| COURSE INFORMATION | | | | | |
|---|---|---|---|---|---|
| **Course Title** | *Code* | *Semester* | *L+P Hour* | *Credits* | *ECTS* |
| Numerical Analysis | ES 272 | Fall | 2 + 2 | 3 | 6 |

| **Prerequisites** |
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| MATH 132, ES 112 or CSE 114 or ES 117 or ES 118 |

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| **Language of Instruction** | English |
| **Course Level** | Bachelor's Degree (First Cycle Programmes) |
| **Course Type** | Compulsory |
| **Course Coordinator** | Onur Cem Namlı |
| **Instructors** | Gulten Polat, Kamil Erkan |
| **Assistants** | |
| **Goals** | This course serves as an introduction to numerical procedures that are common to engineering discipline, and their implementation using Matlab or an equivalent software. |
| **Content** | Computer arithmetic, sources of error, error propagation. Approximating functions, interpolation. Solution of linear system of algebraic equations via direct methods. Roots of nonlinear algebraic equations. Numerical integration and differentiation, Ordinary differential equations. |

| **Learning Outcomes** | **Program Outcomes** | **Teaching Methods** | **Assessment Methods** |
|---|---|---|---|
| 1) Define the consequences of digital arithmetic, estimate numerical accuracy of floating-point computations, function approximation and error propagation. | 1 | 1,2,3 | A,B,C |
| 2) Formulate an approximate solution procedure to an engineering problem, apply basic numerical techniques in this procedure and assess the accuracy and stability of the resulting solution. | 2 | 1,2,3 | A,B,C |
| 3) Select and customize appropriate algorithms from numerical libraries, implement them as computer code files, and integrate files to construct a complete set of procedures. | 4,8 | 2,3 | B,C |

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| **Teaching Methods:** | 1: Lecture, 2: Homework, 3: Laboratory |
| **Assessment Methods:** | A: Midterm and final exams, B: Homework, C: In-class practice |

| COURSE CONTENT | | |
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| **Week** | **Topics** | **Study Materials** |
| 1 | Introduction to numerical analysis. | |

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| 2 | Error analysis in numerical methods. |
| 3 | Error in Taylor and Maclaurin series, Error propagation through computations. |
| 4 | Root-finding methods, Bracketing methods; Bisection and False-Position methods. |
| 5 | Root-finding methods, Open methods; Newton-Raphson and Secant methods. |
| 6 | Linear systems, Elimination methods; Iterative methods; Matrix condition. |
| 7 | Midterm Exam. |
| 8 | Curve Fitting, Least Squares Regression, and Linearization of non-linear equations. |
| 9 | Interpolation methods; Direct interpolation, Newton and Lagrange interpolation methods. |
| 10 | Numerical integration; Trapezoidal rule, Newton-Cotes integration formulas. |
| 11 | Numerical differentiation; Forward, Backwards and Centered divided differences methods. |
| 12 | Midterm Exam. |
| 13 | Numerical Solution of Ordinary Differential Equations (ODEs), Euler's method, Runge-Kutta methods. |
| 14 | Systems of ODEs, Boundary value problems, Shooting method. |

| **RECOMMENDED SOURCES** | |
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| **Textbook** | "Applied Numerical Methods with MATLAB for Engineers and Scientists", Steven C. Chapra, McGrawHill, 3rd Ed. |
| **Additional Resources** | Atkinson, K., Elementary Numerical Analysis, 3nd Ed, Wiley, 1993.M. Heath, Scientific Computing: An Introductory Survey, 2nd ed, McGraw Hill, 2002<br>MATLAB reference manual |

| **MATERIAL SHARING** | |
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| **Documents** | Lecture notes, related links |
| **Assignments** | Homeworks |
| **Exams** | Exams and solutions (excluding the final) |

| **ASSESSMENT** | | |
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| **IN-TERM STUDIES** | **NUMBER** | **PERCENTAGE** |
| Mid-terms | 2 | 60 |
| Assignment | 4 | 40 |
| **Total** | | **100** |
| **CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE** | | 40 |
| **CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE** | | 60 |
| **Total** | | **100** |

| COURSE CATEGORY | Background |
|---|---|

| COURSE'S CONTRIBUTION TO PROGRAM | | | | | | |
|---|---|---|---|---|---|---|
| No | Program Learning Outcomes | Contribution | | | | |
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Adequate knowledge in mathematics, science and engineering subjects pertaining to the relevant discipline; ability to use theoretical and applied information in these areas to model and solve engineering problems. | | | X | | |
| 2 | Ability to identify, formulate, and solve complex engineering problems; ability to select and apply proper analysis and modeling methods for this purpose. | | | | | X |
| 3 | Ability to design a complex system, process, device or product under realistic constraints and conditions, in such a way as to meet the desired result; ability to apply modern design methods for this purpose. | X | | | | |
| 4 | Ability to devise, select, and use modern techniques and tools needed for engineering practice; ability to employ information technologies effectively. | | | | X | |
| 5 | Ability to design and conduct experiments, gather data, analyze and interpret results for investigating engineering problems. | X | | | | |
| 6 | Ability to work efficiently in intra-disciplinary and multi-disciplinary teams. Ability to work individually. | X | | | | |
| 7 | Ability to communicate effectively both orally and in writing; knowledge of a minimum of one foreign language. | X | | | | |
| 8 | Recognition of the need for lifelong learning; ability to access information, to follow developments in science and technology, and to continue to educate him/herself. | | | X | | |
| 9 | Awareness of professional and ethical responsibility. | X | | | | |
| 10 | Information about business life practices such as project management, risk management, and change management; awareness of entrepreneurship, innovation, and sustainable development. | X | | | | |
| 11 | Knowledge about contemporary issues and the global and societal effects of engineering practices on health, environment, and safety; awareness of the legal consequences of engineering solutions. | X | | | | |

| ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION | | | |
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| Activities | Quantity | Duration (Hour) | Total Workload (Hour) |
| Course Duration (Including the exam week: 16x Total course hours) | 16 | 4 | 64 |
| Hours for off-the-classroom study (Pre-study, practice) | 16 | 2 | 32 |
| Mid-terms | 2 | 6 | 12 |
| Homework | 4 | 6 | 24 |
| Final examination | 1 | 8 | 8 |
| **Total Work Load** | | | 140 |

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| **Total Work Load / 25 (h)** | 5.6 |
| **ECTS Credit of the Course** | 6 |