

Physics 301 (3 credit hours)
Spring 2023 Semester
Linear Algebra and Complex Analysis for Physicists

Logistics

Instructor	Dr. Norman Mannella
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Lecture Time and Location	M_W_F: 1:50 – 2:40, Nielsen 304
Office Hours	After class, or by appointment

General Course Description

The course introduces physics students to the basic concepts of Linear Algebra and Complex Analysis. The course focuses on fundamental concepts and develops the ability to work with topics such as Linear Transformations, Matrices, the treatment of functions of a complex variable and their application in the calculation of integrals. These topics serve as part of the mathematical background that is used in upper division courses such as Classical Mechanics, Electromagnetism, Quantum Mechanics, and their applications covered in elective courses.

Course Objectives

The course objectives are:

- 1) Introduce students to concepts of Vector Spaces, Linear Transformations and their representation (Matrices), and functions of complex variables.
- 2) Determine the fundamental properties of a matrix (i.e. determinant, inverse, eigenvalues and eigenvectors), perform the most important operations in matrix algebra, apply the methods of complex analysis to the calculation of integrals.
- 3) Guide students to the implementation of the new math concepts towards the solution of physical problems.
- 4) Improve problem solving skills, develop the ability to synthesize known mathematical expressions with the use of matrices.

Prerequisites

MATH 142 or 148, i.e. Calc II.

Textbook

Mathematical Methods for Physics and Engineering, by Riley, Hobson and Bence, Cambridge.

This is a very comprehensive text about Mathematical Methods used in Physics. It contains all the material discussed in the course.

Another book that I find very good for this course is

Introduction to Linear Algebra and differential Equations, by J. W. Dettman, Dover

A very nice exposition of Linear Algebra, but it does not contain Complex Analysis.

Further reading assignments will be provided to you on Canvas.

List of Topics

Matrix algebra:

Basic operations with matrices, Minors and Cofactors, Determinants and Laplace's expansions, solutions of Systems of Linear Equations with Inverses Matrices and Cramer's rule, eigenvalues and eigenvectors, matrix diagonalization, change of basis.

Vector Spaces:

Linear Independence of vectors, Bases, Dimensions, Linear Transformations (i.e. Linear Operators) and their representation (i.e. Matrices), Inner Product Spaces on Complex fields, Gram-Schmidt Orthogonalization, orthonormal bases, Hermitian (Symmetric), Unitary (Orthogonal) transformations and associated matrix representations, properties of Hermitian and Unitary matrices (i.e. eigenvalues and eigenvectors), examples of functional spaces.

Complex analysis:

Definition of Complex Numbers and operations (Cartesian and Polar Representations, Euler's Formula, De Moivre's Formula, roots), Analytic Functions of a Complex Variable; Taylor's and Laurent's series, Poles and Branch Cuts; Contour Integrals, Residue Theorem.

Class Format and Course Material

I will use a combination of lectures, problem solving sessions, and engage you in discussions. **Attendance is therefore STRONGLY encouraged.**

This course consists of several components: lectures, homework problems, reading assignments, problem solving sessions. The material you will be expected to learn and will be tested on during the exams will be taught to you as part of all of these course components.

Reading Assignments and working out the assigned examples/exercises/problems are a compulsory and vital part of the course. I stress the importance of "Reading": This means carefully working your way through all the parts of the assigned document(s), including examples. You must read carefully and assimilate the concepts, work through the derivations of the equations, follows and work out the examples, and then test your knowledge by doing exercises and problems. This is what "reading" means and this is the meaning of the word in this course.

The lectures will NOT necessarily repeat the material in the textbook, but will be used to discuss the course material in a variety of ways. Some lectures will follow the textbook, some other will discuss topics not covered in the textbook, and/or discuss them in a different manner.

It is extremely important to keep up with the work, since the material builds on itself. Each day, preview the topics for the next class; after class, study the topics in detail and work on the suggested examples/exercises/problems.

Make sure to check the Canvas pages before class. Have a copy of the material on your desk when you attend class.

Homework

There will be approximately 8-10 problem sets, for which you will have to write out full solutions. Your homework grade will be based on the scores of these problem sets. You will be notified in Canvas when the HW is available. **Homework will always be collected at the beginning of the class session**, with due date specified on the HW itself and communicated in Canvas when the HW is made available.

When writing solutions keep in mind that there is also a large difference in sketching a solution and writing up a solution so that someone can read. Be clear in your writing! Clearly state the issue or problem, outline the tools needed, and proceed providing information when needed.

