PHYS 7315: General information, Spring 2019

Quantum field theory II

Time and location:	Tuesdays and Thursdays, 2:00pm-3:20pm, 157 Fondren Science
Instructor:	Pavel Nadolsky
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Office hours:	By appointment, request an appointment at doodle.com/pavelnadolsky.
Course webpage	Posted on SMU Canvas (courses.smu.edu). To view, enter your 8-digit SMU ID and password.

Textbook, learning objectives, grading, policies

Text	*Quantum Field Theory* , by Mark Srednicki, 1st Edition
Recommended reading and materials	1. *Introduction to elementary particle physics*, by Andrew Larkoski 2. *Quantum Field Theory in a nutshell,* by Anthony Zee 3. *An Introduction to Quantum Field Theory,* by G. Sterman 4. *Introduction to Quantum Field Theory,* by M. Peskin and D. Schroeder 5. *The Quantum Theory of Fields*, volumes 1, 2,3 by Steven Weinberg 6. *Fields*, by Warren Siegel (free, hep-th/9912205.) 7. *Classical Electromagnetism in a nutshell,* by Anupam Garg 8. Simon DeDeo's online course on an Introduction to Renormalization.
Grading	Your grade will be based on weekly homework problems (70%) and a final project (30%) • Late Homework: 15% off per day for the first four days, or until graded (whichever is first). Thereafter I'll accept (but won't grade) them at any time for 25% credit.
Homework assignments	In the Assignments folder on the website.

Disability Accommodations: Students needing academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit http://www.smu.edu/Provost/ALEC/DASS (Links to an external

site.)Links to an external site. to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

- **Religious Observance**: Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

- **Excused Absences for University Extracurricular Activities**: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalogue)

PHYS 7315 Syllabus

Sections from Srednicki's book – start with Section 33

Plan to read 3-4 chapters per week

Part I. Spin Zero:

1. Attempts at relativistic quantum mechanics
2. Lorentz invariance
3. Canonical quantization of scalar fields
4. The spin-statistics theorem
5. The LSZ reduction formula
6. Path integrals in quantum mechanics
7. The path integral for the harmonic oscillator
8. The path integral for free field theory
9. The path integral for interacting field theory
10. Scattering amplitudes and the Feynman rules
11. Cross sections and decay rates
12. Dimensional analysis with ?=c=1
13. The Lehmann-Källén form
14. Loop corrections to the propagator
15. The one-loop correction in Lehmann-Källén form
16. Loop corrections to the vertex
17. Other 1PI vertices
18. Higher-order corrections and renormalizability
19. Perturbation theory to all orders
20. Two-particle elastic scattering at one loop
21. The quantum action
22. Continuous symmetries and conserved currents
23. Discrete symmetries: P, T, C, and Z
24. Nonabelian symmetries (skip until later)
25. Unstable particles and resonances (elective)
26. Infrared divergences
27. Other renormalization schemes
28. The renormalization group
29. Effective field theory (skip until later)
30. Spontaneous symmetry breaking (skip until later)
31. Broken symmetry and loop corrections (elective)
32. Spontaneous breaking of continuous symmetries (skip until later)

Part II. Spin One Half

33. Representations of the Lorentz Group
34. Left- and right-handed spinor fields
35. Manipulating spinor indices
36. Lagrangians for spinor fields
37. Canonical quantization of spinor fields I
38. Spinor technology
39. Canonical quantization of spinor fields II
40. Parity, time reversal, and charge conjugation
41. LSZ reduction for spin-one-half particles
42. The free fermion propagator
43. The path integral for fermion fields
44. Formal development of fermionic path integrals (skip until later)
45. The Feynman rules for Dirac fields
46. Spin sums
47. Gamma matrix technology
48. Spin-averaged cross sections
49. The Feynman rules for majorana fields (elective)
50. Massless particles and spinor helicity (elective)
51. Loop corrections in Yukawa theory
52. Beta functions in Yukawa theory
53. Functional determinants (skip until later)

Part III. Spin One

54. Maxwell's equations
55. Electrodynamics in coulomb gauge
56. LSZ reduction for photons
57. The path integral for photons
58. Spinor electrodynamics
59. Scattering in spinor electrodynamics
60. Spinor helicity for spinor electrodynamics (elective)
61. Scalar electrodynamics (elective)
62. Loop corrections in spinor electrodynamics
63. The vertex function in spinor electrodynamics
64. The magnetic moment of the electron
65. Loop corrections in scalar electrodynamics (elective)
66. Beta functions in quantum electrodynamics
67. Ward identities in quantum electrodynamics I
68. Ward identities in quantum electrodynamics II

24.
69. Nonabelian gauge theory
70. Group representations

44.

53.
71. The path integral for nonabelian gauge theory
72. The Feynman rules for nonabelian gauge theory
73. The beta function for nonabelian gauge theory
74. BRST symmetry (elective)
75. Chiral gauge theories and anomalies
76. Anomalies in global symmetries
77. Anomalies and the path integral for fermions

30.

32.
82. Wilson loops, lattice theory, and confinement (skip until later)
83. Chiral symmetry breaking (skip until later)
84. Spontaneous breaking of gauge symmetries
85. Spontaneously broken abelian gauge theory
86. Spontaneously broken nonabelian gauge theory
87. The standard model: Gauge and Higgs sector
88. The standard model: Lepton sector
89. The standard model: Quark sector

29.

82.

83.
90. Electroweak interactions of hadrons