

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	常微分方程 B Ordinary Differential Equations B				
2.	授课院系 Originating Department	数学系 Mathematics				
3.	课程编号 Course Code	MA201b				
4.	课程学分 Credit Value	4				
5.	课程类别 Course Type	通识选修课程 General Education (GE) Elective Courses				
6.	授课学期 Semester	春季 Spring / 秋季 Fall				
7.	授课语言 Teaching Language	英文 English / 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)	苏琳琳 (sull@sustech.edu.cn), URES Raul (ures@sustech.edu.cn) 王学锋(wangxf@sustech.edu.cn), 王勇 (wangy66@sustech.edu.cn), 数学系 Linlin Su(sull@sustech.edu.cn), URES Raul (ures@sustech.edu.cn) Xuefeng Wang(wangxf@sustech.edu.cn), Yong Wang (wangy66@sustech.edu.cn) , Department of Mathematics				
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	32	0	0	80

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MA102B 高等数学 A (下) Calculus II A (MA102B)
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	MA303 偏微分方程 Partial Differential Equations (MA303); MA310 生物数学 Mathematical Biology(MA310)
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

本课程介绍常微分方程中最基本的理论和方法，并将以大量的例子来介绍常微分方程在物理、化学、生物等其他学科中的应用。注重培养学生用常微分方程解决应用问题的意识和能力。理论部分包括：一阶线性方程，分离变量法，方向场，欧拉方法，存在和唯一性定理，相线分析，二阶线性方程，常数变易法，待定系数法，解的渐近行为，拉普拉斯变换，一阶线性方程组，一阶非线性自治系统，驻点的线性稳定性和分类，相平面分析，零值线，不变区域等。

This course introduces the basic theories and methods in Ordinary Differential Equations (ODEs) and lots of examples to illustrate the application of ODEs in physics, chemistry, biology, etc. The course aims to nurture the ability of the student to use ODE to solve problems arising in applications. The theoretical part of the course covers: first order linear equations, separation of variables, direction fields, Euler's method, existence and uniqueness theorem, phase line analysis, second order linear equations, variation of constants, the method of undetermined coefficients, asymptotic behavior of solutions, Laplace transform, first order linear systems, first order nonlinear autonomous systems, linear stability and types of equilibria, phase plane analysis, nullclines, invariant regions, etc.

16. 预达学习成果 Learning Outcomes

1. 能够根据具体实例建立合理的常微分方程；2. 能够掌握常微分方程中最基本的理论和方法；3. 通过求解方程来解释说明实例中的问题。

This course aims to teach students to

1. establish the Ordinary Differential Equations (ODEs) deriving from practical problems in the field of physics, chemistry, biology, etc.; 2. master the basic theories and methods in ODEs ; 3. analyze and explain the original problems by solving ODEs.

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.)

第一章 一阶微分方程 (10学时)

- 1.1. 定义; 方向场
- 1.2. 变量分离方程
- 1.3. 线性方程; 积分因子
- 1.4. 应用举例: 天体运动和混合问题
- 1.5. 恰当方程
- 1.6. 解的存在唯一性定理及其应用
- 1.7. 解对初值的依赖性
- 1.8. 自治方程及其稳定性
- 1.9. 数值方法: Euler 方法

第二章 建模及应用 (2学时)

- 2.1. 人口增长模型
- 2.2. RLC电路

第三章 二阶线性微分方程 (8学时)

- 3.1. 基本概念
- 3.2. 二阶线性方程和方程组; 相平面
- 3.3. 齐次线性微分方程; 特征方程
- 3.4. 应用举例: 简谐振动
- 3.5. 非齐次线性微分方程; 待定系数法
- 3.6. 常数变易法
- 3.7. 应用举例: 强迫振动

第四章 拉普拉斯变换 (10学时)

- 4.1. 基本概念
- 4.2. 基本性质
- 4.3. 拉普拉斯逆变换
- 4.4. 用拉普拉斯变换求解微分方程
- 4.5. Heaviside 函数及 Delta 函数
- 4.6. 卷积

第五章 微分方程系统 (2学时)

- 5.1. 定义及举例
- 5.2. 几何意义; 相空间和相平面
- 5.3. 定性分析
- 5.4. 线性系统
- 5.5. 线性系统的性质; 基本解组

第六章 常系数线性微分方程组 (10学时)

