PHYS4055 Particle Physics and the Universe
Fall 2019
Course Outline / Blended Learning Instruction

Part I Course Outline

A. Teaching Staff

Class time and venue	Online
Instructor	Prof. Tao LIU
Office	Rm4470 (lift 25/26)
Office hour	By appointment
E-mail	taoliu@ust.hk
Teaching Assistant (TA) Name: Lu, Shiyun Office: Fourth floor, IAS E-mail: sluah@connect.ust.hk	

B. Course Description

In this course (3 credits), a systematic introduction to particle physics will be provided, with the topics mainly covering:

(1) The tool of Feynman diagrams;

(2) The Standard Model in particle physics (the zoo of fundamental particles, electroweak unified theory, and Higgs mechanism); a special attention will be given to the role played by symmetries in particle physics;

(3) Particle physics at colliders (particularly at the Large Hadron Collider);

(4) Frontier topics in particle physics: Higgs physics at colliders, physics beyond the Standard Model, the interplay with cosmology, etc.

C. Intended Learning Outcomes

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

(1) explain the spectrum of fundamental particles and their interactions, by using symmetry as a guideline;

(2) use the tool of Feynman diagrams to qualitatively describe the interacting processes of fundamental

particles;

(3) explain the Standard Model in particle physics, appreciate its success (e.g., the prediction about Higgs boson), and understand why physics beyond the Standard Model is required;

(4) survey literatures on particle physics, make qualitative and/or quantitative analyses (e.g., on the measurements of Higgs properties at the LHC), and present their studies in the formats of presentation and essay, by collaborating with each other;

(5) appreciate the success in particle physics, such as the ones which might be achieved in the LHC experiments and in the future collider programs;

Part II Blended Learning Instruction

The course contains one video lecture and one face-to-face lecture each week. It separates into 3 main parts – "Online session", "In-class session" and "After-class session". Below is the instruction of those sessions and items which students have to know.

- **Online session – Introduction**
  - Aim to give an introduction of topics for students
  - Contain two parts – video lecture and online quiz
  - Video lecture: briefly introduce the concept of topics in a number of slides
  - Online quiz: composed of multiple-choice questions **(Week 1 quiz is not counted into final grade)**
  - Students need to finish this session by the "video lecture day''
  - "Discussion" part is provided in each week for students to ask questions, and instructor will answer questions in In-class session (F2F lecture)

- **In-class session (face-to-face / F2F lecture) – Practice**
  - Aim to intensify the understanding on topics through in-class group activities which also give an interaction between teaching staff and students
  - Students are separated into a number of groups with 3 students in one group
  - Group assignment is announced on Canvas in the "F2F lecture day'' and changed every 3 weeks
  - Students in each group need to submit the solution (hardcopy) including the name of groupmates to TA before the instructor post the solution
  - **Week 1 activity is not counted into final grade**
  - The schedule of this session is below:
    - ~30 mins: Video lecture review
    - ~10 mins: Online quiz review
    - ~30 mins: Group activities
    - ~10 mins: Post solutions for group activities

- **After-class session – Apply**
  - Aim to provide opportunity for students to show and apply understanding of new concepts practiced in-class through individual homework
  - Contain two parts – Reading and homework
  - Reading: a supplementary note for the video lecture is provided.

- Students need to finish this session and submit the homework solutions (electronic version) via the Canvas before the next-week "F2F lecture day''

- **Grading Scheme**
  - Online Quiz: 15%
  - Homework: 15%
  - In-class activities: 20% (10% attendance + 10% solution)
  - Midterm Exam: 20%
  - Final Project (Presentation + Essay): 30%

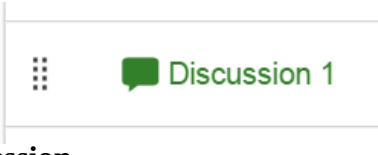
- **Homework**
  There is one homework for each week generally. Students have to submit their homework by uploading the soft copy of homework (either in photo taking of handwriting or electronic typing) before the due date. Otherwise, 0 mark will be graded for that homework.

- **Midterm Exam**
  - Date: Oct 2018
  - Time: TBA
  - Venue: TBA

- **Final Project**
  Instead of having a final exam, students need to finish a final project with an essay and a project presentation. The preparation of final project including group assignment is started after the midterm exam. Details will be announced later

- **Week 1 quiz, in-class activity and homework are not counted into final grade, for practice of using Blended Learning mode**

Any question about the course, please post it on the page "Discussion",



the item under "Quiz" in each week or ask instructor during in-class session.

Course Schedule (up to modification)

Week	Course Content	Post Item
Week 0	F2F Lecture: Course Introduction and Standard Model	No assignment
Week 1	Video Lecture: **Feynman Diagram and Feynman Rules**	Quiz 1
	F2F Lecture of week 1 + In-class activity 1	Hw 1 & Reading 1
Week 2	Video Lecture: **Correspondence Principles**	Quiz 2
	F2F Lecture of week 2 + In-class activity 2	Hw 2 & Reading 2
Week 3	Video Lecture: **Symmetry and Group Theory**	Quiz 3
	F2F Lecture of week 3 + In-class activity 3	Hw 3 & Reading 3
Week 4	Video Lecture: **Lorentz Symmetry, Abelian Gauge Symmetry, and EM Interaction**	Quiz 4
	F2F Lecture of week 4 + In-class activity 4	Hw 4 & Reading 4
Week 5	Video Lecture: **Symmetry and Conservation Law**	Quiz 5
	F2F Lecture of week 5 + In-class activity 5	Hw 5 & Reading 5
Week 6	Video Lecture: **Non-Abelian Gauge Theories: Strong Interaction and Weak Interaction**	Quiz 6
	F2F Lecture of week 6 + In-class activity 6	Hw 6 & Reading 6
Week 7	Video Lecture: **Collider Physics**	Quiz 7
	F2F Lecture of week 7	Reading 7
Midterm Exam		
Week 8	Video Lecture: **Electroweak (EW) Unification**	Quiz 8
	F2F Lecture of week 8 + In-class activity 8	Hw 8 & Reading 8

Week 9	Video Lecture: **Spontaneous Symmetry Breaking**	Quiz 9
	F2F Lecture of week 9 + In-class activity 9	Hw 9 & Reading 9
Week 10	Video Lecture: **Higgs Mechanism**	Quiz 10
	F2F Lecture of week 10 + In-class activity 10	Hw 10 & Reading 10
Week 11	Video Lecture: **Mass Generation of the SM Fermions and Flavor Physics in the SM**	Quiz 11
	F2F Lecture of week 11 + In-class activity 11	Hw 11 & Reading 11
Week 12	F2F Lecture: **Frontier topics I: Higgs Physics**	No Assignment
	F2F Lecture: **Frontier topics II: Physics Beyond the SM**	No Assignment
Final Project Presentation		