# 课程详述

## COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

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|---|---|---|
| 1. | **课程名称 Course Title** | 固体物理 Introduction to Solid State Physics |
| 2. | **授课院系 Originating Department** | 物理系 Department of Physics |
| 3. | **课程编号 Course Code** | PHY321-15 |
| 4. | **课程学分 Credit Value** | 4 |
| 5. | **课程类别 Course Type** | 专业选修课 Major Elective Courses |
| 6. | **授课学期 Semester** | 秋季 Fall |
| 7. | **授课语言 Teaching Language** | 以中文为主，教材以及授课 PPT 为英文 |
| 8. | **授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）** | 徐虎<br>第二科研楼 214 室<br>xuh@sustc.edu.cn<br>0755-8801-8210<br>XU Hu, Associate Professor, Department of Physics<br>Rm.214, No.2 Research Bldg.<br>xuh@sustc.edu.cn<br>0755-8801-8210 |
| 9. | **实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact** | 待公布 To be announced |
| 10. | **选课人数限额(可不填) Maximum Enrolment （Optional）** | |

| 11. 授课方式 Delivery Method | 讲授 Lectures | 习题/辅导/讨论 Tutorials | 实验/实习 Lab/Practical | 其它(请具体注明) Other（Please specify） | 总学时 Total |
|---|---|---|---|---|---|
| | 64 | 0 | 0 | 考试周不算入总学时 | 64 |

| | |
|---|---|
| 12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements | 量子力学 I Introduction to Quantum Mechanics（PHY206-15） |
| 13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite | 无 None |
| 14. 其它要求修读本课程的学系 Cross-listing Dept. | 无 None |

## 教学大纲及教学日历 SYLLABUS

### 15. 教学目标 Course Objectives

Solid state physics is the study of solids, through methods such as quantum mechanics, crystallography, electromagnetism, and metallurgy. It is the largest branch of condensed matter physics. Solid-state physics studies how the large-scale properties of solid materials result from their atomic-scale properties. 本课程主要研究固体的性质、微观结构、各种内部运动，及其相互作用，讲解现代固体物理学的理论基础和重要课题。固体物理学是物理学中最重要的分支学科之一，对技术的发展有重大推动作用。

### 16. 预达学习成果 Learning Outcomes

After the course, the students are expected to able to understand crystal structure, reciprocal lattice, crystal binding, crystal vibrations, thermal properties, free electron Fermi gas, energy bands, semiconductor crystals, and the practical applications in semiconductor physics.

通过固体物理课程的学习，掌握晶体结构，倒空间，晶体结合类型，晶格振动，热学性质，自由电子气，能带结构和半导体晶体等，以及半导体物理在实际问题中的应用等，并能达到基本读懂最新相关前沿研究成果。

### 17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

**Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

1. (Week 1-3) CRYSTAL STRUCTURE.

Periodic Array of Atoms, Fundamental Types of Lattices, Index System for Crystal Planes, Simple Crystal Structures.

晶体结构

原子的周期性阵列，晶格的基本类型，晶面指数，简单晶体结构

2. (Week 4-5) WAVE DIFFRACTION AND THE RECIPROCAL LATTICE.

Diffraction of Waves by Crystals, Scattered Wave Amplitude, Brillouin Zones, Fourier Analysis of the Basis.

晶体衍射和倒格子

晶体衍射，散射波振幅，布里渊区，结构单元的傅立叶分析

3. (Week 6) CRYSTAL BINDING AND ELASTIC CONSTANTS.

Crystals of Inert Gases, Ionic Crystals, Covalent Crystals, Metals, Hydrogen Bonds, Atomic Radii.

晶体结合与弹性常量

惰性气体晶体，离子晶体，共价晶体，金属，氢键，原子半径

4. (Week 7-8) PHONONS I. CRYSTAL VIBRATIONS.

Vibrations of Crystals with Monatomic Basis, Two Atoms per Primitive Basis, Phonon Momentum.

声子（Ⅰ）晶格振动

单原子基元情况下的晶格振动，基元中含有两个原子的情况，声子动量

5. (Week 9) PHONONS II. THERMAL PROPERTIES.

Phonon Heat Capacity, Anharmonic Crystal Interactions, Thermal Conductivity.

声子（Ⅱ）热学性质

声子比热容，非谐晶体相互作用，热传导

6. (Week 10-11 )FREE ELECTRON FERMI GAS.

Energy Levels in One Dimension, Effect of Temperature on the Fermi-Dirac Distribution, Free Electron Gas in Three Dimensions, Heat Capacity of the Electron Gas, Electrical Conductivity and Ohm's Law, Motion in Magnetic Fields, Thermal Conductivity of Metals.

自由电子费米气

一维情况下的能级，温度对费米-狄拉克分布的影响，三维情况下的自由电子气，电子气的比热容，电导率和欧姆定律，在磁场中的运动，金属的导热性

7. (Week 12-13) ENERGY BANDS.

Nearly Free Electron Model, Bloch Functions, Kronig-Penney Model, Wave Equation of Electron in a Periodic Potential, Number of Orbitals in a Band.

能带

近自由电子模型，布洛赫函数，K-P 模型，电子在周期势场中的波动方程，能带中的轨道数目

8. (Week 14-15) SEMICONDUCTOR CRYSTALS.

Band Gap, Equations of Motion, Intrinsic Carrier Concentration, Impurity Conductivity, Thermoelectric Effects, Semimetals, Superlattices.

半导体晶体

能隙，运动方程，本征载流子浓度，杂质导电性，温差电效应，半金属，超晶格

9. (Week 16) FERMI SURFACES AND METALS.

Construction of Fermi Surfaces, Electron Orbits, Hole Orbits, and Open Orbits, Calculation of Energy Bands, Experimental Methods in Fermi Surface Studies.

费米面和金属

费米面的结构，电子轨道，空穴轨道，开放轨道，能带的计算，费米面研究中的实验方法

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

1. Introduction to Solid State Physics, 8th Edition, Charles Kittel, ISBN : 978-0-471-41526-8 Wiley
2. 固体物理导论,第 8 版, C. 基泰尔, 978-7-5025-7183-2, 化学工业出版社

## 课程评估 ASSESSMENT

19.

| 评估形式 Type of Assessment | 评估时间 Time | 占考试总成绩百分比 % of final score | 违纪处罚 Penalty | 备注 Notes |
|---|---|---|---|---|
| 出勤 Attendance | | | | |
| 课堂表现 Class Performance | | | | |
| 小测验 Quiz | | 15% | | |
| 课程项目 Projects | | | | |
| 平时作业 Assignments | | 25% | | |
| 期中考试 Mid-Term Test | | 30% | | |
| 期末考试 Final Exam | | 30% | | |
| 期末报告 Final Presentation | | | | |
| 其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary) | | | | |

20. 记分方式 **GRADING SYSTEM**

☑ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

## 课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
**This Course has been approved by the following person or committee of authority**

物理系教学指导委员会

Education Instruction Committee of Physics department