and if and where they are accessible to students* | **Assessment Language:** Greek<br>**Assessment Language for Erasmus students:** English<br><br>**Assessment methods:** Written final course exam including<br>✓ Comprehensive questions,<br>✓ Exercises solving.<br><br>Minimum passing grade: 5<br>Maximum passing grade: 10 |

| ***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*** |

## 5. RECOMMENDED LITERATURE

(*in Greek*)

- Σιαφαρίκας Παναγιώτης. *Ειδικές Συναρτήσεις*. Εκδόσεις Εταιρείας Αξιοποίησης και Διαχείρισης Περιουσίας Πανεπιστημίου Πατρών, 2009.
- Μασσαλάς Χρήστος Β. *Ειδικές Συναρτήσεις*. Εκδόσεις Gutenberg, 2010.

(*in English*)

- Hochstadt Harry. *The Functions of Mathematical Physics*. Dover Publications, Revised edition 2012.
- Lebedev Nikolai Nikolaevich. *Special functions and their Applications*. Dover Publications, Revised edition, 1972.