<table>
<tr><td>開設學年度 / 學期</td><td colspan="5">108　第 2 學期</td></tr>
<tr><td>課程名稱(中文)</td><td colspan="5">量子物理（一）</td></tr>
<tr><td>課程名稱(英文)</td><td colspan="5">Quantum Physics ( I )</td></tr>
<tr><td>課　　碼</td><td>2203021</td><td>學分數</td><td>4</td><td>修別</td><td>必修</td></tr>
<tr><td rowspan="2">授　課　教　師</td><td colspan="5">姓名：包健華　　■專任　□兼任</td></tr>
<tr><td colspan="5">■教授　□副教授　□助理教授　□講師</td></tr>
<tr><td>授　課　方　式</td><td colspan="5">■課堂上課　□網路教學　□其他_____</td></tr>
<tr><td>教學目標及範圍</td><td colspan="5">This is the first part of one year course for Quantum Physics. Together 2203021 and 2203022 cover quantum physics with applications drawn from modern physics. The first part will be continuous from the content of Modern Physics (2202060). It will cover (i) Quantum physics in 3D, including the angular momentum, Schrodinger equations in 3D with a central potential, and addition of angular momentum. (ii) Approximation methods for time-independent Hamiltonian, including time-independent perturbation theory, the real hydrogen spectrum, semi-classical approximation and variational approximation. (iii) Identical particles and quantum statistical mechanics, including Fermions and Bosons, degenerate Fermi gas, charge particles in a magnetic field.</td></tr>
<tr><td>授　課　大　綱</td><td colspan="5">
1. Quantum mechanics in 3D<br>
a) Angular momentum<br>
b) Schrödinger equation in 3D with a central potential<br>
i. The free particle in 3D<br>
ii. Infinite and finite spherical well potentials<br>
iii. The Hydrogen atom<br>
c) Addition of angular momentum<br>
2. Approximation methods for time-independent Hamiltonians<br>
a) Time-independent perturbation theory: non-degenerate and degenerate perturbations and the Start effect<br>
b) The real Hydrogen spectrum: relativistic mass correction, spin-orbital coupling, the Zeeman effect and the hyperfine splitting<br>
c) Semi-classical approximation (WKB)<br>
d) Variational approximation<br>
3. Identical Particles and Quantum Statistical Mechanics<br>
a) Fermions and Bosons: N-particles system, exchange operator, symmetrization postulate, hydrogen molecule and helium atom<br>
b) Quantum statistical mechanics: the most probable configuration, three statistics and the black-body spectrum<br>
c) Degenerate Fermi gas: density of state, degeneracy pressure, white dwarf stars, Chandrasekhar limit and neutron star
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| | d) Electron in metals: periodic potential, Block waves, band structure, metal-insulator-semiconductor<br>**4. Charge particles in a magnetic field (optional if we have time)**<br>a) Canonical quantization<br>b) The classical particle interacting with EM field<br>c) Electron moving in a constant magnetic field<br>d) The degeneracy of Landau levels<br>e) Integer Quantum Hall effect |
| 教科書及参考書 | 1.1. ***Feynman lectures on Physics*** **(Vol. 3) :** You can find this reference at http://www.feynmanlectures.caltech.edu/III_toc.html, it is a very nice reference for learning the concept of physics for undergraduate courses. Volume 3 is focused on Quantum Physics.<br>2. ***Introduction to Quantum Mechanics*** by R. Liboff (QC174.12 L52, 2003)<br>3. ***Quantum Physics*** by S. Gasiorowcz (QC174.12 G37, 2003)<br>4. ***Introduction to Quantum Mechanics*** by D. Griffiths (QC174.12 G855, 2005)<br>5. ***Quantum Mechanics*** by L. Susskind (QC174.123 S964 2014). A very nice book for amateurs, who are interesting to know what the quantum world is. If you want to read something about quantum physics during this summer. It is a very nice book to start with. You can get this e-book in Kindle through Amazon.<br>• ***There is no required textbook in this course. If you don't want to spend money to buy a textbook, you can find the 1st one (Feynman lecture on Physics, vol.3) in internet above.***<br>• If you do like to own one textbook. I will suggest to purchase ***Quantum Physics by Gasiorowicz.*** It is a very nice textbook on Quantum Physics for students in physics major. Of course, reference 5, Introduction to Quantum mechanics by Griffiths, is also a nice textbook. Read one of these (ref. 3-5) is good enough. If you need more practice on problems in quantum physics, Ref. 3 is a good one. It even includes some mathematical practices in quantum physics. |

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| | • Following two references are more advanced textbooks for graduate levels of Quantum Mechanics. Keep them as a good references but do not try to treat them as a "textbook" reference for this course unless you are familiar with any one of the references listing above (or feel they are too easy for you).<br>6. ***Principles of Quantum Mechanics*** by R. Shankar<br>7. ***Modern Quantum Mechanics*** by J.J. Sakurai, 2nd Ed. You can find this textbook on-line at https://archive.org/details/ModernQuantumMechanicsJ.J.Sakurai/page/n9<br>「請尊重智慧財產權，不得非法影印教師指定之教科書籍」 |
| 課程核心能力 | ■具備物理領域之基本知識<br>■具備執行物理及相關領域專題研究之能力<br>■具備閱讀物理相關論文之能力<br>■具備邏輯推理及解決相關問題之能力<br>□具備終身自我學習成長之能力 |

教學要點概述：

1. 教材編選：☑ 自編教材 ☐ 教科書作者提供

2. 教學方法：☐ 投影片講述 ☑ 板書講述

3. 評量方法：☐ 上課點名 x%, ☑ 小考 10%, ☐ 作業 0%, ☐ 程式實作 0%, ☐ 實習報告 0%, ☐ 專案 0%, ☑ 期中考 40%, ☑ 期末考 50%, ☐ 期末報告 0%, ■其它:on-line materials, in-class activities(bonus) 5%

4. 教學資源：☑ 課程網站 ☐ 教材電子檔供下載 ☐ 實習網站

5. 教學相關配合事項： Class meeting: (i) **10-noon each Tuesday and Thursday** (place: **room 502**) (ii) Recitation: **6:30pm-9pm each Thursday** (place: **room 107**)

課程進度：

第一週：Angular momentum (I)
第二週：Angular momentum (II)
第三週：The free particles in 3D
第四週：Plane Waves and Wavepackets
第五週：Infinite and finite spherical well potential
第六週：The Hydrogen atom
第七週：Addition of angular momentum

第八週：Time-independent perturbation theory
第九週：Start effect and he real Hydrogen atom (I)
第十週：The real Hydrogen atom (I)
第十一週：Semi-classical approximation (WKB method)
第十二週：Variational approximation: theory, the ground state of He, and $H_2^+$
第十三週：Identical particles: N-particle system, exchange operator, and N-fermion in a potential well
第十四週：Quantum statistical mechanics (an introduction)
第十五週：Degenerate Fermi system
第十六週：Electron in a magnetic field (I)
第十七週：Electron in a magnetic field (II)
第十八週：Final