Physics 500A - Mathematical Methods in Physics

Fall 2013

Course Description:

The dynamics of the universe can be described through the language of differential and integral equations. To properly understand these objects, one must turn to the mathematical subject of functional analysis. Within this subject lies the theory of Hilbert space, which plays a central role in wave mechanics, Fourier analysis, and quantum mechanics.

This course provides an introduction to the theory of functions and its application in physics. Our goal is to formally establish the theory of Hilbert space and study ways in which it can be used to solve differential equations.

Course Sections and Topics:

I. Normed spaces, Banach spaces, Weierstrass approximation theorem, Bounded linear operators, Banach fixed point theorem

II. Lebesgue integration, Lebesgue measure, L^P space, Fubini's Theorem

III. Inner product spaces, Hilbert spaces, Orthonormal systems, Trigonometric Fourier Series, Riesz representation theorem

IV. Linear operators on Hilbert spaces, Self-adjoint operators, Positive operators, Spectral decomposition

V. Integral and differential equations, Fredholm equations, Sturm-Liouville systems, Green's functions, Fourier transform

Course Location:

9:35-10:50 AM, Tuesday and Thursday, Neckers 410

Course Instructor:

Dr. Eric Chitambar
Office: 480 Neckers
Email: echitamb@siu.edu

Office Hours:

Tuesday, Wednesday, and Thursday at 2:00 - 4:00 PM

Course Textbook:

Introduction to Hilbert Spaces with Applications, by Lokenarth Debnath and Piotr Mikusiński

Prerequisites:

This is a relatively proof-intensive course aimed at providing a mathematical foundation for the use of functions in physics. That being said, the course is largely self-contained and only requires experience with calculus and basic mathematical analysis.

Homework and Grading:

There will be no official homework for this course. Instead a test will be administered after covering each of the sections listed above. Of the five tests given, the lowest score will be dropped. The student should try to solve as many of the end-of-chapter problems as possible. All work on these problems should be done in one notebook that will be handed in at the time of each test. One-fourth of each test score will depend on the amount of problem-solving effort demonstrated in the notebook. The points will breakdown as follows:

4 out of 5 tests at 20 points each + 1 final exam at 20 points = 100 Total Points.