

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	工程热力学 Engineering Thermodynamics				
2.	授课院系 Originating Department	力学与航空航天工程系 Department of Mechanics and Aerospace Engineering				
3.	课程编号 Course Code	MAE305				
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	秋季 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)	黄仕迪 助理教授 力学与航空航天工程系 huangsd@sustech.edu.cn Huang Shidi Assistant Professor Department of Mechanics and Aerospace Engineering huangsd@sustech.edu.cn				
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)	90				
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				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	高等数学 A 下(MA102B)或者 高等数学 (下) (MA102b)或者数学分析 II(MA102a) MA102B Calculus II A / MA102b Calculus II / MA102a Mathematical Analysis II
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	喷气推进 Jet and Propulsion
14. 其它要求修读本课程的学系 Cross-listing Dept.	机械与能源工程系 Department of Mechanical and Energy Engineering

教学大纲及教学日历 SYLLABUS

15. **教学目标 Course Objectives**

工程热力学作为热力学最先发展的一个分支，主要从工程技术角度研究热能与机械能相互转换的规律及其应用。本课程作为工程类专业本科生的基础课程之一，在培养学生系统掌握科学概念和分析方法，以及构筑完整的知识体系方面占据重要地位。通过本课程的学习，使学生了解热力学的宏观研究方法，理解热力学的基本概念和基本原理，掌握能量转换规律和有效利用能量的基本知识，并能应用这些理论知识对不同的热力过程及热力循环进行正确的分析、计算，同时培养学生对工程中有关热力学问题的判断、分析和估算的综合能力，为将来解决工程实际问题和参加科学研究打下必要的理论基础。

Thermodynamics is a subject that deals with energy, and it has long been an essential part of engineering curricula all over the world. The objectives of this course include: (1) To introduce the basic principles of thermodynamics; (2) To present a wealth of real-world engineering examples to give students a feel for how thermodynamics is applied in engineering practice; (3) To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments that underpin the theory. It is expected that, through careful explanations of concepts and use of numerous practical examples, this course can help students develop the necessary skills to bridge the gap between knowledge and the confidence to properly apply knowledge.

16. **预达学习成果 Learning Outcomes**

通过本课程的学习，学生掌握热力学的基本概念、原理以及如何有效利用热能的方法，并能应用这些理论知识对工程中常见的热力学问题进行正确的分析和计算，为将来解决工程实际问题和参加科学研究打下必要的理论基础。

The expected outcomes are: (1) have a clear understanding of the basic principles of thermodynamics; (2) develop the fundamental ability for the application of thermodynamics in engineering problems; (3) Communicates to the minds of tomorrow's engineers and scientists.

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.)

第一课：导论（2学时）

热力学发展简史，工程热力学的研究内容和方法

Section 1: Introduction (2 credit hours)

Development of thermodynamics, Contents and methods used in engineering thermodynamics

第二课：热力学基本概念和定义（4学时）

热力学系统，热力学状态参数，平衡态，准静态过程，可逆过程，功和热量，热力循环

Section 2: Basic concepts in thermodynamics (4 credit hours)

System, State and Property, Equilibrium state, Quasi-equilibrium process, Reversible process,
Work and heat, Cycle

第三课：热力学第一定律（2学时）

热力学第一定律的实质，热力学能和焓，封闭系统和开放系统的能量方程及应用

Section 3: The first law of thermodynamics (2 credit hours)

Content of the first law of thermodynamics, Internal energy, Enthalpy, Energy analysis of various systems

第四课：理想气体和实际气体（4学时）

理想气体的概念和状态方程，理想气体的比热容、热力学能、焓和熵，理想气体的热力过程分析，
范德瓦尔方程，对比状态方程

Section 4: Ideal gas and real gas (4 credit hours)

Ideal gas and its equation of state, Specific heat, Internal energy, Enthalpy and Entropy of ideal gas,
Various thermodynamic process of ideal gas, van der Waals equation of state, Reduced equation of state

第5课：水和水蒸气（2学时）

水的汽化过程和临界点，水和水蒸气的状态参数，水蒸气的热力过程，克拉伯隆方程和饱和蒸气压方程

Section 5: Water and water vapor (2 credit hours)

Vaporization process of water, Critical point, Properties of water and water vapor,
Thermodynamic process of water vapor, Clapeyron's equation, Vapor pressure equation

第六课：热力学第二定律（4学时）

热力学第二定律概述，卡诺循环和卡诺定理，可逆循环分析，热力学第二定律的数学表达式
状态参数熵和熵方程，孤立系统的熵增原理

Section 6: The second law of thermodynamics (4 credit hours)

Content of the second law of thermodynamics, Carnot cycle and Carnot principle,

Energy analysis of reversible cycle, Equations of the second law of thermodynamics,

