QUANTUM FIELD THEORY II

U. of Chicago, Physics 444 Winter Quarter 2006
J. Rosner, Instructor Tues. and Thurs., 10:30 - 11:50 a.m., KPTC 105

Prerequisite: Quantum Field Theory I (Physics 443) or permission of Instructor

This course is for prospective students of elementary particle and many-body theory and for others interested in the subject who wish experience with calculations using Feynman diagrams. In the first quarter an introduction was given to Lagrangian field theory: fields of spin-0, spin-1/2, and spin-1 particles; quantum electrodynamics (QED); and elementary divergences in higher-order calculations. The course web page was `http://hep.uchicago.edu/~rosner/p443/index.html`. The second quarter (Physics 444) continues the discussion of divergent quantities and how to deal with them using renormalization, introduces Feynman path integrals, and embarks on the study of non-Abelian (Yang-Mills) gauge fields. The course web page is `http://hep.uchicago.edu/~rosner/p444/index.html`.

Problem sets, constituting 80% of the grade, will be assigned each week, due the following week, and returned the week after that. A set of take-home problems, to be assigned on Tuesday, Feb. 28 and due on Tuesday, Mar. 14, will constitute 20% of the grade.

SYLLABUS (approximate guidelines)

Week	Dates	Text pages	Topics
1	1/3	211–230	Electron self-energy; LSZ formalism
	1/5	230–244	Optical theorem; Ward identity
2	1/10	244–256	Vacuum polarization
	1/12	Notes	Application to asymptotic freedom
3	1/17	275–292	Path integrals
	1/19	294–305	Quantizing EM and spinor fields
4	1/24, 1/26	315–335	Renormalization
5	1/31	347–363	Spontaneous symmetry breaking
	2/2	364–369	Effective action
6	2/7, 2/9	370–388	Applications of effective action
7	2/14, 2/16	393–418	Renormalization group
8	2/21, 2/23	418–438	Evolution of couplings and operators
9	2/28, 3/1	481–511	Yang-Mills Theories
10	3/7, 3/9	512–533	Quantization of Yang-Mills theories
11	3/14[a]	533-544	Asymptotic freedom

[a] Supplemental lecture and collection of final problems

Text: Michael E. Peskin and Daniel V. Schroeder, *An Introduction to Quantum Field Theory*, ISBN Number: 0-201-50397-2, Addison-Wesley (1995). This will also likely be the text for Physics 445.

In addition, the following will be *recommended* (not required):

1. F. Mandl and G. Shaw, *Quantum field theory,* Wiley, New York, 1984 (QC174.45.M320), ISBN Number: 0 471 90650 6 (paper).

2. A. Zee, *Quantum Field Theory in a Nutshell,* Princeton University Press, 2003 (QC174.45.Z44), ISBN Number: 0-691-01019-6.

The following references also may be useful:

1. V. Barger and R. J. N. Phillips, *Collider physics,* Addison-Wesley, Redwood City, CA, 1987 (QC793.2.B37)

2. J. D. Bjorken and S. D. Drell, *Relativistic quantum mechanics,* McGraw-Hill, New York, 1964 (QC174.1.B63)

3. J. D. Bjorken and S. D. Drell, *Relativistic quantum fields,* McGraw-Hill, New York, 1965 (QC174.45.B63)

4. Ta-Pei Cheng and Ling-Fong Li, *Gauge theory of elementary particle physics,* Clarendon Press, Oxford, 1984 (QC793.3.F5C480).

5. E. Commins and P. H. Bucksbaum, *Weak interactions of leptons and quarks,* Cambridge University Press, Cambridge, 1983 (QC794.8.W4C650).

6. Francis Halzen and Alan D. Martin, *Quarks and Leptons: An Introductory Course in Modern Particle Physics,* Wiley, New York, 1984 (QC 793.Q2522H34).

7. S. Gasiorowicz, *Elementary particle physics,* Wiley, New York, 1966

8. H. Georgi, *Weak interactions and modern particle theory,* Benjamin/Cummings, Menlo Park, CA, 1984 (QC794.8.W4G46)

9. C. Itzykson and J.-B. Zuber, *Quantum field theory,* McGraw-Hill, New York, 1980 (QC174.45.I770).

10. T. D. Lee, *Particle physics and introduction to field theory,* Harwood, New York, 1981 (QC793.2.L430)

11. D. H. Perkins, *Introduction to high energy physics,* 3rd edition, Addison-Wesley, Reading, Mass., 1987 (QC793.2.P470)

12. M. Perl, *High energy hadron physics,* Wiley, New York, 1974 (QC793.5.H322.P45)

13. Chris Quigg, *Gauge theories of the strong, weak, and electromagnetic interactions,* Benjamin/Cummings, Reading, Mass., 1983 (QC794.Q5), ISBN Number: 0-8053-6020-4.

14. P. Ramond, *Field theory - a modern primer,* Benjamin/Cummings, Reading, Mass., 1981 (QC174.45.R35)