SANT'ANNA INSTITUTE SORRENTO

COURSE NUMBER AND TITLE: MATH 331 - Differential Equations
(4 credits)

Prerequisites: Calculus II

This syllabus is informational in nature and is not an express or implied contract. It is subject to change due to unforeseen circumstances, as a result of any circumstance outside the University's control, or as other needs arise. If, in the University's sole discretion, public health conditions or any other matter affecting the health, safety, upkeep, or well-being of our campus community or operations requires the University to move to remote teaching, alternative assignments may be provided so that the learning objectives for the course, as determined by the faculty and the University, can still be met. The University does not guarantee specific in-person, on-campus classes, activities, opportunities, or services or any other particular format, timing, or location of education, classes, activities, or services.

Mask Policy

Please be advised that the mask policy in this class will follow Sant'Anna Institute requirements. When/if the University enacts a mask policy, all students are expected to adhere to the policy.

COURSE DESCRIPTION

This course provides a comprehensive introduction to ordinary differential equations (ODEs) and their applications in science, engineering, and mathematics. Students will learn methods for solving first-order differential equations, including separable, exact, and linear equations. The course covers higher-order linear differential equations with constant and variable coefficients, along with techniques such as undetermined coefficients and variation of parameters.
Additionally, students will explore systems of differential equations, eigenvalues and eigenvectors, and stability analysis. The use of Laplace transforms for solving initial value problems and differential equations with discontinuous forcing functions is included. Series solutions near ordinary and singular points are introduced to handle more complex equations.

Throughout the course, emphasis is placed on modeling real-world phenomena from physics, biology, and engineering, developing both analytical and numerical solution strategies.

COURSE OBJECTIVES / LEARNING OUTCOMES

At the end of the course students will be able to:

- Solve first-order ordinary differential equations using methods such as separation of variables, integrating factors, and exact equations.
- Analyze and solve higher-order linear differential equations with constant and variable coefficients using appropriate solution techniques.
- Apply Laplace transforms to solve initial value problems, including those with discontinuous or impulsive forcing functions.
- Model and solve systems of linear differential equations, using matrix methods and eigenvalue analysis.
- Develop power series solutions to differential equations near ordinary and singular points.
- Interpret the qualitative behavior of solutions, including stability and phase plane analysis.
- Use computational tools and numerical methods to approximate solutions to differential equations that cannot be solved analytically.
- Translate real-world problems from science and engineering into differential equation models and analyze their solutions.

REFERENCE TEXTS

- The main reference text is: *Elementary Differential Equations and Boundary Value Problems*, by William E. Boyce and Richard C. DiPrima, latest edition.

EXAMS and ASSIGNMENTS

Student performance will be assessed through the following components:

- Homework Assignments (20%)

Regular problem sets focused on solving various types of differential equations and applying methods learned in class.

- Quizzes (10%)

Short tests to evaluate understanding of recent topics and techniques.

- 2 Mid Term Exams (30%)

Written exams assessing conceptual knowledge and problem-solving abilities on material covered before the exam.

- Final Exam (25%)

Comprehensive exam covering the full course content.

- Attendance and Participation (15%)

Attendance and active engagement in lectures and discussions.

GRADING SCALE

A	95%-100%
A-	90%-94%
B+	87%-89%
B	83%-86%
B-	80%-82%
C+	77%-79%
C	73%-76%
C-	70%-72%
D+	67%-69%
D	63%-66%
D-	60%-62%
F	< 60

SCHEDULE OF TOPICS

1. Introduction to Differential Equations

- Definition and terminology
- Order and degree
- Initial value and boundary value problems

2. First-Order Differential Equations

- Separable equations

- Linear first-order equations
- Exact equations and integrating factors
- Applications and modeling with first-order ODEs

3. Second-Order Linear Differential Equations

- Homogeneous equations with constant coefficients
- Characteristic equation and solutions
- Nonhomogeneous equations: method of undetermined coefficients and variation of parameters

