

UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS
UNDERGRADUATE PROGRAM

Title: Methods of Mathematical Physics II

Code: PHYS 4032

Number of Credits: 3

Pre-requisite: PHYS 4031

Co-requisite: MATH 3153

Description

This course is the second part of Mathematical Physics, which covers fundamental mathematical concepts applied to Physics. The following topics are covered: Fourier Analysis; Periodic functions; Trigonometric Series; Fourier series; Fourier integrals; Fourier transform; Sine and cosine transforms; Partial Differential Equations: D'Alembert's solution of the wave equation; Solutions of the heat equation by Fourier series and Fourier integrals; Two-dimensional wave equation; Complex Analysis: Complex plane, analytic functions; Complex integration: line integrals, Cauchy's integral theorem, Cauchy's integral formula; Power series, Taylor and Laurent series; singularities and zeros; residues and the Residue theorem; Evaluation of real integrals

Objectives

After completing this course the student will be able:

- to understand the properties of differential equations in total derivatives and the general behavior of their solutions.
- to apply solution methods to types of differential equations that are particularly important in Physics.
- to solve linear differential equations in partial derivatives, with special emphasis to wave equation and heat equation in one and two dimensions.
- to work with Laplace's equation in different sets of orthogonal coordinates.
- to master the application of complex analysis in the evaluation of integrals.

Course Content

Topic	Assigned time (hours)
1. Vector algebra. Vector and scalar fields. Curves, tangents.	3
2. Gradient of a scalar field. Directional derivative.	3
3. Divergence of a vector field. Curl of a vector field. Examples: Gravitational field, electrical field and magnetic field.	3

4. Line integrals, double integrals, triple integrals.	3
5. Green's theorem.	3
6. Gauss' theorem. Stokes's theorem.	3
7. Fourier analysis. Periodic functions. Trigonometric series.	3
8. Complex Fourier series. Fourier integrals. Fourier transform.	3
9. Differential equations in partial derivatives. Wave equation in one and two dimensions.	3
10. Heat equation. Solution by separation of variables. Solution by Fourier integrals and transforms.	3
11. Laplace's equation in polar, cylindrical and spherical coordinates. Solution by separation of variables.	3
12. Complex numbers, complex plane. Cauchy-Riemann equations. Laplace's equation. Conformal mapping.	3
13. Line integral in the complex plane. Cauchy's integral theorem. Cauchy's integral formula.	3
14. Power series. Taylor and Laurent series. Singularities and zeros.	3
15. Residues and Residue theorem. Evaluation of real integrals.	3
Total hours	45 contact hours

Instructional Strategies

The main instructional tool in this course is lecturing. The emphasis is to introduce the student to the importance of differential equations in physics and engineering, and why and how they appear. Pure mathematical derivations of some of the results, (e.g. the existence and uniqueness of solution) are kept to a minimum and are only used to introduce the basic concepts. Most of the lecturing time is thus dedicated to the demonstration of solving problems. Weekly homework assignments allow the student to practice problem-solving techniques discussed in class and to develop a deeper understanding of the material. Homework problems are subsequently discussed in class, where the students have the opportunity to deepen their understanding of the problems and their solution.

Minimum Required Facilities

Traditional lecture room.

Student Evaluation

Since the emphasis of this course is on problem solving techniques, the grades are mainly based on four exams where the student will work on problems similar to the ones encountered in class and in the homework problems, as well as on the performance in homework assignments.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

1. Advanced Engineering Mathematics by Erwin Kreyszig, 1999, John Wiley & Sons, Inc.

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