COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	DE PARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	B.1	SEMESTER	B
COURSE TITLE	DIFFERENTIAL EQUATIONS-TRANSFORMS		

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

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

(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*

Differential Equations-Transforms of the third semester refers to differential equations (ordinary and partial) for topics such as: types of differential equations, solution of differential equations (first and higher order), elements of qualitative and analytical theory, systems of differential equations, etc. On the other hand new concepts are introduced for the student, such as Laplace transformation, Fourier series and transformations (for circuit solving, for using in Automatic Control Systems, for waveform analysis, etc.) and Z transformation.
Finally, students will be introduced to the theory of Partial Differential Equations (PDE) through an introductory approach. PDEs are one of the most important areas of both theoretical and applied

mathematics. This fact is due, on the one hand, to the frequent use of PDEs in physics, technology, biology, economy and into other applied sciences, and, on the other hand, to the plethora of new problems, questions and theorems that are created and developed in the field of theoretical mathematics. Like every mathematical course and lesson, also Differential Equations-Transforms, is the promotion of mathematical literacy and the analytical mathematical thinking of the student.

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

- Able to recognize the type of differential equations, categorize and solve them.
- Study first order ordinary differential equations, second and higher order homogeneous and non-homogeneous differential equations with stable coefficients.
- Able to apply their applications in many fields of science and engineering.
- Apply the Laplace Transformation to solve differential equations and also to apply it to differential equations that model electric circuits.
- Know and be able to explain in writing the nature, role and basic laws of Laplace transform and of frequency domain.
- Know to develop the Fourier series of periodic function and plan their frequency spectrum.
- Be familiar with the use of Fourier Transformation in Systems and with the concept of transportation functions.
- Apply Z transformation and its inverse to solve difference equations.
- Study Partial Differential Equation and their Applications.
- Select the appropriate method for the solution of a given problem. Do this for problems coming from various fields of science and technology.

General Competences

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

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

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

(3) SYLLABUS

The lesson is organized in 26 three-hour lectures.

Section 1 " First Order Ordinary Differential Equations"

• **Lecture 1**: Introduction, Homogeneous Differential Equations, Linear Differential Equations, Bernoulli's Differential Equation.

• **Lecture 2**: Exact and Non-Exact Differential Equations, Euler's multiplier, Examples and Exercises.

Section 2 " Elements of Qualitative Analytical Theory"

• **Lecture 3:** Picard and Peano Theorems, Gronwall inequality.

Section 3 " Ordinary Differential Equations second and upper class"

• **Lecture 4**: Second Order Homogeneous and non-Homogeneous Differential Equations with fixed Coefficients, Rate Determination Method (Euler).

• **Lecture 5**: Fixed Changed Method (Lagrange).

Section 4 "Power Series Method"

• **Lecture 6**: Basic Concepts, Properties, Criteria and Convergence Radius, Power Series Operations, Solutions-Series around Smooth Point.

• **Lecture 7**: Solutions-Series around Normal irregular Point, Exercises.

Section 5 "Systems of Differential Equations"

• **Lecture 8:** Linear Systems with Fixed Coefficients, Homogeneous Systems, Self-Coupling Systems

• **Lecture 9:** Non Self-Coupling Systems, Types of Eigenvalues, Exercises.

Section 6 "Lyapunov Stability-Boundary Value Problems"

• **Lecture 10:** Stability of Linear Systems, General Theory, Autonomous Linear Systems.

• **Lecture 11:** Stability of Almost Linear Systems, Linearization

• **Lecture 12:** Sturm-Liouville's Problems

Section 7 "Laplace Transformation"

• **Lecture 13:** Laplace Transform (LT), Properties, Theorems, Solving Differential Equations Using Laplace Transform.

• **Lecture 14**: Applications of Laplace Transform on RL, RC, LC, RLC Circuits, Inverse of Laplace Transform.

• **Lecture 15**: Applications and Exercises in Systems of Differential Equations.

