Alanya Alaaddin Keykubat University | Rafet Kayış Faculty of Engineering
**Mechanical Engineering Department**
2024-2025 Spring Semester

**Syllabus**

| | |
|---|---|
| **Code/Name** | MEC 208 / Numerical Methods |
| **Type** | Required |
| **Credit/ECTS** | 3/4 |
| **Hour per Week** | 3 (3+0+0) |
| **Level/Year** | Undergraduate/2 |
| **Semester** | Spring |
| **Classroom** | Thursday | A003 |
| **Content** | Introduction to Numerical Analysis and Error Analysis, Solutions of Equations in One Variable, Interpolation and Polynomial Approximation, Numerical Differentiation, Numerical Integration, Numerical solutions to the initial-value problems for ordinary differential equations. |
| **Prerequisites** | - |
| **Textbooks** | *Primary*<br>Lecture Notes.<br>*Supplementary*<br>R. L. Burden and J. D. Faires, Numerical Analysis, 9th edition, Brooks/Cole, Cengage Learning Canada, 2010.<br>S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, 8th edition, McGraw-Hill, 2021. |
| **Objectives** | ● To give the ability to make error analysis in the results obtained by numerical methods<br>● To introduce the concepts of numerical methods to engineering students<br>● To gain the ability to use numerical methods concepts and techniques for finding approximate solutions to some kinds of problems such as root-finding problems, interpolation and polynomial fitting, numerical differentiation and integration and numerical solutions to the initial-value problems for ordinary differential equations.<br>● To gain the ability to figure out how numerical methods can be applied to engineering problems. |
| **Course Outcomes** | In this course you will be able to:<br>CO1 The ability to develop numerical solution algorithms for a given problem and perform error analysis for the obtained results,<br>CO2 The ability to apply an appropriate method to root-finding problems,<br>CO3 The ability to apply various interpolation and polynomial approximation in the solution of engineering problems,<br>CO4 The ability to apply numerical differentiation and integration methods in the solution of engineering problems,<br>CO5 The ability to understand engineering problems expressed by ODEs and give a numerical solution to the initial-value problems for ordinary differential equations. |

**Weekly Schedule of Topics**

| W | Topic |
|---|---|
| 1 | Introduction to numerical analysis and error analysis. Taylor polynomial and Truncation error. Round-off error. |
| 2 | Decimal Machine Numbers (with "chopping" and "rounding"). Finite-Digit Arithmetic. Error definitions. True error. Absolute error. Relative error. Percent relative error. Approximate error. Relative approximate error. Percent relative approximate error. Definitions of tolerance and the stopping criteria. |
| 3 | Solutions of Equations in One Variable (root-finding problem). Bisection method. Newton's Method (Newton-Raphson Method). Secant method. |
| 4 | Fixed-Point Iteration. False Position (Regula Falsi) Method. |

| 5 | Interpolation and Polynomial Approximation. Lagrange Interpolation. |
|---|---|
| 6 | Newton interpolation. Linear Interpolation. Quadratic interpolation. General form of Newton's interpolating polynomials. |
| 7 | Divided-differences and Newton's Divided-Difference Formula. |
| 8 | Forward-Difference operator. Newton Forward-Difference formula. Backward-Difference operator. Newton Backward-Difference formula. |
| 9 | Numerical Differentiation. Three-Point Formulas. Five-Point Formulas. Higher-order numerical differentiation. |
| 10 | Elements of Numerical Integration. Numerical quadrature. Quadrature formula. |
| 11 | Trapezoidal Rule. Simpson's Rule. Closed Newton-Cotes formulas. Open Newton-Cotes formulas. |
| 12 | Composite Numerical Integration. Gaussian Quadrature. Multiple Integrals. |
| 13 | Initial-Value Problems for Ordinary Differential Equations. The Elementary Theory of Initial-Value Problems. Euler's Method. |
| 14 | Higher-Order Taylor Methods. Runge-Kutta Methods. |

| **Professional Contribution** | In general, the ability to apply an appropriate numerical method to some problems and obtain an approximate solution for the problem. |
|---|---|

**Contribution to Program Outcomes***

|  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 5 | 4 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |
| CO2 | 5 | 4 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |
| CO3 | 5 | 4 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |
| CO4 | 5 | 4 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |
| CO5 | 5 | 4 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |

* Contribution Level | 0: None | 1: Very Low | 2: Low | 3: Medium | 4: High | 5: Very High

| **Special Conditions** | - |
|---|---|
| **Requirements** | The ability to use a scientific calculator is required and the usage of a "Standard Scientific Calculator" is compulsory during numerical computations. |
| **Course Policy** | ● According to ALKU Undergraduate Education - Teaching and Examination Regulation; **70% attendance** in theoretical courses is **mandatory**. Students who cannot meet these conditions cannot take the end-of-term exam (final exam) and are given a letter grade of **DZ**. |
| **Cheating & Plagiarism** | ● According to ALKU Undergraduate Education - Teaching and Examination Regulation; the exam of a student who attempts to cheat, cheats or assists in cheating, has someone else take the exam instead of him/herself, or takes the exam in someone else's place is considered invalid and necessary legal action is taken against him/her. |
| **Evaluation** | Midterm 40% <br> Final Exam 60% <br> Total 100% |
| **Rubric** | According to ALKU Undergraduate Education - Teaching and Examination Regulation; Success grade evaluation is carried out according to the relative evaluation system by taking into account the distribution of grades and the class average, together with the raw success grade, and the general success level of the class. Students who do not take the end-of-term exam (final exam) are given a grade of **FF**. |

**Instructor**

| Name/Surname | İrem Küçükoğlu | Email | irem.kucukoglu@alanya.edu.tr |
|---|---|---|---|
| Room | 420 | Office Hours | Thursday 10.00-12.00 |

Prepared by İrem Küçükoğlu on February 2nd, 2025.