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.

1.	**课程名称 Course Title**	热力学与统计物理 I Thermodynamics and Statistical Physics I
2.	**授课院系 Originating Department**	物理系 Department of Physics
3.	**课程编号 Course Code**	PHY204
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业基础课 Major Foundational Courses
6.	**授课学期 Semester**	春季/秋季 Spring/Fall
7.	**授课语言 Teaching Language**	中英双语 English & Chinese
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）**	王克东，副教授，物理系 慧园一栋 404 室 Wang Kedong, Associate Professor, Department of Physics Rm. 404, Building 1，HuiYuan wangkd@sustech.edu.cn 0755-8801-8207
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
学时数 Credit Hours	48	16（另外安排，不占用上课时间）	0	0	48

12.	先修课程、其它学习要求 **Pre-requisites or Other Academic Requirements**	大学物理 B 下（PHY105B） General Physics II B
13.	后续课程、其它学习规划 **Courses for which this course is a pre-requisite**	本课程为物理系必修专业基础课程，是继续学习物理系其它课程的基础。其中一个直接后续课程为统计物理 II。 This course is a major-required course for students in physics department, as one basic course for other advanced physics courses. It is the pre-requisite for statistical mechanics II.
14.	其它要求修读本课程的学系 **Cross-listing Dept.**	其它需要相关热力学统计物理知识的学科院系也可以学修本门课程。 Students in other departments with relevant requirement for the thermodynamics and statistical physics can take this course.

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

介绍热力学和统计物理的基本知识，包括热力学基本定律，各种热力学势的含义和它们之间的相互转换，相变和相平衡，各种条件下的的热力学稳定性，近独立系统的统计分布，及其他相关内容。

Introduce the basics of Thermodynamics and Statistical Physics including the zeroth, first, second and third laws, thermodynamical potentials and Legendre transformation, phase transition, thermodynamical stability under different conditions, statistical distribution of almost independent systems, and others.

16. **预达学习成果 Learning Outcomes**

熟练掌握热力学基本定律的内涵，了解统计物理的基本原则，并能够运用热力学统计物理的知识对各种热力学现象进行分析阐述。

After learning this course, students should be familiar with the fundamental laws of thermodynamics, understand the basic rules of statistical physics, and utilize the knowledge of thermodynamics and statistical physics to give interpretations to some thermodynamical

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.)

Week1. Lecture 1 Fundamental concepts and laws of thermodynamics
1.1 The Scope of Thermodynamics ;
1.2 Applications of Thermodynamic Phenomena ;
1.3 Evolution of Thermodynamics ;
1.4 Equilibrium State ;
1.5 Zeroth Law of Thermodynamics and Temperature ;
1.6 The Equation of State ;
1.7 Ideal Gas and Real Gas

Week2. Lecture 1 Fundamental concepts and laws of thermodynamics
1.8 Work, Heat and the First Law of Thermodynamics
1.9 Heat Capacity and Enthalpy
1.10 Applications of the 1st Law in Idea Gas
1.11 Carnot's cycle
1.12 The 2nd Law of Thermodynamics
1.13 Carnot's theorem
1.14 Thermodynamics temperature scale

Week3. Lecture 1 Fundamental concepts and laws of thermodynamics
1.15 The Clausius theorem
1.16 Entropy
1.17 The calculations of entropy
1.18The entropy increase principle
1.19 Principle of maximum work
1.20 Free energy and Gibbs function

Week4. Lecture 2 Maxwell Relations and Their Applications
2.1 The Maxwell Relations
2.2 Applications of Maxwell Relations
2.3 Adiabatic Expansion, Throttling Expansion /Joule–Thomson expansion, and Cooling Machines
2.4 The Determination of Fundamental Thermodynamic Functions

Week5. Lecture 2 Maxwell Relations and Their Applications
2.5 Thermodynamic Functions of Gasses
2.6 Characteristic Thermodynamic Functions
2.7 Thermal Radiation

Week6. Lecture 2 Maxwell Relations and Their Applications
2.8 Magnetic Medium
2.9* Cooling Methods (not required in the exams)

Week7. Lecture 3 Phase Transition
3.1 Thermodynamic Functions in Open Systems
3.2 Equilibrium Criterion and Equilibrium Conditions
3.3 Stability of Equilibrium
3.4 Phase Equilibrium of Pure Substances
3.5 The formation of liquid droplet

