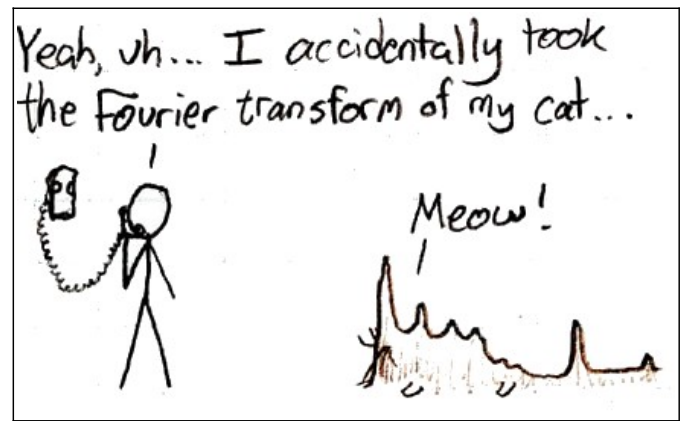


# Mathematical Methods for the Physical Sciences

Instructor: Lia Vas, Ph.D.

Class times, Spring 2023: Tue, Th 3:30–4:45 pm.

Class meeting location, Spring 2023: the UC campus, MSTC 137.



Office hours, Spring 2023 are by appointment: email me and we will find a time for us to meet. I will be glad to answer all of your questions about the course material, go over some problems together with you, check your assignment work, review together for an exam, or discuss any course content you may have questions about.

E-mail: [lvas@sju.edu](mailto:lvas@sju.edu)

Instructor Website: <http://liavas.net> (class handouts, review sheets, video recordings)

Text: NO TEXTBOOK REQUIRED. Handouts with course material and practice problems are on my website. The textbooks used for the class preparation include:

- Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press, 3rd edition, 2006.
- Calculus, J. Stewart, Brooks/Cole Publishing Company, 7<sup>th</sup> edition, 2011.
- Symmetry and Structure, S.F.A. Kettle, John Wiley & Sons, 1986.

## Topics covered:

1. Line and surface integrals, flux, Stokes' and Divergence Theorems
2. Complex functions and complex integrals
3. Fourier Series Fourier Transform
4. Series solutions of ordinary differential equations
5. Groups, Symmetry Groups of Molecules, intro to Group Representations



## Tentative Exam Schedule:

Exam 1. During week 4 (Feb 9)  
Exam 3. During week 11 (Mar 30)

Exam 2. During week 7 (Mar 2)  
Exam 4. During the finals week

## Grading:

4 Assignments	12%
Exams 1-3	18% each
Exam 4	22%
Project	12%
<b>TOTAL</b>	<b>100%</b>

Grades are computed according to the following system:

letter grade	A	A-	B+	B	B-	C+	C	C-	D+	D	F
number grade	93 to 100	90 to 92	87 to 89	83 to 86	80 to 82	77 to 79	73 to 76	70 to 72	67 to 69	60 to 66	0 to 59

## Relevant Course Elements.

**Number of credits:** 3

**Prerequisites:** Calculus III or the permission of instructor.

**Attendance:** It is imperative that students attend all classes. Students are responsible for all material covered in class, even if attendance is not checked or assignments collected.

**Exams, assignments and project:** There will be **four assignments** during the semester and one **student project** concentrated on applications of mathematics to physics or understanding mathematical arguments. Assignments turned in after their due date will receive an automatic reduction in grade. No assignment grade will be dropped. Sample project topics are on my website.

There will be **four exams**. No makeup exam will be given unless the excuse for missing the scheduled exam is acceptable to the instructor. Any makeup exam must be taken **before** the next regularly scheduled exam. No exam grade will be dropped.

After the assignments, projects, and exams are graded, their solutions will be emailed to you and, also, posted on Brightspace (D2L).

**Response time:** The assignments, projects and exams are typically graded in three days after they are turned in. Special circumstances like snow days, school closing or holidays, may occasionally delay the response time. Barring special circumstances, students' emails are usually responded to within one working day.

### **More on the topics:**

- **Fourier Series and Transform.** Students will learn about the Fourier transform and its use in nuclear magnetic resonance and signal processing.
- **Complex numbers, contour integrals, residues, Divergence and Stokes theorems.** These topics represent basics for numerous and widespread applications.
- Finding **series solutions of ODEs** is a method of finding solutions of ODEs with nonconstant coefficients which appear in physics applications.
- **Groups and Symmetries of Molecules.** Group theory is a powerful mathematical theory used in physics and chemistry, in particular quantum mechanics, crystallography and spectroscopy. Students will learn the mathematical definition of a group, basics of the theory of finite groups and point groups and their applications.

For students interested in continuing their education at a graduate level, the course presents some **mathematical techniques** that certain graduate programs in physics, chemistry and engineering use. The course emphasizes **general ideas**, not just mastering various techniques or methods. The underlying theme behind most course topics (Fourier Transform, Groups and Symmetries and Series Solutions) is that it might be easier to solve a certain problem by translating it to a different set up, solve it there and then translate the solution back into the original setting. This general principle of problem solving is often used in various fields and will be a useful concept for the students to acquire.

### **Course Objectives.**

- Use mathematical methods to develop strategies to solve real world physics and physical science problems.
- Develop mathematical models from physical principles, solve problems using of mathematical techniques covered in the course and verify the validity of the solutions obtained.
- Present the findings in a form of a written report.

### **Learning outcomes.** Students will:

- develop understanding of various mathematical concepts and techniques required for successful application of mathematics in physics and related sciences.
- be able to model data using the language and techniques of mathematics.
- be able to understand and solve multidisciplinary application problems using mathematical methods.
- demonstrate ability to cover a topic independently and present their results in a written report.

**Academic Integrity Statement:** Saint Joseph's University encourages the free and open pursuit of knowledge; we consider this to be a fundamental principle and strength of a democratic people. To this end, SJU expects its students, its faculty, its administrators, and its staff to uphold the highest standards of academic integrity. The University expects all members of the University community to both honor and protect one another's individual and collective rights.

**Students with Disabilities Statement:** Reasonable academic accommodations may be provided to students who submit appropriate documentation of their disability. If students have need of assistance or questions with this issue, they are encouraged to contact the Office of Student Disability Services (SDS) at [sds@sju.edu](mailto:sds@sju.edu) or by phone at 610.660.1774. The Office of SDS also provides an appeal/grievance procedure for complaints regarding requested or offered reasonable accommodations. More information can be found at: [www.sju.edu/sds](http://www.sju.edu/sds).

**Health and Wellness Statement:** Saint Joseph's University recognizes that physical and mental health strongly impact one's ability to do well in school and in life. As a result, there are many helpful campus resources designed to help students to care for their physical, mental, and spiritual health. Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. All of us benefit from support during times of struggle and challenges. If you are experiencing concerns, seeking assistance sooner rather than later is a courageous thing to do for yourself and those who care about you. The resources at <https://sites.sju.edu/counseling/> can help you to cope with stress and to achieve your academic and personal goals.

**COVID-19:** SJU's Covid-19 policy is available at:

<https://www.sju.edu/hawk-hill-ahead/health-and-safety/monitoring>

In particular, it states that all faculty, staff, students and visitors are asked to carry a mask at all times while on campus and that they should wear it if asked to. Since my office is relatively small, please note that I ask you to wear a mask when you are in my office.