南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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**	凸优化及其在机器学习中的应用 Convex optimization and its application in machine learning
2.	**授课院系** **Originating Department**	系统设计与智能制造学院 School of System Design and Intelligent Manufacturing
3.	**课程编号** **Course Code**	SDM368
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业选修课 Major Elective Courses
6.	**授课学期** **Semester**	秋季 Autumn
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）**	吴旭阳 系统设计与智能制造学院 wuxy6@sustech.edu.cn Xuyang Wu School of System Design and Intelligent Manufacturing
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	0	0	0	48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	线性代数 MA107A、Linear Algebra A MA107A 高等数学（下）MA102B、Calculus II B MA102B
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无
14. 其它要求修读本课程的学系 Cross-listing Dept.	无

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

培养学生科学地运用优化理论和算法解决实际优化问题的能力以及从优化的角度看待和求解及其学习问题的能力。本课程要求学生掌握基础优化理论，典型的优化算法、常见机器学习算法等

This course aims to teach students how to use optimization theories and algorithms effectively to solve real-world problems. It also helps them understand and solve machine learning problems from an optimization point of view. To succeed in this course, students need to learn the basics of optimization theories, typical optimization methods, and machine learning frameworks and algorithms.

16. 预达学习成果 Learning Outcomes

理解最优化的基本概念和基础理论。
Understand basic concepts and foundational theories of optimization.

熟悉常见的优化算法及其优缺点，能够选择并实现适用的算法解决实际问题。

Be familiar with classical optimization algorithms and their pros and cons, and be able to select and implement suitable algorithms to solve real-world problems.

能够对简单的优化算法进行理论收敛性分析。

Be capable of performing theoretical convergence analysis on simple optimization algorithms.

可以从优化的角度理解和求解机器学习问题。

Be able to perceive and solve machine learning problems from an optimization perspective.

学会使用常用优化求解软件包。

Be familiar with commonly used optimization software packages.

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.)

章节	内容	学时
Section 1	课程介绍 / Introduction	2
Section 2	凸集和凸函数/ Convex set and convex functions	4
Section 3	凸优化问题/ Convex optimization problem	3
Section 4	无约束优化方法 I: 梯度下降/ Unconstrained optimization method I: gradient descent	3
Section 5	无约束优化方法 II: 次梯度下降和近端法/ Unconstrained optimization method II: subgradient descent and proximal method	3
Section 6	无约束优化方法 III: 共轭梯度法/ Unconstrained optimization method III: conjugate gradient method	1.5
Section 7	无约束优化方法 IV: 二阶算法/ Unconstrained optimization method IV: second-order methods	4.5
Section 8	课程回顾 I/ Course review I	1.5
Section 9	带约束优化: 拉格朗日对偶和 KKT 条件/ Constrained optimization: Lagrange duality and KKT condition	4.5
Section 10	带约束优化方法 I: 对偶梯度上升/ Constrained optimization method I: dual ascent	3
Section 11	带约束优化方法 II: 基于惩罚函数的算法/ Constrained optimization method II: penalty function-based methods	3
Section 12	带约束优化方法 III: 内点法/ Constrained optimization method III: interior-point method	3
Section 13	机器学习简介/ Illustration of machine learning from an optimization perspective	3
Section 14	经典机器学习算法/ Typical machine learning algorithms	4.5
Section 15	优化求解软件包介绍/ Software packages for solving optimization problems	3
Section 16	课程回顾 II/ Course review II	1.5

Section 1 – 3, 9: 优化理论基础/ Theoretical foundations of optimization
Section 4 – 7, 10 – 12: 优化算法/ optimization algorithms
Section 13 – 14: 优化的重要应用: 机器学习/ machine learning
Section 15 : Matlab / Python 优化求解器/ software packages for solving optimization problems
Section 8, 16: 课程回顾/ course review

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

1. 凸优化/ Convex Optimization, Stephen Boyd and Lieven Vandenberghe, Cambridge University Press （**主要参考**）
2. 非线性规划/ Nonlinear Programming, Dimitri. P. Bertsekas, Athena Scientific Press
3. 用于数据分析的优化算法/ Optimization for Data Analysis, Stephen J. Wright and Benjamin Recht, Cambridge University Press

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	Week 5, 10, 15	10		

Quiz				
课程项目 Projects				
平时作业 Assignments	Week 1-15	20		
期中考试 Mid-Term Test				
期末考试 Final Exam		70		
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