- 6.1. 平面系统及相平面; 平衡点的分类
- 6.2. 迹-行列式 平面
- 6.3. 高维系统; 重特征值
- 6.4. 矩阵指数; 基本解组
- 6.5. 线性系统的定性分析
- 6.6. 高阶线性方程; 待定系数法及常数变易法
- 6.7. 非齐次线性系统; 基解矩阵

第七章 非线性微分方程组 (6学时)

- 7.1. 非线性方程组的线性化
- 7.2. 解的稳定性分析
- 7.3. 不变集及零值线
- 7.4. 守恒量
- 7.5. 非线性力学
- 7.6. 李雅普诺夫方法
- 7.7. 捕食-被捕食系统

Chapter 1. First-Order Differential Equations(10 Credit Hours)

- 1.1. Definitions; Direction Fields
- 1.2. Separable Equations

- 1.3. Linear Equations; Integrating Factors
- 1.4. Models of Motion and Mixing Problems
- 1.5. Exact Differential Equations
- 1.6. The Existence and Uniqueness Theorem and its Applications
- 1.7. Dependence of Solutions on Initial Conditions
- 1.8. Autonomous Equations and Stability; Phase line
- 1.9. Numerical Method: Euler's Method

Chapter 2. Modeling and Applications(2 Credit Hours)

- 2.1. Modeling Population Growth
- 2.2. Electrical Circuits

Chapter 3. Second Order Linear Equations(8 Credit Hours)

- 3.1. Second-Order Linear Equations; Spring-Mass Equation
- 3.2. Second-Order Equations and Systems; Phase Plane
- 3.3. Linear, Homogeneous Equations with Constant Coefficients; Characteristic Equations
- 3.4. Harmonic Motion
- 3.5. Inhomogeneous Equations; the Method of Undetermined Coefficients
- 3.6. Variation of Parameters
- 3.7. Forced Harmonic Motion

Chapter 4. The Laplace Transform(10 Credit Hours)

- 4.1. Definition of the Laplace Transform
- 4.2. Basic Properties of the Laplace Transform
- 4.3. The Inverse Laplace Transform
- 4.4. Using the Laplace Transform to Solve Differential Equations
- 4.5. Discontinuous Forcing Terms
- 4.6. The Heaviside function and Delta Function
- 4.7. Convolutions

Chapter 5. An Introduction to Systems(2 Credit Hours)

- 5.1. Definitions and Examples
- 5.2. Geometric Interpretation of Solutions; The Phase Space and Phase Plane
- 5.3. Qualitative Analysis
- 5.4. Linear Systems
- 5.5. Properties of Linear Systems; Fundamental Set of Solutions

Chapter 6. Linear Systems with Constant Coefficients(10 Credit Hours)

- 6.1. Planar Systems and Phase Plane Portraits; The Classification of Equilibrium
- 6.2. The Trace-Determinant Plane
- 6.3. Higher Dimensional Systems; Repeated Eigenvalues
- 6.4. The Exponential of a Matrix; Fundamental System of Solutions
- 6.5. Qualitative Analysis of Linear Systems
- 6.6. Higher-Order Linear Equations; The Methods of Undetermined Coefficients and Variation of Parameters
- 6.7. Inhomogeneous Linear Systems; Fundamental Matrices

Chapter 7. Nonlinear Systems(6 Credit Hours)

- 7.1. The Linearization of a Nonlinear System
- 7.2. Long-Term Behavior of Solutions; Stability
- 7.3. Invariant Sets and the Use of Nullclines
- 7.4. Conserved Quantities
- 7.5. Nonlinear Mechanics
- 7.6. The Method of Lyapunov
- 7.7. Predator-Prey Systems

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

Textbook:

1. Differential Equations with Boundary Value Problems, second edition, John Polking, Albert Boggess and David Arnold, Pearson, 2005.
2. Elementary Differential Equations and Boundary Value Problems, 11th edition, William E. Boyce, Richard C. DiPrima and Douglas C. Meade, Wiley, 2017.

Reference:

常微分方程教程, 第二版, 丁同仁, 李承治, 高等教育出版社, 2004年.

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	10-20 minutes per week	20		
课程项目 Projects				
平时作业 Assignments	3 hours per week	20		
期中考试 Mid-Term Test	2 hours	25		
期末考试 Final Exam	3 hours	35		
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