I generally encourage students to work together as far as homework is concerned. The goal is to use homework as one of the most effective ways of assimilating the material. Do not take advantage of the

work of other people, and do not let anybody take advantage of your own work: efforts should be shared. You must write up your own solutions to the homework problems. In other words, do NOT just copy someone else's solution since this constitutes plagiarism and will have grave consequences.

Each problem will be graded on a 0 - 5 scale (0 = no work, 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent), or similarly if worth more points (e.g. 0 = no work, 2 = poor, etc.). Note that answers, even if correct, not supported by work will receive 0 points.

For each HW set, I will make available for you a **Forum in Canvas** where you can discuss among yourself. Questions regarding the HW problems may be asked in lecture, during office hours, or in the Forum, but NOT by email.

Due dates and time for HW are firm. I post all assignments at least one week in advance, so please plan ahead. Problem sets turned in 1 day late will receive 90% of the maximum score. Your work will receive 0 points if turned in later than 1 day.

A point is a point: this means that different HW sets might have different total scores, and your total score will be given by the sum of the points that you will collect.

Make-up problem sets will not be given. If there are extremely serious circumstances supported by proper documentation, exception to this policy may be considered at my discretion.

Tests and Final Exam

There will be two Short Tests (1 hour-long), and one comprehensive, Final Exam (2 hours-long). The Final Exam is comprehensive, i.e. you will be tested on the whole material covered in class, homework, and previous tests. Short Test and Final questions will generally be similar in character to example problems in the book and example problems given in lectures. *If needed*, you will receive a handout containing selected mathematical and physics formulas. The handouts will be posted on Canvas before Tests and Final Exam. Students are expected to perform all work in conformance with the University policies regarding Academic Honesty. In particular, all work submitted by a student during Tests and Final Exam is expected to represent his/her own work. Violation of the Academic Honesty policies will result in disciplinary actions according to the University rules.

Appeals

You are welcome to discuss the grading of a given assignment, such as Homework, Short Tests, or Final Exam. Appeals must be dropped in my mailbox, with a brief explanation of the issue. Any appeal will be given consideration if it is raised no later than one week after the date on which the graded Exam/Tests/HW are made available for return to the class. After this "appeal period" of one week, scores will be considered final and will not be altered.

Grading Policy and Grading Scale

The semester Grade will be based on a Weighted Averages of the scores in the Final Exam grade, Short Tests, and Homework as follows:

Homework: 50%
Short Tests: 25%
Final Exam: 25%

No score will be dropped, and ordinarily make-up Short Tests and Homework sets will NOT be given. unless there are extremely serious circumstances supported by proper documentation.

The scores will be converted to the grading scale as follows:

≥ 90 A

86 – 89	A –
80 – 85	B +
75 – 79	B
70 – 74	B –
65 – 69	C +
60 – 64	C
55 – 59	C –
50 – 54	D+
45 – 49	D
40 – 44	D-
< 40	F

Announcements, Lecture Notes, Course Material, and Course Updates

Lectures and Canvas (Online@UT) are my primary modes of communication with the class. Announcements, Lecture Notes, additional Course Material, Homework, solutions to Homework, and Course Updates including definite dates for exams etc. will be posted on Canvas. Please note that it will be your responsibility to be aware of the content of any communication taking place in class, be it an announcement or anything related to the course material, in case you are not present. You are required to have an official UT email address and read announcements on Canvas and your email on a daily basis. Information that cannot be transmitted to you during the lectures or on Canvas, or any personal communication, will be given to you via email.

Contacting the Instructor

I prefer personal contact to e-mail contact, and therefore encourage you to come to office hours, or schedule an appointment. As another alternative, I am going to be in my office most of the time, if you show up chances are that I might see you, unless I am really in the middle of something. Call me in the office to check. **Anyhow, I strongly encourage you to see me.** As a general rule, I do NOT address homework problems by e-mail. On the other hand, if you have a personal emergency, e-mail is fine. If you send an email to me, **please include “PHYS 301” in the subject.**

Cheating and Plagiarism will not be tolerated

Cheating will not be tolerated. Everyone must have an equal chance to do well. The penalty for cheating on any aspect of this course will be an “**F**” for the course.

Plagiarism of any kind will not be tolerated. Working together on homework does not count as plagiarism. A line by line copy of another student’s homework does. If you use a source (book, articles, internet material etc.), you must quote it. Use of a source without citation is plagiarism.

Cheating and/or plagiarism cases found to be in Violation of the Academic Honesty policies will result in disciplinary actions according to the University rules, without exception.