4. Higher-Order Linear Differential Equations

- General theory and solutions
- Reduction of order

5. Systems of Differential Equations

- Introduction to systems
- Matrix methods and eigenvalues
- Phase plane analysis and stability

6. Laplace Transforms

- Definition and properties
- Inverse Laplace transform (basic notions)
- Solving initial value problems
- Handling discontinuous and impulsive forcing functions

7. Series Solutions of Differential Equations

- Power series solutions near ordinary points
- Frobenius method for singular points

8. Numerical Methods

- Euler's method
- Improved Euler and Runge-Kutta methods (brief introduction)

9. Applications and Modeling

- Mechanical vibrations
- Population models
- Electrical circuits
- Other applied problems

CLASS POLICY

Attendance

You are allowed **ONE** unexcused absence. Documentation for any other absence MUST be produced and APPROVED by your faculty. For absences due to illness, please provide the faculty with a doctor's note upon returning to class as well as inform them and/or the Office the first day of illness.

Participation grants the student one point for each lesson they attend. Unjustified absences result in 0 points. Participation in **field-trips,** if any, awards 2 points, while non-participation results in a loss of 2 points.

Both by school policy and Italian law attendance at all classes is required of all students. (Yes, your student visa is dependent on perfect attendance.) Even so, I will reward students (round a borderline grade up) for perfect or very good attendance, but I am also forced by school policy to penalize students who accrue more than two unexcused absences, so please do your very best to be here and engaged when you are here. Students are expected to arrive at class on time, having completed the readings and written assignments due that day (see schedule below), in order to receive a passing (C or better) grade.

Since our texts are provided in electronic form, you will have a laptop in front of you during our class sessions, both the literary discussions and the workshops. Having lived for some years in a world free of such devices, I can tell you from experience that your laptop is *not* your friend, that it has already damaged your ability to concentrate and made it far more difficult for you to stay focused and benefit from classroom education than those of us lucky enough to have studied before this very tempting distraction-machine was invented. Serious psychological studies have demonstrated again and again that the laptop (and the myth of "multitasking") is seriously detrimental to human information retention, that taking notes on a computer is a far less effective memory jog than notes written on paper, and that the distractions that computers offer (social media, online shopping, games, etc.) are the greatest impediments to your education at the present moment. Please do your best to defeat these temptations and use the

laptop only to refer to the text under discussion and, if you must, to take notes and jot down thoughts, interpretations, and possible paper topics. For 1.5 hours twice a week, please try your best to leave the buzz of the cyber world behind, to stay with us and live "in the moment." This is your only hope.

Late submissions:
Assignments not submitted by the due date will receive a penalty of 10% for the first 24 hours, 20% for a 48-hour delay. No submissions will be accepted more than 3 days after the deadline, unless arrangements have been made with the instructor (for extensions under exceptional circumstances, apply to the course instructor).

Personal Technology:
Please turn cell phones off during class. You can use laptops to take notes, however social networking, e-mailing, surfing the Internet, playing games, etc. are forbidden during class. Any student caught using their laptop/cell phones inappropriately during class will be asked to turn them off. Repeated violations of this rule after the first warning will result in the student being marked absent for the day and permanently losing their laptop privileges. Please be respectful and limit your use of personal electronic devices during class to academic purposes.

Contesting a grade:
If students wish to contest a grade, they must make an appointment to do so in person. The student should contact the instructor with any concerns within ONE week of receiving the grade. The student must also demonstrate that they have read the comments accompanying the grade by presenting a brief written statement specifying why the grade does not reflect the quality of the work. It is at the discretion of the instructor to decide whether the work and the student's request warrant any increase or decrease in the grade. Students should retain a copy of all submitted assignments and feedback (in case of loss) and should also retain all of their marked assignments.

