课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	PHY5030/量子场论导论 Introduction to Quantum Field Theory
2.	**课程性质** **Compulsory/Elective**	专业选修课 Elective Course
3.	**课程学分/学时** **Course Credit/Hours**	4/64
4.	**授课语言** **Teaching Language**	英文 English
5.	**授课教师** **Instructor(s)**	Leonardo Modesto
6.	**是否面向本科生开放** **Open to undergraduates or not**	是 YES
7.	**先修要求** **Pre-requisites**	（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.） 量子力学 II PHY305 分析力学 PHY205-15 线性代数 A Quantum Mechanics II, Analytical Mechanics, Linear Algebra.
8.	**教学目标** **Course Objectives**	

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

现代物理学的目标是找到所有基本相互作用（电磁，弱，强和引力相互作用）的在量子尺度下的一致统一，同时解释宇宙的其他奥秘，例如暗物质，暗能量及其他。本课程将介绍标量场，旋量场，矢量场和张量场的数学定义。第一部分将向学生介绍自由粒子的相关理论。之后，我将集中讨论以下几种情况的经典拉格朗日公式：

-相互作用的标量场，
-物质与光子的相互作用（电子动力学），
-夸克和胶子的相互作用（色动力学），
-（最后）物质和引力子的相互作用（量子引力）。

下一步将是在“量子场理论框架”中对上述理论进行量子化，包括正则化和随后的重整化过程。一旦学生逐渐熟悉了越来越复杂的理论中的“量子场论”，下一步将介绍“粒子物理学的标准模型”及其与“希格斯自发对称破缺机理”有关的量子一致性。

The goal of modern physics is to find a quantum consistent unification of all fundamental interactions (electro-magnetic, weak, strong and gravitational interaction), while at the same time to explain other mysteries of the Universe like, Dark Matter, Dark Energy, and so on.
I will begin the course by presenting the mathematical definitions of the fundamental constituents of nature: scalar, spinorial, vectorial and tensorial fields. This first part will confront the student with the theory of free particles. Afterwards, I will concentrate on the definition of the classical Lagrangian formulation for:

- interacting scalar fields,
- interaction of matter and photons (Electro -Dynamics),
- interaction of quarks and gluons (Chromo-Dynamics),
- (eventually) interaction of matter and gravitons (Quantum Gravity).

The next step will be the quantization of the above-mentioned theories in the “quantum field theory framework,” including the regularization and the subsequent renormalization procedure.
Once students will have gained familiarity with “quantum field theory” in increasingly complicated theories, then they will be introduced to the Standard Model of Particle Physics” and its quantum consistency" related to the ``Higgs spontaneous symmetry breaking mechanism”.

9. **教学方法**
Teaching Methods

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

讲授 Theoretical lectures

10. **教学内容**
Course Contents
（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

Section 1	粒子不可约表示及庞加莱群 Particles as irreducible representations if the Poincare group.
Section 2	拉格朗日场论 Lagrangian field theory
Section 3	克莱因戈登场 The Klein-Gordon field
Section 4	狄拉克场 The Dirac field.
Section 5	光子场 The photon field
Section 6	S 矩阵 S-Matrix.
Section 7	量子电动力学的费曼图 Feynman diagrams for Quantum Electro Dynamics (QED).
Section 8	单圈量子电动力学、正则化及重整化 One-loop QED, regularization and renormalization
Section 9	弱相互作用 Weak interactions.
Section 10	杨米尔斯规范理论 Yang-Mills Gauge Theories.
Section 11	自发对称性破缺及希格斯机制 The spontaneous symmetry braking and Higgs mechanism.
Section 12	标准电弱理论 The standard electro-weak theory.

11. **课程考核**
Course Assessment

（①考核形式 Form of examination；②.分数构成 grading policy；③如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

出勤 Attendance：20%
课堂表现 Class performance：10%
平时作业 Homework：10%
期末考试 Final Exam：60%

12. **教材及其它参考资料**
Textbook and Supplementary Readings

1) Quantum Field Theory, second edition,
Franz Mandl, Graham Shaw, Wiley.
2) An Introduction to Quantum Field Theory,
Michael E. Peskin,
The Advanced Books Program,
Perseus Books Reading,
Massachusetts.
3) Quantum Field Theory, A Modern Introduction,
Michio Kaku,
Oxford University Press.
4) Quantum Field Theory in a Nutshell,
second edition,
E. Zee,
Princeton University Press.