Section 8 " Fourier Series and Fourier Transformation"

• **Lecture 16**: Trigonometric and Exponential Fourier Series, Calculation of Fourier Coefficients, Discrete Spectrum of Phases and Widths (frequency spectrum, energy spectrum, etc)

• **Lecture 17**: Extension of Fourier Series, Fourier Series computation for periodic signals (waveforms), Introduction to Fourier Transform.

• **Lecture 18**: Properties of Fourier Transform, Inverse of Fourier Transform, Exercises and Examples.

• **Lecture 19**: Applications in: Systems, Electrical Circuits, Transfer Functions -Exercises.

Section 9 " z Transformation "

• **Lecture 20**: Z Transformation, Inverse Z transformation, Properties, Exercises.

• **Lecture 21**: Z Transformation in Difference Equations, Exercises.

• **Lecture 22:** Applications of Z Transformation to Transfer Systems, Exercises.

Section 10 "Partial Differential Equations"

• **Lecture 23**: Classification of second order Partial Differential Equations, Applications, Exercises.

• **Lecture 24**: 2nd Order Linear PDE with fixed Coefficients, D' Alembert Solution for the Wave Equation, Problems.

• **Lecture 25**: Dirichlet Boundary Conditions, Poisson's Equation with Dirichlet Formula Conditions, Problems.

• **Lecture 26**: Polar Coordinates, The Dirichlet Problem in a Disk and in a Rink.

(4) TEACHING and LEARNING METHODS - EVALUATION

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

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

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

(5) ATTACHED BIBLIOGRAPHY

Greek:

- **Advanced Mathematics for Engineers**, Erwin Kreyszig, *Tziolas Publications*.
- **Differential Equations: Ordinary and Partial,** Stavrakakis N, Tsotras, 2019**.**
- **Advanced Mathematics for Engineers**, Zill Dennis, 2020
- **Differential Equations, Transformations and Complex Functions,** Milonas N, *Tziolas Publications.*
- **Mathematics for Engineers,** Georgoudis, Prezerakos,Makriggianis, *Singhroni Ekdotiki* , 2016.
- **Applied Mathematics**, Alexandropoulos, Vrizidis, *Singhroni Ekdotiki* , 2016.
- **Applied Mathematics**, Hatzarakis, Milonas, *Tziolas Publications*.
- **Infinite Calculus II**, Finney R.L., Weir M.D., Giordano F.R., *University Crete Publications.*

Foreign Language:

- **Fourier Series**, W. Bolton.
- **Laplace Transforms**, Schaum's Outlines.
- **Differential Equations, A systems approach**, Goldberg and Potter, *Prentice Hall*.
- **Fourier Series and Boundary Value Problems** (5th Edition), J. W. Brown and R. Churchill, *Mc Graw-Hill int. Edition, New York*.
- **Laplace Transforms and an Introduction to Distributions**, P.B. Guest, Ellis Horwood, *New York.*
- **Methods of Engineering Mathematics**, E. Hang and K.K. Choi, *Prentice Hall, Englewood Cliffs, New Jersey.*
- **Laplace Transforms for Electronic Engineers**, J.G. Holbrook, *Pergamon Press*.
- **Complex Variables and the Laplace Transforms for Engineers**, W.R. LePage, *Dover Publications, New York*.
- **Introduction to Fourier Analysis and Generalized Functions**, *Cambridge University Press, Cambridge.*
- **Laplace and the Z-transform**, A.C. Grove, (Nottingham Polytechnic), *Prentice Hall.*
- **Signals and Systems**, A. Oppenheim - A. Willsky (M.I.T) and S. Nawab *(Boston University), Prentice Hall.*

- **The Transforms and Applications** Handbook, A. Poularikas, *CRC Press*.
- **Advanced Calculus for Applications**, F.B. Hildebrand, *Prentice Hall.*

***Related Scientific Journals**:*

- Journal of Engineering Mathematics
- Journal of Differential Equations
- Electronic Journal of Differential Equations
- Journal of Fourier Analysis and Applications
- Topological Methods in Nonlinear Analysis and Applications
- Applicable Analysis and Applications
- Discrete and Continues Dynamical Systems
- Nonlinear Analysis TMA
- Nonlinear Functional Analysis and Applications
- International Journal of Nonlinear Analysis and Applications