Course: PHY 306-001
Title: Theoretical Methods of Physics

Term: Spring 2025
Credit hours: 3
Meeting days/time/location: CP287, Tues/Thurs 11:00-12:15 am

Instructor Information

Name: Christopher Crawford
Email: c.crawford@uky.edu
Office building and room number: CP281
Office phone: (859) 257-2504, (859) 421-9612 (cell)
Office hours: Tuesday and Thursday 3:00-5:00 pm

Course Description

"A lecture and problems course on the applications in physics of vector calculus, Fourier series and transforms, special functions and asymptotic forms."

The course will begin with a review of algebra, trigonometry, calculus, basic functions, and expansions. After an introduction to complex algebra, these concepts will be completed in the complex domain. The bulk of the course will focus on the development of the ubiquitous tools of linear algebra and vector calculus from a geometric viewpoint. These two concepts merge in the treatment of infinite-dimensional function spaces, involving Fourier transforms and Sturm-Louisville theory. Finally, we will combine the forces of these two methodologies in the solution of ordinary and partial differential equations, which are used to describe most physical phenomena.

Most of our class time will be spent working on homework problems in small groups up at the blackboard.

Course Prerequisites

MA 214, which may be taken concurrently with PHY 306

Required Materials

James Nearing, "Mathematical Tools for Physicists" (free online, required)
Susan Lea, "Mathematics for Physicists" (recommended)
Mary L. Boas, "Mathematical Methods in the Physical Sciences" (optional)
Murray R. Spiegel, "Vector Analysis", Schaum's Outline Series (supplement)
Harley Flanders, "Differential Forms with Applications to the Physical Sciences" (supplement)

Associated Expenses

Mathematica software, $6--$10/month. You can get by with a free limited Wolfram Cloud account. The department provides a license for the older version 8 on Windows, Mac (32 bit, pre-Catalina or VM), and Linux. The Raspberry Pi also comes with Mathematica for free.

Activities Outside of Regular Class Meetings

No other activities except lectures and recitations.

Office Hours

I have an open-door policy: come by my office and discuss physics at any time unless my door is closed (for a phone conference or approaching deadline). Please prepare by reading the assigned chapters before coming to my office and turn off cell phones and text messaging while in my office. Office visits may be carried out over Zoom at uky.zoom.us/my/c.crawford by appointment. Refer to my schedule at the bottom of https://www.pa.uky.edu/~crawford and email me a request to meet at a certain time (possibly right then if I'm free). Regular office hours are in the format of weekly homework recitations.

Please use the Canvas discussion board instead of email for questions of general interest. Please respond to each other's questions. The instructor will monitor and participate in discussions.

Skill and Technology Requirements

We will use the mathematical software Mathematica® to explore different mathematical constructs and to speed up tedious calculations. This skill will be useful in advanced math and physics courses. The following tutorial will help you learn the basics quickly. For a more detailed introduction, see James J. Kelly, getting started, part of an introductory tutorial website.

For technical assistance, contact ITS Customer Services 24/7 at 859-218-HELP (4357) for urgent needs. For non-urgent matters, visit the ITS web page at https://its.uky.edu (ITS Tech Help Center), submit a Customer Services Assistance Request form, or click on the chat bubble at the bottom right corner of https://ukam.uky.edu .

Student Learning Outcomes

After completing this course, the student will be able to:

1. Describe the geometric interpretation of vector products, complex numbers, linear operations.
2. Perform linear algebra computations, such as perform rotations and calculate eigenvectors.
3. Describe the geometry of vector calculus and its fundamental theorems.
4. Calculate partial derivatives, multidimensional integrals, and coordinate transformations.
5. Perform discrete and continuous Fourier transformations.
6. Solve Sturm-Louisville systems of 2^{nd}-order ordinary differential equations.
7. Apply techniques of linear algebra to solve partial differential equations.
8. Describe the solutions of the wave equation in different dimensions and geometries.

Course Details

Tentative Course Schedule

The complete course schedule is published in Canvas, including daily reading assignments, lectures, quizzes, and weekly homework assignments, and is subject to change. Students must complete the assigned reading, watch the published online lecture, and take an online quiz before each class. The first few minutes of class will be devoted to a discussion of the reading and lecture, answering questions, and performing occasional demonstrations or experiments. The bulk of each class will be dedicated to solving specific problems from the weekly homework assignment in groups of two or three up at the chalkboard. Thus, students should be able to complete most of the homework during class, while most of the work at home should be spent preparing for each class. Office hours will be held in the format of optional recitations to help students catch up on the homework or discuss principles more in-depth than can be done at the beginning of each class.

Course Activities and Exams

An online quiz must be completed in Canvas prior to the beginning of each class. Quizzes typically contain three questions worth one point each and are graded electronically for immediate feedback. 5 of the quizzes will be dropped, but the scores will still contribute as extra credit, so it is possible to get above 100% in the quiz category. As an alternative to each quiz, the student may submit a reading journal entry at the time of the quiz, which will be graded on the scale of 1 (partial), 2 (complete), or 3 (exemplary). It is not sufficient to simply turn in notes from the readings; the reading journal but must demonstrate substantial evidence of actively processing the material.

A homework assignment will be due every week, worth approximately 100 pts each. Each assignment will be weighted by its total points. The goal is to complete most of the homework together in groups during class. There will be an optional recitation each week to wrap up the homework and for in-depth discussion of difficult concepts learned that week.

There will be two midterm exams and a cumulative final exam. The exams are closed book, but an 8½×11 in^2 formula sheet is allowed. Exams will only be rescheduled for officially excused absences.

