

**Course Title:** Numerical analysis of Ordinary Differential Equations

**Course Description:** Theory and implementation of numerical methods for initial and boundary value problems in ordinary differential equations. One-step, linear multi-step, Runge-Kutta, and extrapolation methods; convergence, stability, error estimates, and practical implementation, Study and analysis of shooting, finite difference and projection methods for boundary value problems for ordinary differential equations.

**Prerequisite:** Math 471 or consent of the instructor

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|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Textbook:</b>   | Numerical Methods for Ordinary Differential Equations, J. Butcher, 3rd ed, 2016                                                                                            |
| <b>References:</b> | Numerical Solution of ODEs, E. Suli, 2022<br>Numerical methods for ODEs, Griffiths & Higham, 2010<br>Finite difference methods for ordinary and partial Des, Leveque, 2007 |

**Learning Outcomes:**

1. Define the fundamental concepts of numerical methods for ODEs.
2. Explain the merits and limitations of each numerical method.
3. Use numerical methods for solving ordinary differential equations.
4. Analyze numerical methods based on their accuracy and stability.
5. Develop algorithms that describe the steps of numerical methods.
6. Implement algorithms for solving ODEs using suitable software.

**Assessment:** Assignments 30%, Project 10%, Midterm Exam 25%, Final Exam 35%

| WK        | Date          | Topics                         |
|-----------|---------------|--------------------------------|
| 1         | Jan 15-17     | Preliminaries and IVP          |
| 2         | Jan 22-24     | One-step methods               |
| 3         | Jan 29-31     |                                |
| 4         | Feb 05-07     | Linear multistep methods       |
| 5         | Feb 12-14     |                                |
| 6         | Feb19-21      | Runge-Kutta methods            |
| 7         | Feb 26-28     |                                |
| 8         | Mar 05-07     |                                |
| 9         | Mar 12-14     | Stiff problems                 |
| 10        | Mar 19-21     | Richardson extrapolation       |
| 11        | Mar 26-28     | Boundary value problem methods |
| 12        | Apr 02-04     |                                |
| 13        | Apr 09-11     |                                |
| Eid break |               |                                |
| 14        | Apr 30-May 02 | Project presentations          |
| 15        | May 07-09     | Review                         |