Week8. Lecture 3 Phase Transition
3.6 Liquid - gas phase transition and Critical point
3.7 Normal-Superconducting Phase Transition
3.8 Ehrenfest Classification

Week9. Lecture 3 Phase Transition
3.9 Landau phase transition theory
3.10 Critical phenomena and critical exponents

Week10. Lecture 4 Chemical reactions and the 3rd law
4.1 Thermodynamic functions in multi-component systems
4.2 Equilibrium Conditions
4.3 Gibbs phase rule

Week11. Lecture 4 Chemical reactions and the 3rd law
4.4 Chemical equilibrium
4.5 Properties of mixed ideal gases
4.6 Chemical equilibrium of mixed ideal gases

Week12. Lecture 4 Chemical reactions and the 3rd law
4.7 Gibbs paradox
4.8 The 3rd law of thermodynamics

Week13. Lecture 5 Fundamental concepts in statistical physics
5.1 Why do we need statistical physics
5.2 Macrostates and Microstates
5.3 The principle of equal probability

Week14. Lecture 6 Distribution of quasi-independent particle system
6.1 Microstates, Stirling's approximation
6.2 Boltzman distribution
6.3 Bose distribution and Fermi distribution
6.4 Expressions of thermodynamics functions in distribution

Week15. Lecture 7 Application of statistical physics with distribution
7.1 State function of ideal gases
7.2 Maxwell velocity distribution
7.3 Equipartition theory

Week16. Lecture 7 Application of statistical physics with distribution
7.4 Heat capacity of solid materials
7.5 Paramagnetic solids
7.6 Negative temperature

1-3周：第一章、热力学的基本概念和定律
1.1-1.3 热力学的研究范围和发展历史
1.4 热动平衡态
1.5 热力学第零定律和温度
1.6 物态方程
1.7 理想气体和真实气体
1.8 功、热和热力学第一定律
1.9 热容和焓
1.10 热力学第一定律在理想气体中的应用
1.11-1.15 卡诺循环，热力学第二定律，卡诺定理，热力学温标，柯劳修斯定理
1.16-1.18 熵及其计算，熵增原理
1.19 最大功原理
1.20 自由能与吉布斯函数

4-6周：第二章、麦克斯韦关系及其应用
2.1-2.2 麦克斯韦关系及其推演
2.3 绝热膨胀、焦耳-汤姆逊膨胀、制冷机
2.4-2.6 特殊函数，理想气体的热力学函数
2.7 热辐射
2.8 磁介质

7-9 周：第三章 相变
3.1 开放系统的热力学函数
3.2-3.3 平衡判据和平衡稳定性分析
3.4 单元系统的相平衡
3.5 液滴的形成
3.6 气-液相变和临界点
3.7 正常导体-超导体相变
3.8 埃伦费斯特分类
3.9 朗道相变理论
3.10 临界现象和临界指数

10-12周：第四章、化学反应与热力学第三定律
4.1-4.2 多元系统的热力学函数及平衡条件
4.3 吉布斯相律
4.4 化学平衡
4.5-4.7 混合理想气体中的化学平衡及吉布斯佯谬
4.8 热力学第三定律

13 周：第五章、统计物理中的基本概念

宏观与微观态，等几率假设

14 周：第六章、近独立粒子系统的统计分布

玻尔兹曼分布，费米分布，玻色分布及对应的热力学函数

15-16周：应用统计分布研究热力学系统

理想气体系统的状态函数，麦克斯韦速度分布，能量均分原理，固体的热容，稀磁体及负绝对温度

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

(1) 热力学与统计物理，林宗涵，北京大学出版社
(2) 热力学.统计物理，汪志诚，高等教育出版社
(3) 热与热力学（Heat and Thermodynamics), Mark W. Zemansky and Richard H. Dittman, 英文影印版，机械工业出版社
(4) Thermodynamics and Statistical Mechanics, W. Greiner, L. Neise and H. Stocker, Springer
(5) Statistical Physics Part 1, Landau and Lifshitz, Butterworth-Heinemann

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		10%		
课程项目 Projects				
平时作业 Assignments		20%		
期中考试 Mid-Term Test		30%		
期末考试 Final Exam		40%		
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