هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA

2024
TPG-153

Course Specification

(Postgraduate Programs)

Course Title: :	Quantum Field Theory
Course Code:	PHYS660
Program:	Master of Science in Physics
Department:	Physical Sciences
College:	Science
Institution:	Jazan
Version:	
Last Revision Date:	20/4/2024

Table of Contents

A. General information about the course:

1. Course Identification:

1. Credit hours: (3)					
2. Course type					
A.	☐University	☐College	☒ Department	☐Track	
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (level 2 or 3 / year 1 or 2)					
4. Course general Description:					
This course is designed to give the basic concepts and techniques of quantum field theory, with applications to elementary particle physics, Quantum Electrodynamics (QED), with special emphasis to Quantum Chromodynamics (QCD).					
5. Pre-requirements for this course (if any)**: Non**					
6.Co-requirements for this course (if any)**: Non**					

7. Course Main Objective(s):

The main objectives of this course are focused on the following:

- **Outline the basic concepts and techniques of quantum field theory**
- **Discuss the applications to elementary particle physics, Quantum Electrodynamics (QED), with special emphasis to Quantum Chromodynamics (QCD).**
- **Apply the Lagrangian formulation for the canonical quantization of free fields.**
- **Apply the perturbation theory for interacting fields and Feynman diagram methods for Quantum Electrodynamics.**
- **Investigate path integral methods in quantum field theory.**
- **Identify the quantization of gauge theories and forms an essential tool for the understanding and development of the 'standard model' of particle physics.**

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)……**	
	Total	45

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding: Upon completing the course students will be able to**			
1.1	Describe the interactions between not merely particles and particles or particles and fields	**PLO1.1**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
1.2	Define the methods of quantum _eld theory, including quantization of free scalar and fermion fields and explain the perturbation	**PLO1.1**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	theory for interacting theories			Indirect: student survey
1.3	Recall the concepts of S-matrix expansion, scattering amplitudes and cross-sections, Feynman diagrams and rules, and path integral methods in quantum _eld theory.	**PLO1.1**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
1.4	Discuss the radiative corrections, regularization and renormalization methods, and path integral methods.	**PLO1.2**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.0	**Skills: Upon completing the course students will be able to**			
2.1	Derive Feynman rules from a Lagrangian	**PLO2.1**	Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.2	Apply Feynman rules to calculate probabilities for basic processes with Particles (scattering cross sections and decay rates)	**PLO2.1**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
2.3	Apply functional integrals and perturbation theory in quantum field theory	**PLO2.1**	Lectures, Research articles, web of science, previous thesis	Direct: In class interactive questioning, quizzes, written exams Indirect: student survey
3.0	**Values, autonomy, and responsibility: Upon completing the course students will be able to**			
3.1	Independent work, critical/analytical thinking	**PLO3.3**	Research articles, web of science, previous thesis	Group assignments, discussion Indirect: student survey

C. Course Content:

No	List of Topics	Contact Hours
1.	**The Klein-Gordon Field** • The Necessity of the Field Viewpoint • Elements of Classical Field Theory (Lagrangian Field Theory; Hamiltonian Field Theory; Noether's Theorem) • The Klein-Gordon Field as Harmonic Oscillators • The Klein-Gordon Field in Space-Time • Causality; The Klein-Gordon Propagator; Particle Creation by a Classical Source	10.5
2.	**The Dirac Field** • Lorentz Invariance in Wave Equations • The Dirac Equation • Free-Particle Solutions of the Dirac Equation (Spin Sums) • Dirac Matrices and Dirac Field Bilinears • Quantization of the Dirac Field (Spin and Statistics; The Dirac Propagator) • Discrete Symmetries of the Dirac Theory (Parity; Time Reversal; Charge Conjugation)	10.5
3. .	**Interacting Fields and Feynman Diagrams** • {Perturbation Theory • Perturbation Expansion of Correlation Functions • Wick's Theorem • Feynman Diagrams • Cross Sections and the S-Matrix • Computing S-Matrix Elements from Feynman Diagrams • Feynman Rules for Fermions • Feynman Rules for Quantum Electrodynamics	10.5
4. .	**Functional Method** • Path Integrals in Quantum Mechanics • Functional Quantization of Scalar Fields (Correlation Functions; Feynman Rules; Functional Derivatives and the Generating Functional)	7.5
5.	**Introduction to renormalization** • Renormalized Perturbation Theory • Renormalization of Quantum Electrodynamic	6
Total		**45**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1	Assignments and Classroom Activities	3,7,10,13	30
2	Mid Term Exams	6, 12	20
3	Final Exam	16	50

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	• Peskin, Michael E., and Daniel V. Schroeder. An Introduction to Quantum Field Theory. Boulder, CO: Westview Press, 1995.
Supportive References	• Quantum Field Theory" (2nd Edition), F. Mandl, and G. Shaw (Wiley, 2010) • C.Itzykson and J-BZuber, Quantum Field Theory,(McGraw-Hill,1980). • M.Srednicki, Quantum Field Theory,(Cambridge, 2007). • M. Magguore, A Modern Introduction to Quantum Field Theory Oxford, 2005
Electronic Materials	Web of Science
Other Learning Materials	Research articles from web of science regarding student’s work.

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classroom is already provided with data show
Technology equipment (Projector, smart board, software)	Saudi digital library
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Peer and program leader	Indirect (CES)-Indirect peer evaluation
Effectiveness of students assessment	Students, Program assessment committee	Direct/Indirect
Quality of learning resources	Students, Faculty members	Indirect
The extent to which CLOs have been achieved	Instructor	Direct/Indirect
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**Department Council**
REFERENCE NO.	**Psci2415**
DATE	**1/10/2024**