Grading Scale

Grades will be recorded and calculated in Canvas. Extra credit will be awarded for finding new errors in the textbook or solving special questions posed during class. The total grade is weighted from assignments, quizzes and exams and assigned a letter grade according to the tables below.

Component weighting:		*Grading scale:*
50%	Homework	*85 – 100% = A*
10%	Quizzes	*70 – 84% = B*
20%	Midterm exam	*55 – 69% = C*
20%	Final exam	*40 – 54% = D*
		Below 40% = E

Midterm Grades

Midterm grades will be calculated based on graded homework, quizzes, and the midterm exam proportionally weighted by the above table.

For undergraduates, midterm grades will be posted in myUK by the deadline established by the University Senate and published in the Academic Calendar. (https://registrar.uky.edu/calendars/academic-calendar).

Attendance Policy

There is no explicit attendance requirement, either in person or online, except for the midterm and final exams. Our goal is that classes will be a valuable resource for understanding the online lectures and completing the homework assignments in a timely manner. However, it is important to prepare for class to benefit the most from our time together.

Assignment Policies

Assignment Submissions

All homework will be submitted electronically in Canvas before midnight of the assigned due date. Scanned copies, electronic ink, or typed solutions will be submitted as a single PDF file, with supplements, including computer code or spreadsheets, attached as separate files. Please do not attach photographs of individual pages because they are incompatible with the online grading platform. There are free cell phone applications to take pictures of documents and export them as a pdf file.

Returning Assignments to Students

Online quizzes will be graded electronically for immediate feedback before each class. The instructor will return graded homework assignments within one week (maximum of two weeks). The midterm exam will be returned and reviewed during the next class following the exam. The final exam will not be returned but can be reviewed in the instructor's office.

Late Assignments

There is a penalty of 25% per class for late homework. Arrangements must be made with the instructor prior to the due date to receive a homework extension. Late assignments will be accepted for excused absences, if the student contacts the instructor prior to the due date and provides documentation of the excused absence, per the University Administrative Regulations
(https://regs.uky.edu/administrative-regulation/ar-academic-and-student-affairs)

Assignments Due during Prep Week

No homework is currently scheduled during Prep Week, but the final homework assignment due date may be extended into Prep Week if the classes fall behind schedule. There will be optional recitations during Prep Week to help prepare for the final exam.

Academic Policy

A full list of UK academic policies is available at https://provost.uky.edu/proposals/guidance-course-proposals/standard-academic-policy-statements .

Academic Offenses (Cheating, Plagiarism, and Falsification or Misuse of Academic Records)

UK policies on academic offenses are available at https://provost.uky.edu/proposals/guidance-course-proposals/academic-offenses
For a thorough description of "plagiarism," see https://ombud.uky.edu/students/what-plagiarism
For a thorough description of "cheating," see https://ombud.uky.edu/students/what-cheating

While students will solve homework problems in groups, each student is responsible to turn in their own work. You may not copy from any online sites (e.g. Course Hero or Chegg) or utilize composition technologies (e.g. ChatGPT or other GenAI software). For this course, any use of these sites or tools will be considered academic misconduct and consequences will follow University policies. If you have any questions or concerns about this policy, contact your instructor before submitting any assignment.

Resources

The university offers a variety of resources available to students. Visit the Office of Student Success (https://studentsuccess.uky.edu/get-help) to access the full list.
A list of course resources including reference material is maintained at the bottom of the course homepage (https://www.pa.uky.edu/~crawford/phy306_sp25).

Classroom Emergency Preparedness and Response

Please see the following link for information related to emergency reporting and action:
https://provost.uky.edu/curriculumproposals/syllabus-information

Classroom Behavior Policies

Laptop computers will be regularly used during class. Use of cellphones and other technology is permitted but must not disrupt the learning of others. Because the classroom is largely based on group work it is especially important to use respectful language and cultivate an inclusive environment.

Course evaluation

Course evaluations are an important component of our Department's instructional program. We value your feedback on both the course content and instructor. The standard university TCE eXplorance Blue (http://www.uky.edu/eval) will be used to collect evaluations via your computer, tablet, or smart phone. You will receive a reminder email near the end of the semester with instructions. We would also appreciate immediate feedback at http://www.pa.uky.edu/~crawford/phy306%20sp25/feedback.html and will address issues or incorporate suggestions into the course in a timely manner.

Course Recordings

The University of Kentucky Code of Student Conduct defines Invasion of Privacy as using electronic or other devices to make a photographic, audio, or video record of any person without their prior knowledge or consent when such a recording is likely to cause injury or distress.

This course includes prerecorded video lectures. All video and audio recordings of lecturers and class meetings are for educational use only. They and are not to be copied, shared, or redistributed.

As addressed in the Code of Student Conduct, students are expected to follow appropriate university policies and maintain the security of linkblue accounts used to access recorded class materials. Recordings may not be reproduced or uploaded to other online environments.

Video and audio recordings by students are not permitted during the class unless the student has received prior permission from the instructor. Any sharing, distribution, and or uploading of these recordings outside of the parameters of the class is prohibited. Students with specific recording accommodations approved by the Disability Resource Center should present their official documentation to the instructor.

Course Copyright

All original instructor-provided content for this course, which may include handouts, assignments, and lectures, is the intellectual property of the instructor. Students enrolled in the course this academic term may use the original instructor-provided content for their learning and completion of course requirements this term, but such content must not be reproduced or sold. Students enrolled in the course this academic term are hereby granted permission to use original instructor-provided content for reasonable educational and professional purposes extending beyond this course and term, such as studying for a comprehensive or qualifying examination in a degree program, preparing for a professional or certification examination, or to assist in fulfilling responsibilities at a job or internship; other uses of original instructor-provided content require written permission from the instructor(s) in advance.