

## **Quantum Field Theory 1 Syllabus.**

### I. Classical and Quantum fields.

Canonical quantization of Klein-Gordon field

KG propagator

Interacting fields and Feynman diagrams

### II. Functional methods

Path Integral in quantum mechanics

Generating functional

Functional quantization of fields

### III. Renormalization

Perturbation theory for scalar ( $\phi^4$ ) theory

Divergent Feynman diagrams

Dimensional regularization

Renormalization schemes

### IV. Renormalization Group equations

Wilsonian RG

Callan Symanzik equations

Running of coupling constants

*Additional topics to be discussed if time permits*

### V. Quantization of fermions

Path integral with fermions

Quantum Electrodynamics

Vacuum polarization

### VI. Critical phenomena

VII. Non-Abelian Gauge Field theory.  
Quantum Chromo-Dynamics

VIII. Symmetry and Symmetry breaking  
Higgs mechanism  
Superfluidity and Superconductivity

**Prime book:**

M.E. Peskin and D.V. Schroeder, "An Introduction to Quantum Field Theory"

**Additional books:**

S. Weinberg, "The Quantum Theory of Fields "

M. Srednicki, "Quantum Field Theory", available as a pdf at  
<http://www.physics.ucsb.edu/~mark/qft.html>

**Old classics:**

P. Ramond, "Field Theory: Modern Primer"  
C. Itzykson and J-P. Zuber, "Quantum Field Theory"  
L. Zinn-Justin, "Quantum Field Theory and Critical Phenomena"  
J.J. Bjorken and S.D. Drell, "Relativistic Quantum Fields"  
N.N. Bogoliubov and D.V. Shirkov, "Quantum Fields"  
S. Coleman, "Aspects of symmetry"

**Online books and lectures**

"Fields" by Warren Siegel (book)  
<http://insti.physics.sunysb.edu/~siegel/errata.html>

QFT by Michael Luke (lectures)  
<http://www2.physics.utoronto.ca/~luke/PHY2403/References.html>

QFT by David Tong (lectures)

<http://www.damtp.cam.ac.uk/user/tong/qft.html>

**Grading:**

A set of home assignments will be given approximately every 2-3 weeks. Total weight of these assignments to the final grade will be 50%.

At the end of the course a more lengthy home project will be given, which will constitute the remaining 50%.