Lahore University of Management Sciences

PHY 539 – Introduction to Quantum Field Theory

Spring 2018

Instructor	Dr. Muhammad Sabieh Anwar
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Office Hours	
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TA Office Hours	
Course URL (if any)	http://physlab.org/courses-taught/

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes
Recitation (per week)	Nbr of Rec (s) Per Week	0	Duration	N/A
Lab (if any) per week	Nbr of Session(s) Per Week	0	Duration	See timetable issued by Registrar's office.
Tutorial (per week)	Nbr of Tut(s) Per Week	1	Duration	See timetable issued by Registrar's office.

Course Distribution	
Core	
Elective	For Physics and Math Majors and Physics and Math Graduate (MS and PhD) Students
Open for Student Category	SBASSE
Closed for Student Category	N/A

COURSE DESCRIPTION
This is not an exhaustive coverage of quantum field theory. Rather it is a first introduction for the motivated physics student to understand and appreciate the basics of one of physics's most powerful and far-reaching machinery to understand the natural world. The concepts will be physically motivated and addressed in the formal mathematical descriptions. By the end of this course, students will be able to take more extensive

treatments of the subject or initiate, through self-study, the reading of more advanced texts. The lectures will be video recorded. However attendance in class is mandatory.

COURSE PREREQUISITE(S)	
•	Undergraduates must have taken Quantum Mechanics I and II. In case, some undergraduates haven't taken QM II, they need to check with me. Graduate physics students can take this course.

COURSE OBJECTIVES	
• • •	Understand the need for quantum fields Why is quantum field theory a powerful paradigm for discussing nature Be cognizant of the kind of phenomena in condensed matter physics that could be meaningfully described and motivated by QFT

Learning Outcomes	
	After successful completion of this course, students should be able to: 1. Apply the machinery of second quantization to operators 2. Construct Lagrangians for simple problems 3. Construct quantum field theories out of classical field theories by canonical quantization 4. Appreciate the relationship between symmetry and conservation laws 5. Understand and use Green's functions and Feynman diagrams to calculate various processes

Grading Breakup and Policy

Grading will be absolute if number of students is less than 20. I have the liberty of changing the grading criterion by 5%. In this course, there is considerable emphasis on homeworks. These homeworks must be submitted individually but team work is allowed.

Homework	50%
Mid-Term	25%
Final Exam	25%

Examination Detail

Midterm Exam	Yes. Closed book, closed notes.
Final Exam	Yes. Closed book, closed notes.

The following distribution of topics is approximate. Wishfully thinking, I will cover some aspects of renormalization during the course of our lectures.

Week	Topics
1	Second quantization, fermionic and bosonic fields, Hubbard model
2-3	Lagrangians, Klein-Gordon equation, massless and massive scalar fields
4-7	Canonical quantization, symmetries and transformation, Noether's theorem, massive electromagnetism, gauge fields and gauge theory
Mid Term	
8-11	Propagators, Green's functions, Feynman propagators, S-matrix and Feynman diagrams
12-14	Some applications from condensed matter: superconductivity, fractional quantum Hall effect
Final Exam	

Textbook(s)/Supplementary Readings

1. An Introduction to Quantum Field Theory, Michael Peskin and Daniel Scroeder.
2. Quantum Field Theory for the Gifted Amateur, Tom Lancaster and Stephen Blundell.