## Course Code
PHYS8552 (RPG)

## Title
Condensed matter physics

## Offering Department
Physics

## Course Co-ordinator
Dr C J Wang  
Physics

## Course Co-ordinator Email
cjwang@hku.hk

<table>
<thead>
<tr>
<th>Teachers Involved</th>
<th>Name</th>
<th>Department</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dr C J Wang</td>
<td>Physics</td>
<td>100</td>
</tr>
</tbody>
</table>

## Course Objectives
This course introduces many-body physics in quantum matter. Systems consisting of many particles (bosons or fermions) display novel collective phenomena that individual particles do not have, for example, ferromagnetism and superfluidity. It aims to introduce students the general principles behind these phenomena, such as elementary excitations, spontaneous symmetry breaking, adiabatic theorems, emergent topological phases of matter, etc. Theoretical language useful in the interpretation of experiments, such as linear response theory and response functions, will be discussed. This course is intended for both experimentalists and theorists. While there are no official prerequisites, students who would like to take this course are assumed to have sufficient knowledge on quantum mechanics and statistical mechanics.

## Course Contents & Topics
This course will focus on the phenomena of emergent many-body states that require not only the effect of quantum statistics but also that of inter-particle interaction. Examples include: Ferromagnetism, Fermi liquid, superfluidity, superconductivity, and the quantum Hall states. Some general themes related to these quantum states, such as elementary excitation, Ginzburg-Landau description, spontaneous symmetry breaking, and topological phases of matter will be discussed.

## Course Learning Outcomes (CLO)
On successful completion of this course, students should be able to:

1. CLO 1 understand the general principle of spontaneous symmetry breaking
2. CLO 2 understand the basic properties of superfluidity and superconductivity and their Ginzburg-Landau descriptions
3. CLO 3 understand the many-body phenomena based on many-body wave functions and can describe the elementary excitations on top of it
4. CLO 4 apply response function formalism to understand simple experiments and carry out analysis based on analytic properties of response functions
5. CLO 5 understand the basics of quantum Hall effects

## Pre-requisites (and Co-requisites and Impermissible combinations)
Nil

## Offer in 2022 - 2023
Y  
2nd sem  
Examination  
May

## Course Grade
Pass or Fail

## Grade Descriptors
Pass: Demonstrate thorough mastery at an advanced level of extensive knowledge and skills required for attaining all the course learning outcomes. Show strong analytical and critical abilities and logical thinking, with evidence of original thought, and ability to apply knowledge to a wide range of complex, familiar and unfamiliar situations. Apply highly effective organizational and presentational skills.

Fail: Demonstrate little or no evidence of command of knowledge and skills required for attaining the course learning outcomes. Lack of analytical and critical abilities, logical and coherent thinking. Show very little or no ability to apply knowledge to
solve problems. Organization and presentational skills are minimally effective or ineffective.

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Lecture-based elective course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Teaching &amp; Learning Activities</strong></td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td>Details</td>
</tr>
<tr>
<td>Lectures</td>
<td></td>
</tr>
<tr>
<td>Tutorials</td>
<td></td>
</tr>
<tr>
<td>Reading/Self study</td>
<td></td>
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</table>

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<thead>
<tr>
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<th>Details</th>
<th>Weighting in final course grade (%)</th>
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| Required/recommended reading and online materials | James F. Annett, *Superconductivity, Superfluids, and Condensates*, Oxford, 2004  