

NUMERICAL METHODS FOR THE SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

1. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	CIVIL ENGINEERING/ MSc APPLIED MATHEMATICS		
LEVEL OF STUDIES	MSc - LEVEL 7		
COURSE CODE		SEMESTER	1 st SEMESTER
COURSE TITLE	NUMERICAL METHODS FOR THE SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS		
TEACHING ACTIVITIES <i>If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.</i>		TEACHING HOURS PER WEEK	ECTS CREDITS
		3	7,5
<i>Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.</i>			
COURSE TYPE <i>Background, General Knowledge, Scientific Area, Skill Development</i>	Scientific area		
PREREQUISITES:	NO		
TEACHING & EXAMINATION LANGUAGE:	Greek		
COURSE OFFERED TO ERASMUS STUDENTS:	NO		
COURSE URL:	https://eclass.duth.gr/courses/TMB360/		

2. LEARNING OUTCOMES

Learning Outcomes <i>Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.</i>
<p>After completing the course, the participants will be able to:</p> <ul style="list-style-type: none"> • Approximate the solution of a first-order differential equation with single-step methods and with multiple-step methods • Solve numerical systems of differential equations • Solve higher order differential equations numerically • Understand the concepts of initial and boundary conditions problems

- Find the numerical solution of a problem according to some limitations and characteristics of a numerical method, such as accuracy, stability and computing time of its application
- Check the accuracy of a numerical method, compare and choose the most appropriate numerical method
- To solve 2nd order problems with Numerov's method

By participating in the course lectures and carrying out the assignments, the postgraduate student applies the basic knowledge of the course to selected problems. At the end of the course the postgraduate student will be able to:

- 1) Choose the appropriate numerical method, check its convergence, accuracy and stability
- 2) Apply the numerical method, optimize it and compare the results with other methods

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, Project design and management

ICT Use Equity and Inclusion

Adaptation to new situations Respect for the natural environment

Decision making Sustainability

Autonomous work Demonstration of social, professional and moral responsibility and sensitivity to gender issues

Teamwork Critical thinking

Working in an international environment Promoting free, creative and inductive reasoning

Working in an interdisciplinary environment

Production of new research ideas

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Autonomous work.
- Production of free, creative and inductive thinking.
- Decision making.

3. COURSE CONTENT

- Initial Value Problems. Difference Equations.
- Single Step Methods. Runge-Kutta methods (Second order, Third order, Fourth order, Higher order). Calculation results. Convergence. Approximation of truncation errors). Elimination methods. Stability analysis. Implicit Runge-Kutta methods.
- Multistep Methods. Explicit multistep methods. (Adams, Bashforth, Nystrom, Types for $j=0,1,3,5$. Results of calculations with prediction methods). Implicit multistep methods. Multistep methods based on differentiation. General multi-step methods (determination of coefficients). Estimation of truncation error. Propagation Error Estimates). Prediction-Correction Methods.
- Numerical solution of systems of differential equations and differential equations of higher order.
- Convergence, stability of methods
- Numerov's method.

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD <i>Face to face, Distance learning, etc.</i>	Distance learning
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT)	Use of ICT technologies in Teaching and Communication with students

<i>Use of ICT in Teaching, in Laboratory Education, in Communication with students</i>													
<p>TEACHING ORGANIZATION</p> <p><i>The ways and methods of teaching are described in detail.</i></p> <p><i>Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.</i></p> <p><i>The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.</i></p>	<table border="1"> <thead> <tr> <th style="text-align: center;"><i>Activity</i></th> <th style="text-align: center;"><i>Workload/semester</i></th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td style="text-align: center;">39</td> </tr> <tr> <td>Research & Analysis</td> <td style="text-align: center;">0</td> </tr> <tr> <td>Review studies</td> <td style="text-align: center;">108</td> </tr> <tr> <td>Examinations</td> <td style="text-align: center;">3</td> </tr> <tr> <td>Total</td> <td style="text-align: center;">150</td> </tr> </tbody> </table>	<i>Activity</i>	<i>Workload/semester</i>	Lectures	39	Research & Analysis	0	Review studies	108	Examinations	3	Total	150
	<i>Activity</i>	<i>Workload/semester</i>											
	Lectures	39											
	Research & Analysis	0											
	Review studies	108											
	Examinations	3											
Total	150												
<p>STUDENT EVALUATION</p> <p><i>Description of the evaluation process</i></p> <p><i>Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others</i></p> <p><i>Please indicate all relevant information about the course assessment and how students are informed</i></p>	Examinations												

5. SUGGESTED BIBLIOGRAPHY

- Γ. Δ. Ακρίβης και Β. Α. Δουγαλής, Αριθμητικές Μέθοδοι για Συνήθεις Διαφορικές Εξισώσεις, Πανεπιστημιακές Εκδόσεις Κρήτης, 2006
- U. M. Ascher and L. R. Petzold, Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations, SIAM, Philadelphia, 1998.
- L. F. Shampine, Numerical Solution of Ordinary Differential Equations, Chapman and Hall, New York, 1994.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Avrilia Konguetsof
Contact details:	akogkets@civil.duth.gr
Supervisors: (1)	NO
Evaluation methods: (2)	Written examination by distance learning methods
Implementation Instructions: (3)	<p>• Failure to enter or entry at an unscheduled time will result in the student being disqualified from the exam. • Throughout the exam, examinees are connected to MS Teams and should have an open microphone so that there is uninterrupted audio contact between the examinee and the examiner. At the same time, they should immediately activate their microphone and camera in case they are asked for identification. • Required technological equipment: Ability to connect to the internet, use a camera, speakers, microphone, ability to scan/photograph the manuscript and create a pdf or compressed file in case of more than one page of response to a topic. • For the written exam, the examinees: (1) they will read the topics that will be posted in the eclass in the “Tasks” of the course one by one, (2) they will write their answer in Ms-Word (3) they will create a pdf or compressed zip/rar file and (4) they will upload it to eClass – Assignments - Submit Assignment, in a predetermined time (for each topic will be given a time proportional to its difficulty and extent) CAUTION! The file must be readable, otherwise they cannot be corrected and will be rejected. • Within the framework of actions for the protection of personal data, it is prohibited to record the examination process in any way, as well as to record or publish or post on websites or share with third parties or transmit or distribute in any way all or part of the distance examination. Also, it is the students' responsibility to protect their personal data by showing only what is required on camera. • Non-compliance of examinees with the rules of the examination and a finding of fraud on their part will result in the application of the plagiarism provisions. In the case of inability to participate in a remote assessment, the decision of the Rector's Council of the IFT will be made.</p>

(13) Please write YES or NO

(14) Note down the evaluation methods used by the teacher, e.g.

6. *written assignment* or/and exercises

7. written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(15) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises**: the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and **any other necessary information**.

b) in case of **oral examination with distance learning methods**: the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.