

## Mathematics II – Advanced Calculus

1. GENERAL			
<b>SCHOOL</b>	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
<b>DEPARTMENT</b>	Materials Science and Engineering		
<b>LEVEL OF STUDIES</b>	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
<b>COURSE CODE</b>	<b>MSEN 204</b>	<b>SEMESTER</b>	2 <sup>nd</sup> Semester
<b>COURSE TITLE</b>	<b>Mathematics II – Advanced Calculus</b>		
<b>TEACHING ACTIVITIES</b>	Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.	<b>TEACHING HOURS PER WEEK</b>	<b>ECTS CREDITS</b>
		4	6
<b>COURSE TYPE</b>	This is a <b>core/compulsory engineering mathematics course</b> that provides advanced calculus tools, including multivariable calculus, vector calculus, differential equations, and numerical methods, with a strong focus on applications in materials engineering, such as heat transfer, diffusion, stress analysis, and material behavior modeling		
<b>PREREQUISITES</b>	Mathematics II builds on foundational calculus concepts covered in Mathematics I and introduces advanced tools required for modeling and analyzing complex engineering systems.		
<b>TEACHING AND EXAMINATION METHODS</b>	Lectures, Homework assignments, Quizzes (algebra, analytic geometry, differentiation), Midterm examination, Final exam		
<b>COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes.		
<b>COURSE URL</b>	<a href="https://elearning.auth.gr/course/view.php?id=xxxxx">https://elearning.auth.gr/course/view.php?id=xxxxx</a>		

2. LEARNING OUTCOMES	
<b>Learning Outcomes</b>	Students will be able to apply advanced calculus, vector calculus, and differential equations to model and analyze materials engineering systems. They will perform multivariable optimization, evaluate multiple integrals, solve ODEs and PDEs, use Laplace transforms, and apply numerical methods to solve engineering problems, interpreting mathematical results in the context of heat transfer, diffusion, stress analysis, and material behavior.
<b>General Skills</b>	By the end of the course, students will develop advanced problem-solving, analytical thinking, and quantitative reasoning skills, apply mathematical modeling to materials engineering problems, use computational tools effectively, and communicate mathematical results clearly in engineering contexts.

### 3. COURSE CONTENT

This course covers advanced calculus tools essential for analyzing and modeling materials engineering systems. Topics include higher-order derivatives, Taylor series, multivariable calculus, partial derivatives, optimization, multiple integrals, vector calculus, and key theorems such as Green's, Stokes', and Divergence Theorem. Students also study ordinary and partial differential equations, Laplace transforms, and basic numerical methods. Emphasis is placed on applications to heat transfer, diffusion, stress analysis, and other core materials engineering processes.

### 4. LEARNING & TEACHING METHODS - EVALUATION

<b>Teaching method</b>	Face-to-face.												
<b>Use of ICT</b>	<p>ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows:</p> <p><b>Computational Tools for Problem Solving:</b> Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica</p> <p><b>Online Learning Platforms:</b> Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,</p> <p><b>Communication and Collaboration:</b> Online discussion forums, Collaborative documents, Sharing of data and reports</p> <p><b>Presentation and Reporting Tools:</b> Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</p>												
<b>Teaching organization</b>	<p>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).</p> <table border="1"> <thead> <tr> <th>Activity</th> <th>Workload/semester (hours)</th> </tr> </thead> <tbody> <tr> <td>Lectures</td> <td>52</td> </tr> <tr> <td>self-study, quizzes, on-line tests</td> <td>46</td> </tr> <tr> <td>Independent study</td> <td>50</td> </tr> <tr> <td>Final written exam</td> <td>2</td> </tr> <tr> <td><b>Total</b></td> <td><b>150</b></td> </tr> </tbody> </table>	Activity	Workload/semester (hours)	Lectures	52	self-study, quizzes, on-line tests	46	Independent study	50	Final written exam	2	<b>Total</b>	<b>150</b>
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<b>Total</b>	<b>150</b>												
<b>Student evaluation</b>	<p>Assessment Language: English</p> <ul style="list-style-type: none"> <li>Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</li> </ul>												

### 5. SUGGESTED BIBLIOGRAPHY

#### Course Bibliography

Mathematical Methods for Physics and Engineering: A Comprehensive Guide | ISBN: 978-0521679718 | Cambridge University Press, 2006

#### Additional bibliography for study

Advanced Engineering Mathematics | ISBN: 9781352010275 | Bloomsbury Publishing, 2020