# MATH 301 - Numerical Methods and Scientific Computing

| Course Code | Course Name | Semester | |
|---|---|---|---|
| MATH 301 | Numerical Methods and Scientific Computing | Fall ☒ Spring ☐ Summer ☐ | |
| **Hours** | | **Credit** | **ECTS** |
| **Theory** | **Practice** / **Lab** | 3 | 5 |
| 3 | 0 / 0 | | |

| **Course Details** | |
|---|---|
| **Department** | Computer Engineering |
| **Course Language** | English |
| **Course Level** | Undergraduate ☒ Graduate ☐ |
| **Mode of Delivery** | Face to Face ☒ Online ☐ Hybrid ☐ |
| **Course Type** | Compulsory ☒ Elective ☐ |
| **Course Objectives** | Understand numerical methods in solving real-world scientific problems.<br>Analyze and evaluate the accuracy, stability, and convergence.<br>Solve linear and nonlinear equations.<br>Implement numerical methods through programming languages<br>Apply interpolation and approximation techniques.<br>Numerically solve differential equations (ODEs and PDEs).<br>Optimize algorithms for computational efficiency and performance.<br>Develop problem-solving skills using numerical simulations.<br>Communicate results effectively through visualization and error analysis. |
| **Course Content** | Introduction to Numerical Methods<br>Overview of numerical methods, sources of error, and computational tools<br>Root-Finding Methods<br>Solving linear systems<br>Interpolation and Approximation<br>Numerical Differentiation and Integration<br>Solving ODEs and PDEs<br>Practical Applications |
| **Course Method/ Techniques** | Lecture ☒ Question & Answer ☐ Presentation ☐ Discussion ☐ |
| **Prerequisites/ Corequisites** | |
| **Work Placement(s)** | |
| **Textbook/References/Materials** | |

- Chapra, S and Canale R (2021) Numerical Methods for Engineers, 8th Edition, Mc-Graw Hill.
- Course notes

| **Course Category** | | | | |
|---|---|---|---|---|
| Mathematics and Basic Sciences | ☒ | | Education | ☒ |
| Engineering | ☒ | | Science | ☒ |
| Engineering Design | ☐ | | Health | ☐ |
| Social Sciences | ☐ | | Profession | ☐ |

**Weekly Schedule**

| No | Topics | Materials/Notes |
|---|---|---|
| 1 | Course description, introduction | Course description, introduction, error in numerical analysis |
| 2 | Solution of nonlinear equations | Root finding: Secant method, Bisection and Newton Raphson Iteration Methods |
| 3 | Solution of nonlinear equations | Regula Falsi method, Fixed point iteration method |
| 4 | Solution of systems of linear equations | Gauss elimination, Gauss-Jordan elimination, LU decomposition |
| 5 | Solution of systems of linear equations | Matrix inversion, Gauss-Siedel iteration method |
| 6 | Least-square regression | Linear Regression, Polynomial regression, Non-linear regression |
| 7 | Interpolation and polynomial approximation, curve-fitting | Interpolation Polynomials, Lagrange interpolation, Newton Interpolation |
| 8 | Midterm Exam | |
| 9 | Numerical differentiation | Numerical differentiation |
| 10 | Numerical differentiation | Numerical differentiation |
| 11 | Numerical integration | Trapezoid rule, Simpson rule |
| 12 | Numerical integration | Composite Simpson rule, Romberg integration |
| 13 | Solution of order ordinary differential equations | Euler method, 2nd order Runge-Kutta Method, 4th order Runge-Kutta Method |
| 14 | Solution of partial differential equations | Techniques for solving PDEs with finite difference methods. |
| 15 | Boundary value problems | Boundary value problems |
| 16 | Final Exam | |

| **Assessment Methods and Criteria** | | |
|---|---|---|
| **In-term studies** | **Quantity** | **Percentage** |
| Attendance | | |
| Lab | | |
| Practice | | |
| Fieldwork | | |
| Course-specific internship | | |
| Quiz/Studio/Criticize | | |
| Homework | 4 | 20% |
| Presentation / Seminar | | |
| Project | | |
| Report | | |
| Seminar | | |
| Midterm Exam | 1 | 30 |
| Final Exam | 1 | 50 |
| | **Total** | **100%** |
| **Contribution of Midterm Studies to Success Grade** | | 50 |
| **Contribution of End of Semester Studies to Success Grade** | | 50 |
| | **Total** | **100%** |

| **ECTS Allocated Based on Student Workload** | | | |
|---|---|---|---|
| **Activities** | **Quantity** | **Duration (Hrs)** | **Total Workload** |
| Course Hours | 16 | 3 | 48 |
| Lab | | | |
| Practice | | | |
| Fieldwork | | | |
| Course-specific Work Placement | | | |
| Out-of-class study time | | | |
| Quiz/Studio/Criticize | | | |
| Homework | 4 | 8 | 32 |
| Presentation / Seminar | | | |
| Project | | | |
| Report | | | |
| Midterm Exam and Preparation for Midterm | 1 | 20 | 20 |
| Final Exam and Preparation for Final Exam | 1 | 20 | 20 |
| **Total Workload** | | | **120** |
| **Total Workload / 25** | | | **4.80** |
| **ECTS Credit** | | | **5** |

| **Course Learning Outcomes** | |
|---|---|
| **No** | **Outcome** |
| **L1** | to solve real-life and engineering applications reflecting the student ability. |
| **L2** | to recognize and apply appropriate theories, principles and concepts relevant to numerical methods. |
| **L3** | to assess and evaluate the literature within the field of numerical methods. |
| **L4** | to analyze and interpret information from a variety of sources relevant to numerical methods. |
| **L5** | to compare numerical methods for advantages and drawbacks. |
| **L6** | to choose the suitable numerical method among several existing methods for a specific type of problem and develop the computational solution. |
| **L7** | to implement numerical methods using any of existing programming languages and compare them. |

**Contribution of Course Learning Outcomes to Program Outcomes**

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

| | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** | **P8** | **P9** | **P10** | **P11** | **P12** | **P13** | **P14** | **P15** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **L1** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L2** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L3** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L4** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L5** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L6** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| **L7** | 5 | 5 | | 5 | | 5 | 5 | 3 | 3 | | | | | | | 29 |
| | | | | | | | | | | | | | | | **Total** | |