Department of Physics and Astronomy Statement on Civility & Community

The Department of Physics & Astronomy at the University of Tennessee is committed to creating an environment that welcomes all people, regardless of their identities. We value the diversity that enriches our department. We understand the importance of free and open dialogue that includes the free exchange of ideas. We do not tolerate uncivil speech or any form of discourse that infringes on others’ rights to express themselves, or has a negative impact on their education, or work environment. We actively promote an environment of collegiality and an atmosphere of mutual respect and civility. We understand that respect includes being considerate of others’ feelings, circumstances, and their individuality. We recognize the necessity of a civil community in realizing the potential of individuals in teaching, learning, research, and service. We believe these values extend beyond the department into our work within physics regionally, nationally, and internationally, as well as work and studies in the university, and the broader community. We encourage all members of the department to intervene and report any incidents involving bigotry, or that violate the university code of conduct. <http://www.phys.utk.edu/about/civility-community.html> 3

Reporting

Anyone who experiences or observes any such incident is encouraged to report it to the Department Head (Prof. A. Del Maestro) or one of the Associate Heads (Prof. M. Breinig and Prof. K. Jones). Students can also speak to any faculty or staff member with whom they feel comfortable. Incidents that involve sexual harassment or stalking will be reported to the office of Title IX under mandatory reporting requirements.

<http://www.phys.utk.edu/about/civility-community.html> 3

University Civility Statement

“Civility is genuine respect and regard for others: politeness, consideration, tact, good manners, graciousness, cordiality, affability, amiability and courteousness. Civility enhances academic freedom and integrity and is a prerequisite to the free exchange of ideas and knowledge in the learning community. Our community consists of students, faculty, staff, alumni, and campus visitors. Community members affect each other’s well-being and have a shared interest in creating and sustaining an environment where all community members and their points of view are valued and respected. Affirming the value of each member of the university community, the campus asks that all its members adhere to the principles of civility and community adopted by the campus” <https://civility.utk.edu/>

Academic Integrity

Each student is responsible for his/her personal integrity in academic life and for adhering to UT’s Honor Statement. The Honor Statement reads: “An essential feature of the University of Tennessee, Knoxville is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity.”

For students with disabilities

Students needing an accommodation based on the impact of a disability should contact me privately to discuss specific needs. Students are also responsible to contact the Office of Disability Services at 865-974-6087 in Hoskins Library to coordinate reasonable accommodations for students with documented disabilities. <https://sds.utk.edu/>

The University of Tennessee, Knoxville, is committed to providing an inclusive learning environment for all students. If you anticipate or experience a barrier in this course due to a chronic health condition, a learning, hearing, neurological, mental health, vision, physical, or other kind of disability, or a temporary injury, you are encouraged to contact Student Disability Services (SDS) at 865-974-6087 or sds@utk.edu. An SDS Coordinator will meet with you to develop a plan to ensure you have equitable access to this course. If you are already registered with SDS, please contact your instructor to discuss implementing accommodations included in your course access letter

Wellness

The Student Counseling Center is the university’s primary facility for personal counseling, psychotherapy, and psychological outreach and consultation services. The Center for Health Education and Wellness manages 974-HELP, the distressed student protocol, case management, the Sexual Assault Response Team, and the Threat Assessment Task Force. <https://counselingcenter.utk.edu/> and <https://wellness.utk.edu/>

COVID-19 Guidelines

Masking -- According to public health authorities, in areas where there is substantial or high COVID transmission, wearing masks in indoor spaces can help reduce transmission of the virus and keep communities healthy. Any individual can choose to wear a mask anywhere on campus, even when it is not required. The university expects everyone to protect others from the spread of COVID-19 and strongly recommends wearing masks in academic and administrative spaces.

For the most current information on masks, please check the COVID-19 website at utk.edu/coronavirus.

Vaccines -- The university recommends that all members of the campus community be vaccinated for their own protection, to prevent disruption to the semester, and to prevent the spread of COVID-19. Vaccination information and appointment signups are available at tiny.utk.edu/vaccine. The Student Health Center medical staff is available to students to answer questions or discuss concerns about vaccines, and the center provides vaccines free of charge for anyone 18 years or older who would like one.

Sickness or Exposure -- If students think they are sick or have been exposed to COVID-19, they should contact the Student Health Center or their preferred health care provider. Students can also contact the university's COVID-19 support team for guidance by filling out the COVID-19 self-isolation form at covidform.utk.edu.

Students are advised not to attend class in-person if they have tested positive for COVID-19 and are in the isolation period, if they have COVID-19 symptoms and have not been cleared by a medical provider, or if they are an unvaccinated close contact in the quarantine period. The university recommends that students and employees stay home anytime they do not feel well. **If you need to miss class for illness, please email me as soon as possible.**

The instructor reserves the right to revise, alter or amend this syllabus as necessary. Students will be notified on Canvas.