FCH: Function Spaces and the Basic Formalism of Quantum Mechanics (PHY-690D)

This is the First-Course-Handout (FCH) for the course PHY-690D which is named as "Function Spaces and the Basic Formalism of Quantum Mechanics". This course is a nine credit elective course primarily meant for curious students who are interested in the mathematical formalism of quantum mechanics (QM). Ideally this course can be treated as a course on advanced mathematical physics.

The course starts with the theory of linear vector spaces made up of various kinds of functions. Why such spaces are appealing will be discussed with a special emphasis on QM. The difficulties one faces to define the quantum mechanical operators will be shown explicitly. Once this part is over we will move to more formal properties of function spaces and the theory of distributions will be discussed. A considerable part of the course will be spent on the topic of integration measure and Lebesgue integration. The theory of Fourier transforms will be discussed with a special eye on convergence of those series.

The next part of the course will tackle the issues of Banach space and Hilbert space and the theory of bounded and unbounded operators appearing there. It will be discussed that in QM we require a proper theory of unbounded operators. Lastly we will address all the conceptually difficult questions arising in the formal QM part.

Prerequisites: The students who want to take this course must have done QM-1 and Mathematical Methods-I.

Recommended books:

- 'Introductory Functional Analysis With Applications' by Erwin Kreyszig
- 'Principles of Quantum Mechanics' by R. Shankar
- 'Modern Quantum Mechanics' by J. J. Sakurai
- 'A Physicist's Introduction to Algebraic Structures' by Palash B. Pal

Examinations: Depending upon the size of the class I will decide whether we will have standard examinations or project based examination.

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