

Math 4381/6378

Symmetry Analysis of Differential Equations

Semester: Spring 2025 CRN 34710/31474

Meeting times: MW 3:00–4:15 pm

Room: MCS 212

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Office location: MCS 201

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Office hours: MW 2-3 pm, TR 2-4 pm (unless I have a meeting)

Textbook: Symmetry Analysis of Differential Equations - An Introduction
by Daniel Arrigo, publisher Wiley and Sons

Prerequisites

The prerequisite for this course Math 3331 (ODEs) and Math 4315 (PDEs).

Introductory Remarks

The method of symmetry analysis could be possibly viewed as the most powerful method in solving nonlinear differential equations. In the case of ordinary differential equations (ODEs) symmetries can lead to a simplification of the equation (*i.e.* a reduction of the order of the equation) and often leads to the general solution. In fact, all the “special” techniques introduced for solving first order ODEs can be unified by the method symmetry analysis. In the case of partial differential equations (PDEs), symmetry analysis can provide a method for obtaining exact solutions of the given equation. This is particularly important since most physical phenomena modeled by PDEs are typically modeled using nonlinear PDEs in which there are only a handful of techniques for obtaining their exact solutions.

Course Outline

- 0) Review of first order ODEs and PDEs.
- 1) Introduction to symmetries, infinitesimal transformations,
- 2) Symmetries of first order ODEs, standard integration techniques,
- 3) Finite Lie groups and the infinitesimal operator,
- 4) Higher order ODEs, systems of ODEs,
- 5) First order PDEs,
- 6) Second order PDEs and the heat, wave and Laplace’s equation,
- 7) Nonlinear PDEs (Burgers and Potential Burgers equation²),
- 8) Systems of PDEs (if time permits).

Grades

Your grade for this course will be determined by homework, a test, preliminary research, and a final project. The homework will count 80% of your final grade. There will be one

take-home test that will be given around mid-term and will be 10% of your final grade. The remaining 10% of your grade is determined from a final seminar. The objective is to find, understand, and present the results from a research article in the literature. Your group may have no more than two people.

Grade		Grade Scale	
Homework:	80%	90% - 100%	A
Test:	10%	80% - 89%	B
Seminar:	10%	70% - 79%	C
		60% - 69%	D
		0% - 59%	F.

The Seminar

The projects should be chosen based on the student's interest and their possible future research plans. For example, if a student plans on graduate work in acoustics then maybe the topic of the reduced wave equation can be chosen for the project since this equation is commonly used to model sound wave propagation in oceans and atmospheres. Graduate student may use this opportunity to find a possible thesis topic.

Attendance

Attendance is highly recommended. If you are absent for approximately 10% without a valid excuse, where appropriate, you will be dropped from the course. It is a good idea to form small groups to work together in doing homework problems. You will learn from each other and your progress will be more rapid. However, joint work (or copying) during tests and exams is forbidden – the University has an academic dishonesty policy that you can find in the student handbook. Severe penalties apply.

University policy on Academic Integrity and Academic Misconduct

The University of Central Arkansas affirms its commitment to academic integrity and expects all members of the university community to accept shared responsibility for maintaining academic integrity. Students in this course are subject to the provisions of the university's Academic Integrity Policy, approved by the Board of Trustees as Board Policy No. 709 on February 10, 2010, and published in the *Student Handbook*. Penalties for academic misconduct in this course may include a failing grade on an assignment, a failing grade in the course, or any other course-related sanction the instructor determines to be appropriate. Continued enrollment in this course affirms a student's acceptance of this university policy.

The Americans with Disabilities Act statement

The University of Central Arkansas adheres to the requirements of the Americans with Disabilities Act. If you need an accommodation under this Act due to a disability, please contact the Office of Accessibility Resources and Services (OARS), 450-3613.

Building Emergency Plan statement

An Emergency Procedures Summary (EPS) for the building, in which this class is held, will be discussed during the first week of this course. EPS documents for most buildings on campus are available at <http://uca.edu/mysafety/bep>. Every student should be familiar

with emergency procedures for any campus building in which he/she spends time for classes or other purposes.

The Title IX disclosure

In furtherance of its core values— academic vitality, integrity, and diversity—UCA is dedicated to promoting a campus community free from discrimination. Title IX of the Education Amendments Act of 1972 requires all educational institutions to address gender-based discrimination on campus, and UCA implements these Federal requirements through a fair, consistent, and appropriate process of investigation and adjudication. Please see UCA’s Title IX website (<https://uca.edu/titleix/>) for the university’s policy, relevant forms, training opportunities, and related information.

Departmental Policy

Use of cell phones (including texting), MP3 players, web browsers, ear buds/plugs is NOT ALLOWED during class time. Cell phones must be set to silent/vibrant mode while in class. Instructors may also disallow use of any other technology not relevant to the instruction. Use of any type of laptop during class time requires consent of the instructor.

Other Policies

Students should familiarize themselves with all policies listed in the UCA *Student Handbook*, such as the Sexual Harassment Policy and Academic Policies.