Entropy and Entropy equation, The increase of entropy principle

第七课：热力学关系（4 学时）

麦克斯韦关系，热力学能、焓、熵和比热容的一般关系式，热系数，绝热节流

Section 7: Thermodynamic property relations (4 credit hours)

Maxwell relations, General relations for internal energy, enthalpy, entropy and specific heat,

Thermal coefficient, Adiabatic throttling

第八课：期中考试（2 学时）

Section 8: Mid-term Exam (2 credit hours)

第九课：热能的可用性及火用（2 学时）

热能的可用性，火用的概念，能量贬值原理，火用平衡方程，火用的分析和计算

Section 9: Exergy (2 credit hours)

Concept of Exergy, Exergy Transfer, Decrease of exergy principle, Exergy balance and its applications

第十课：气体的流动（4 学时）

稳定流动的基本方程，管内定熵流动的基本特性，气体流量和喷管计算，喷管效率，合流，扩压管

Section 10: Flow of Gas (4 credit hours)

Equation of steady flow, Property of adiabatic flow, Flow in nuzzles and its efficiency, interflow, Diffuser

第十一课：压气机的热力过程（2 学时）

压气过程的热力学分析，活塞式压气机的工作原理，多级压缩和极间冷却，压气机效率

Section 11: Thermodynamic process of compressor (2 credit hours)

General analysis of compressor, The principle of piston compressor, Multistage compression,

Stage-stage cooling, Compressor efficiency

第十二课：气体动力循环（4 学时）

分析动力循环的一般方法，活塞式内燃机的理想循环，燃气轮机装置循环

Section 12: Gas power cycle (4 credit hours)

General analysis of power cycle, Ideal cycle of piston type internal combustion engine, Gas turbine

第十三课：蒸汽动力循环（2 学时）

朗肯循环，再热循环，回热循环，热电合供循环，蒸汽—燃气联合循环

Section 13: Vapor power cycle (2 credit hours)

Rankine cycle, Reheat cycle, regenerative cycle, Thermoelectric supply cycle, Gas-vapor power cycle

第十四课：制冷循环（4 学时）

逆向卡诺循环，压缩空气制冷循环，压缩蒸气制冷循环，热泵循环，制冷剂及其热力学性质

Section 14: Refrigeration cycle (4 credit hours)

Reversed Carnot cycle, Air-compressor and Vapor-compressor refrigeration cycles, Heat pump cycle, Refrigerants and their thermodynamic properties

第十五课：湿空气（2 学时）

湿空气的概念和状态参数，绝对湿度和相对湿度，湿空气的焓（含湿量图），湿空气的热力过程及应用

Section 15: Moist air (2 credit hours)

The concept and properties of moist air, Specific and relative humidity, Enthalpy of moisture, The thermodynamic process of moisture and its application

第十六课：化学热力学基础（4 学时）

化学反应概述，热力学定律在化学反应中的应用，绝热理论燃烧温度，化学平衡和平衡常数，
化学反应方向判据及平衡条件，反应自由焓，等温等压反应的平衡常数，绝对熵和热力学第三定律

Section 16: The fundamental of chemical reactions (4 credit hours)

Introduction of chemical reaction, The application of thermodynamics laws in chemical reaction, Adiabatic flame temperature, Chemical equilibrium and equilibrium constant, The criterion for equilibrium, Free enthalpy, Absolute entropy and the third law of thermodynamics

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

教材：

Yunus A. Gengel, Michael A. Boles, Thermodynamics: An Engineering Approach, 机械工业出版社

参考书目/Supplementary readings

- [1] 曾丹苓, 《工程热力学》, 高等教育出版社, 2006 (第 3 版)
- [2] 华自强, 张忠进, 高青, 《工程热力学》, 高等教育出版社, 2009 (第 4 版)
- [3] 何雅玲, 《工程热力学精要解析》, 西安交通大学出版社, 2014 (第 1 版)
- [4] 沈维道, 童钧耕, 《工程热力学》, 高等教育出版社, 2016 (第 5 版)
- [5] Mark W.Zemansky, Richard H. Dittman, Heat and Thermodynamics, 机械工业出版社, 2015(英文影印版, 原书第 8 版)
- [6] R. E. Sonntag, C. Borgnakke, Fundamentals of Thermodynamics, Wiley, 2012 (第 8 版)

[7] Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, Fundamentals of Engineering Thermodynamics, Wiley, 2014 (第8版)

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		10		
小测验 Quiz				
课程项目 Projects		10		
平时作业 Assignments		20	抄袭记 0 分 (No score for plagiarism)	
期中考试 Mid-Term Test		20	作弊记 0 分 (No score for cheating)	
期末考试 Final Exam		40	作弊记 0 分 (No score for cheating)	
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

力学与航空航天工程系教学指导委员会
The commission of teaching instruction in department of mechanics and aerospace engineering