Recommended behavior:

- Class begins promptly at the beginning of the class period. It is advisable that you be in your seat and ready to start participating in class at that time.
- Always bring the required supplies and be ready to be actively engaged in the learning process. This communicates preparedness and interest.
- Turn your cell phone off or to vibrate mode before the start of class;
- It is fine to bring a drink or a snack to class, as long as it is not distracting. In conjunction with this, please pick up your trash when you leave the room.
- Your professor expects your full attention for the entire class period. If you know that you'll need to leave before the class is over, try to sit as close to the door as possible so as not to disrupt others. Similarly, if you arrive in class late, just slip in as quietly as possible and take the first available seat you come to.

- Do not sleep in class! Laying your head on the desk or sleeping in class is rude, and it is distracting to others. Turn in assignments on time.
- When you have a question or comment, please raise your hand first as a courtesy to your classmates and the professor. Remember, your questions are NOT an imposition – they are welcome. So, ask questions! You'll learn more, it makes the class more interesting, and you are helping others learn as well.
- If an emergency arises that requires an absence from a session, it is your responsibility to get the notes and all other information that was covered in class from a colleague you trust.

Secular and religious holidays:

Sant'Anna Institute recognizes that there are several secular and religious holidays - not included in the Italian calendar - that affect large numbers of its community members. In consideration of their significance for many students, no examinations may be given and no assigned work may be required on these days. Students who observe these holidays will be given an opportunity to make up missed work in both laboratories and lecture courses. If an examination is given on the first class day after one of these holidays, it must not cover material introduced in class on that holiday. Students who wish to observe such holidays must inform their instructors within the first two weeks of each semester of their intent to observe the holiday even when the exact date of the holiday will not be known until later so that alternative arrangements convenient to both students and faculty can be made at the earliest opportunity.

Students who make such arrangements will not be required to attend classes or take examinations on the designated days, and faculty must provide reasonable opportunities for such students to make up missed work and examinations. For this reason it is desirable that faculty inform students of all examination dates at the start of each semester.

ACADEMIC HONESTY

"Members of the Jacksonville University community are expected to foster and uphold the highest standards of honesty and integrity, which are foundations for the intellectual endeavors we engage in.

To underscore the importance of truth, honesty, and accountability, students and instructors should adhere to the following standard:

"On my honor as a student of Jacksonville University, I promise to uphold the values of honesty, trust, fairness, respect, and responsibility in all my dealings with faculty, staff, and students."

Academic misconduct occurs when a student engages in an action that is deceitful, fraudulent, or dishonest regarding any type of academic assignment that is intended to or results in an unfair academic advantage. In this context, the term "assignment" refers to any type of graded or ungraded work that is submitted for evaluation for any course. Academic misconduct

includes but is not limited to cheating, collusion, falsification, misrepresentation, unauthorized collaboration on assignments, copying another student's work, using or providing unauthorized notes or materials, turning in work not produced by the individual, attempting to get credit for a single instance of work submitted for more than one course, and plagiarism. Furthermore, providing deceitful, fraudulent, or dishonest information during discussions of an academic matter with faculty are also examples of academic misconduct." (Jacksonville University Academic Integrity Policy).

Throughout this course we will be reading and reporting about the work of others. All information that is not original to the student must be appropriately attributed in both presentations and written work. All students are expected to do their own work and give appropriate credit for all sources used in the process of preparing papers, presentations, and homework assignments. Group assignments will be graded based on the product of the work, although some adjustment may be made for participation. [If you have a question about whether or not collaboration is allowed, or how to cite a reference, please ask. It is always better to check than to be accused of an unintended violation of the academic honesty policy]. Violations of the academic honesty policy will be dealt with in accordance with university policies

Course Level Penalties: A first offense may result in a failing grade for the assignment. Second offenses may result in failure in the course. Significantly egregious violations may result in expulsion from the university. When in doubt give credit for all information that did not come directly out of your head!

DISABILITY STATEMENT

Students with a documented disability requesting classroom accommodations or modifications, either permanent or temporary, resulting from the disability are encouraged to inform the faculty in the first week of the program.