Short Description of One Year QFT course at IPM

Quantum Field Theory (QFT) is the natural and the only consistent description of relativistic quantum mechanics. As such the background knowledge for QFT includes special relativity and quantum mechanics. Although I will try to make the course as self-contained as possible, a good grasp of the above two topics plus classical mechanics and electrodynamics at masters level will be assumed.

In this course we will be following

An Introduction to Quantum Field Theory
By Michael Peskin and Daniel Schroder

as the main text, while other QFT books, specially the excellent Weinberg's trio, could be used as side readings. In this one year course there will not be enough time to cover the whole book but I hope to be able to cover about 70% of the book.

QFT has become the main theoretical framework for all branches of theoretical physics and has not remained limited to high energy physics, from where it originated. Although our text is mainly arranged with a high energy and particle physics taste, the course will hopefully be accessible and useful for all PhD level theoretical physics students.

My plan for this one year course is to cover the following chapters of Peskin's book:

First semester plan

Starting from chapter one, we go through free scalar and fermionic field theories (chapters two and three) and then turn on interactions perturbatively and introduce S-matrix, as done in chapter four. We will then make more exercises on computing tree level scattering cross sections in QED, as in chapter five. However, unlike the book, we will introduce non-Abelian gauge field theories and study its quantization and tree level processes.

Having covered the tree level QFT's and their canonical quantization we start studying loop processes, following chapters six and seven.

Second semester plan

This part starts with Part II of Peskin's book. The main goal of this semester is to get acquainted with loop calculations, get familiar with functional methods and path integral quantization and most important of all learn renormalization process and renormalization group equations and the concept of running of couplings and parameters. The latter is indeed the cornerstone of *QUANTUM* field theory. We will apply all these machinery to the important example of non-Abelian gauge field theories and discuss the concept of asymptotic freedom.

Depending on the timing we will cover some more advanced topics in QFT's and gauge field theories, such as anomalies, Operator Product Expansion (OPE) or Spontaneous Symmetry Breaking.

Important Notes for the Students

- Interested students are all kindly asked to contact department secretary Ms Pileroudi, niloufar@theory.ipm.ac.ir, providing their name, institution (or affiliation) and level (Masters or PhD).
- For non-IPM students there is the possibility of formally registering for the course as a "guest student". For the latter please arrange the formal details with Ms Pileroudi.
- I expect that all the students, those who have formally registered or otherwise alike, to attend the lectures regularly and more importantly take the end-of-chapter problem sets seriously; the problem set is an integral part of the book and the course.
- I hope we can arrange for a tutorial sessions once per week. The details of that will be fixed in the first week of the classes.
- The first session of the course will be on Monday Mehr 5th at 8am in Farmanieh classroom.

With our mutual devotion, I am quite positive to have a fruitful experience together in this course.

Sincerely,
Sheikh-Jabbari.