UMBRA INSTITUTE
PERUGIA, ITALY

MATH 260: Differential Equations

Summer Session I – 2026
Instructor: TBD
Credits: 3
Contact Hours: 45
Prerequisites: Calculus II (e.g., MATH 1132Q at UConn, MATH 1320 at UVA, or equivalent); Linear Algebra recommended
Class Meeting Days & Time: TBD (e.g., M/T/W/Th, 9:00 AM–11:15 AM)
Office Hours: By appointment after class or via Zoom (see Moodle)
Email: TBD
Course Type: Standard Course
Course Fee: TBD with Institute staff

Course Description
This course introduces ordinary differential equations (ODEs), emphasizing analytical techniques, computational methods, and applications in engineering, physics, and biology. Topics include first- and second-order ODEs, systems of ODEs, Laplace transforms, series solutions, and applications to modeling. Optional computational labs using MATLAB or Python enhance problem-solving and visualization, preparing students for advanced mathematics and applied fields.
Learning Outcomes and Assessment Measures

By the end of this course, students will be able to:

- Solve first-order ODEs using separation of variables, integrating factors, and exact methods (Quizzes, Problem Sets, Midterm, Final).
- Solve second- and higher-order linear ODEs with constant and variable coefficients (Quizzes, Problem Sets, Midterm, Final).
- Analyze systems of ODEs using matrix methods (Problem Sets, Midterm, Final).
- Apply Laplace transforms and series solutions to ODEs (Problem Sets, Final).
- Model physical systems using ODEs (e.g., circuits, oscillations) (Problem Sets, Computational Labs).
- Use computational tools (optional) to solve and visualize ODE solutions (Computational Labs).

Course Materials
Textbook

- Boyce, W. E., & DiPrima, R. C. (2022). *Elementary Differential Equations and Boundary Value Problems* (12th ed.). Wiley.

Additional Resources

- Course reader with supplementary notes and practice problems on Moodle.
- Software (optional): MATLAB or Python (NumPy, SciPy) for computational labs, accessible via institutional licenses or free downloads.

- Moodle: Primary location for readings, assignments, and announcements.

Assessment

- **Attendance**: 10%
- **Quizzes**: 15% (weekly, in-class, testing core skills)
- **Problem Sets**: 25% (weekly, theoretical and applied problems)
- **Computational Labs**: 10% (weekly, MATLAB/Python, optional, submitted via Moodle)
- **Midterm Exam**: 25% (Week 3, covering Weeks 1–2)
- **Final Exam**: 25% (Week 5, comprehensive)

Grading
(See Umbra Policies)

Course Requirements

- **Attendance**: One excused absence allowed. Each unexcused absence deducts 4% from the final grade (max 10%).
- **Quizzes**: Weekly, in-class, assessing foundational skills.
- **Problem Sets**: Weekly, submitted via Moodle, covering theoretical and applied problems.
- **Computational Labs**: Weekly, optional, using MATLAB/Python for numerical solutions or visualizations, submitted via Moodle. Students may opt for additional Problem Set problems if not completing labs.
- **Midterm Exam**: In-class, Week 3, covering Weeks 1–2.
- **Final Exam**: In-class, Week 5, comprehensive.
- **Late Work**: Zero for late submissions, except one 24-hour extension (email instructor before deadline).

Policies
Attendance
(See Umbra Policies)

Tardiness
(See Umbra Policies)

Academic Integrity
(See Umbra Policies)

Classroom Policy
(See Umbra Policies)

Schedule of Topics, Readings, and Assignments

Week 1: First-Order Differential Equations

- **Meeting 1**: Introduction to ODEs, separable equations.
- **Meeting 2**: Linear first-order equations, integrating factors; MATLAB/Python assistance (numerical solutions).
- **Meeting 3**: Exact equations, applications (e.g., population models).
- **Meeting 4**: Modeling with first-order ODEs; MATLAB/Python assistance (plotting solutions); Quiz 1.
- **Readings**: Boyce & DiPrima, Sections 1.1–1.3, 2.1–2.3.

- **Assignments**:
    - **Problem Set 1**: Solve separable and linear first-order ODEs, analyze exact equations, model growth/decay problems.
    - **Computational Lab 1** (optional): Use MATLAB/Python to solve first-order ODEs numerically (e.g., ode45 in MATLAB). Submit .m or .py file via Moodle.

Week 2: Second-Order Linear Differential Equations

- **Meeting 1**: Homogeneous second-order ODEs with constant coefficients.
- **Meeting 2**: Non-homogeneous ODEs, undetermined coefficients; MATLAB/Python assistance (second-order solutions).
- **Meeting 3**: Variation of parameters, applications (e.g., oscillations).
- **Meeting 4**: Mechanical and electrical systems; MATLAB/Python assistance (oscillation modeling); Quiz 2.
- **Readings**: Boyce & DiPrima, Sections 3.1–3.5, 3.7.
- **Assignments**:
    - **Problem Set 2**: Solve homogeneous/non-homogeneous second-order ODEs, apply variation of parameters, model spring-mass systems.
    - **Computational Lab 2** (optional): Use MATLAB/Python to solve and plot second-order ODEs (e.g., odeint in SciPy). Submit .m or .py file via Moodle.

Week 3: Higher-Order ODEs and Systems

- **Meeting 1**: Higher-order linear ODEs.
- **Meeting 2**: Systems of first-order ODEs, matrix methods; MATLAB/Python assistance (system solutions).
- **Meeting 3**: Eigenvalue methods for systems, applications.
- **Meeting 4**: Midterm Exam (covers Weeks 1–2); MATLAB/Python assistance (system visualizations).
- **Readings**: Boyce & DiPrima, Sections 3.8, 7.1–7.5.
- **Assignments**:
    - **Problem Set 3**: Solve higher-order ODEs, analyze systems using eigenvalues, model coupled systems.
    - **Computational Lab 3** (optional): Use MATLAB/Python to solve systems of ODEs (e.g., eig for eigenvalues). Submit .m or .py file via Moodle.

Week 4: Laplace Transforms

- **Meeting 1**: Laplace transform definitions, properties.
- **Meeting 2**: Solving ODEs with Laplace transforms; MATLAB/Python assistance (Laplace transforms).
- **Meeting 3**: Inverse transforms, step and impulse functions.
- **Meeting 4**: Applications (e.g., circuits); MATLAB/Python assistance (circuit modeling); Quiz 3.
- **Readings**: Boyce & DiPrima, Sections 6.1–6.4, 6.6.
- **Assignments**:
    - **Problem Set 4**: Compute Laplace transforms, solve ODEs, model systems with step functions.
    - **Computational Lab 4** (optional): Use MATLAB/Python to compute Laplace transforms or simulate circuits (e.g., sympy.laplace_transform). Submit .m or .py file via Moodle.

Week 5: Series Solutions and Applications

- **Meeting 1**: Series solutions near ordinary points.
- **Meeting 2**: Series solutions near regular singular points; MATLAB/Python assistance (series solutions).
- **Meeting 3**: Applications (e.g., Bessel functions); MATLAB/Python assistance (Bessel function plotting).
- **Meeting 4**: Final Exam (comprehensive); MATLAB/Python assistance (review applications); review (finalize lab submission).
- **Readings**: Boyce & DiPrima, Sections 5.1–5.3, 5.7.
- **Assignments**:
  - **Problem Set 5**: Find series solutions, analyze Bessel functions, apply to physical systems.
  - **Computational Lab 5** (optional): Use MATLAB/Python to plot series solutions or Bessel functions (e.g., scipy.special.jn). Submit .m or .py file via Moodle.