Al al-Bayt University
Qality and Assurance Department

بسم الله الرحمن الرحيم
جامعة آل البيت

Faculty of Science
Physics Department

Course Outline of Elementary Particle Physics

1. Instructor's Information

Instructor's / Coordinator's Name:	Dr. Ahmed Fawaz Al-Jamel
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Research and Teaching Assistant / Supervisor / Technical (if any):	NA

2. Course Description

This course is an introduction to particle physics for seniors (4th year level). The main topics to be covered are: Basic Concepts such as natural units, relativistic kinematics, the Standard Model (quarks, leptons, and gauge bosons), fundamental interactions (EM, Strong, Weak) and their main characteristics, groups and symmetry principle, conservation laws (parity, charge conjugate, time-reversal, CPT, isospin, hypercharge, etc.), experimental methods (detectors, accelerators, and cosmic rays).

3. Course Information

Course No.: 402465	Course Title: Elementary Particle Physics	Level: Bachelor 4th Yr.
Course Type: Theoretical	Prerequisite: Quantum Mechanics 1	Class Time: 12:00-13:00
Academic Year:2019-2020	Semester: Fall	Study hours:

4. Course Objectives:

a-	Acquire the knowledge of the Standard Model of Particles: quarks, leptons, and gauge bosons (gluons, photons, W Z), and antiparticles.
b-	Introduce the basic interactions and their main characteristics.
c-	Discuss the relation between symmetries (external and internal) and group theory, and the conservation laws of various quantities.

d-	Use the Feynman rules to calculate cross sections and decay rates.
e-	Be familiar with the main experimental tools and language: detectors and accelerators.

5. Learning Outcomes (LO)
(Knowledge, Skills, and Competencies)(K,S,C)

Upon successful completion of the course, the students will be able to:

LO 1. Classify elementary particles and their interactions in terms of quantum numbers according to the Standard Model. (K)
LO 2. Distinguish among the various fundamental interactions of nature and draw simple Feynman diagrams. (K)
LO 3. Calculate the outcome of various reactions and decay processes using relativistic kinematics (4-vector momentum notation) and invariant mass concept. (S)
LO 4. Apply symmetry principles and conservation laws on various interactions. (S)
LO 5. Apply the Schrödinger equation as an energy eigenvalue problem on bound states (mesons and baryons) with confining potential. (S)
LO 6. Calculate the cross section and decay rates using the Feynman calculus and Fermi Golden rules for some interactions. (S,C)

6. Course Content

Week	Topic	Comments	Course Outcome
1	**CHAPTER 1: Historical introduction**	Do it your own	CO1
2-3	**Chapter 2: Elementary particle Dynamics**	Particle exchange, Yukawa theory, EM, strong, weak, and gravitational interactions, Feynman diagrams. Decays and conservation laws	LO1/LO2/LO3
4-6	**Chapter 3: Relativistic Kinematics**	Lorentz transformation, Four-vectors, Energy and momentum, Relativistic collisions.	LO2/LO3/LO5/ LO6
FIRST EXAM 25%			

7-8	**Chapter 4: Symmetries and Conservation Laws**	Symmetries, Groups and conservation laws, PT and CPT symmetries, internal symmetries, conservation laws, quantum numbers.	LO3/LO4
9	**Chapter 5: Bound States**	The Schrodinger equation, Heavy quarkonia (Charmonium and bottomonium), light quarks mesons, baryons.	
SECOND EXAM 25%			
10-12	**Chapter 5: The Feynman Calculus**	Cross section and decay rates review Fermi Golden rules The Feynman rules firstly using the ABC-Toy model and then the real rules. Examples	LO5/LO6
13-15	**Chapter * Miscellaneous topics**	The color charge, color algebra, evidence of color existence. QED and QCD and Gauge theories Experimental Methods [1 week] Accelerators (linear and cyclic), focusing and beam stability, fixed-target experiments, colliding-beam machines, detectors.	
16	Review	Review	**Final Exam**

7. Teaching and Learning Strategies and Evaluation Methods

No.	Learning Outcomes	Teaching Strategies	Learning Activities	Evaluation /Measurement Method (Exam/ presentations/ discussion/ assignments)
1	(LO1)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
2	(LO2)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
3	(LO3)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
4	(LO4)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam
5	(LO5)	trad. lect.	Discussion & Problem Solving	HW & Mid-exam & Final Exam

8. Assessment

Methods Used	Assessment Time	Distribution of grades
1- semester work (report, assignments, attendance)	During semester	00%
3- First Exam	Tenth week	25%
3- Second Exam		25%
4- Final Exam	Week of the final exams	50%

9. Textbook

Main Reference	Introduction to Elementary Particles
Author	**David J. Griffiths**
Publisher	Harper & Row Publisher
Year	2004
Edition	2nd (or any Edition)
Textbook Website	https://www.amazon.com/Introduction-Quantum-Mechanics-David-Griffiths/dp/0131118927

10. Extra References (books and research published in periodicals or websites)

1-	Donald H. Perkins, Introduction to High Energy Physics, Addison-Wesley Publishing Company, Inc. 5th Ed. (2000).
2-	B.R. Martin & G. Shaw, Particle Physics, John Wiley & Sons, (1997).
3-	The Review of Particle Physics : http://pdg.lbl.gov