Mathematics I – Algebra, Analytic Geometry and Introduction to Calculus

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	**MSEN 104**	**SEMESTER**	1st Semester
COURSE TITLE	**Mathematics I – Algebra, Analytic Geometry and Introduction to Calculus**		
TEACHING ACTIVITIES Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
		4	6
COURSE TYPE	Students will develop: • A foundational understanding of the physical principles needed for later courses in physics, engineering, and applied sciences. • Familiarity with the scientific method, evidence-based reasoning, and quantitative analysis, forming the conceptual groundwork for scientific problem-solving. Students will be able to: • Understand and apply the principles of conservation (energy, momentum, angular momentum). • Demonstrate an understanding of experimental measurement, units, and dimensional analysis. The course helps students develop important scientific and engineering skills such as: • Translating physical situations into mathematical equations. • Solving multi-step quantitative problems. • Using calculus-based methods to analyze motion and waves.		
PREREQUISITES	Mathematics Background ● Calculus I (or concurrent enrollment) Students should understand: ● Limits and derivatives ● Basic integral concepts ● Algebraic manipulation and trigonometry Students should be able to: ● Apply mathematical reasoning ● Analyze graphs and quantitative data Solve multi-step problems		
TEACHING AND EXAMINATION METHODS	Lectures, Homework assignments, Quizzes (algebra, analytic geometry, differentiation), Midterm examination, Final exam		
COURSE OFFERED TO ERASMUS STUDENTS	Yes.		
COURSE URL	https://elearning.auth.gr/course/view.php?id=xxxxx		

2. LEARNING OUTCOMES	
Learning Outcomes	Upon successful completion of course students will be able to: Apply algebraic methods to solve engineering problems involving equations, functions, and material property relationships. Use analytic geometry concepts—including lines, conic sections, and vectors—to model and interpret material structures and engineering systems. Demonstrate understanding of limits and continuity as foundations for describing rate-based physical and chemical processes. Compute and apply derivatives to analyze stress–strain behavior, optimize engineering processes, and model kinetics and diffusion. Perform basic integration to evaluate accumulated quantities such as work done in deformation, heat transfer, and mass transport. Interpret mathematical results and use quantitative reasoning to support analysis and decision-making in materials engineering contexts.
General Skills	By the end of the course, students will develop essential problem-solving, analytical thinking, and quantitative reasoning skills, gain the ability to communicate mathematical ideas clearly, use appropriate technical tools for modeling and visualization, and learn to connect mathematical methods to real materials engineering applications.

3. COURSE CONTENT

This course builds the mathematical foundation required for advanced study in materials engineering, emphasizing algebraic methods, geometric interpretation, and introductory calculus tools used in material behavior modeling, structural analysis, and process calculations.

1. Algebra (Engineering Foundations): Essential for material property calculations and processing equations. Applicable to stress–strain relationships, thermal expansion, and phase boundaries.
2. Analytical Geometry for microstructure imaging, crystallography projections, and mechanical plotting, modeling stress distributions, heat transfer paths, and optical properties, crystallographic directions, force systems, and material deformation analysis.
3. Introduction to Calculus: foundational for understanding rate-based material processes, Rates of change in thermal/chemical processes, Optimization in materials design and processing, identifying maximum strength points, minimum energy configurations, and analyzing dynamic systems. Accumulated change in heat or mass transport, Foundation for later courses in thermodynamics and transport phenomena
4. Relevance to Materials Engineering: Students learn mathematical tools that support: Mechanical behavior and elasticity analysis, Diffusion and kinetics modeling. Thermal processes and phase transformation calculations, Data analysis from material testing, Engineering design and optimization

4. LEARNING & TEACHING METHODS - EVALUATION	
Teaching method	Face-to-face.
Use of ICT	ICT plays a significant role in enhancing teaching, learning, experimentation, visualization, and assessment in this course as follows: Computational Tools for Problem Solving: Spreadsheet calculations (Excel, Google Sheets), Coding solutions in Python, MATLAB, or Mathematica

<table>
<tr><td></td><td>Online Learning Platforms: Learning management systems (LMS) like Moodle, Online lectures, video tutorials, and animations,
Communication and Collaboration: Online discussion forums, Collaborative documents, Sharing of data and reports
• Presentation and Reporting Tools: Lab reports (word processors), Data plots and charts (graphing tools), Presentations (PowerPoint, Google Slides).</td></tr>
<tr><td>Teaching organization</td><td>The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).
<table>
<tr><th>Activity</th><th>Workload/semester (hours)</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>self-study, quizzes, on-line tests</td><td>48</td></tr>
<tr><td>Independent study</td><td>48</td></tr>
<tr><td>Final written exam</td><td>2</td></tr>
<tr><td>Total</td><td>150</td></tr>
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<tr><td>Student evaluation</td><td>Assessment Language: English
• Assessment Methods: Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Written Exams</td></tr>
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5. SUGGESTED BIBLIOGRAPHY

Course Bibliography

Introductory Mathematics for Engineering Applications | ISBN: 978-1119604426 | Wiley 2021

Additional bibliography for study

Technical Calculus with Analytic Geometry | ISBN: 978-0201711127 | Pearson 2001