PHYC 370 Introductory Mathematical Physics 1

Course Description

A study of the application of mathematical techniques to the formulation and solution of physical problems, particularly those which occur in classical mechanics, thermodynamics, electromagnetic theory, and quantum mechanics. Topics include vector methods, generalized coordinates, functions of complex variable, computer algebra system and applications. (3 credit hours)

Prerequisite: PHYC 122 and 260 or permission of department chairperson.

Course Objective

To impart to the physics student:

An appreciation of the overall unity of the underlying mathematical methods in classical and modern physics.

Familiarity with frequently encountered mathematical methods, equations, functions, and solutions occurring in advanced physics courses.

Skill in the techniques of problem formulation and solution in mathematical physics.

Course Rationale

To familiarize the student with mathematical physics as a method for solving a great variety of problems in the physical sciences.

To illustrate the mathematical techniques with examples from theory and experiments in physics.

By providing an emphasis on practice in problem solving, the students will develop the experience and confidence to be able to apply the mathematical problem-solving techniques in a variety of applications.

Course Content, Format, and Bibliography

Content

Vector analysis, with applications to mechanics and potential theory

Review of vector algebra -vector mechanics

Vector calculus

Vector differentiation: gradient, divergence, curl, the del operator

Vector integration: line, surface, volume integrals, Gauss's, Stokes's, Helmholtz' theorems; applications to mechanics and potential theory

Curved Coordinates and Tensors

- Circular Cylindrical Coordinates
- Spherical Polar Coordinates
- Tensor Analysis and differential operators

Determinants and Matrices

- Determinants
  - Determinant algebra
- Systems of linear equations; electrical circuit analysis by determinants

Matrices

- Orthogonal, hermitian, unitary matrices
- Diagonalization of matrices; the simple eigenvalue problem in physics
- Matrices in mechanics: the moment of inertia problem

Infinite Series

- Convergence tests – Uniform and absolute convergence
- Alternating series and Series of functions
- Taylor's expansion – Binomial theorem
- Power series – Uniqueness theorem

Functions of a complex variable

- Review of complex algebra
- Cauchy-Riemann condition – analytic functions
- Cauchy's theorem and formula
- Conformal mapping – basic properties and harmonic conjugates
- Calculus of residues and poles

Format

Lectures and problem solving.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Bibliography

Arfken and Weber, *Mathematical Methods for Physicists*, 6th Ed., Academic Press, ISBN 0-12-059876-0