

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	现代控制与最优估计 (Modern Control and Estimation)				
2.	授课院系 Originating Department	机械与能源工程系 Department of Mechanical and Energy Engineering				
3.	课程编号 Course Code	ME424				
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 Fall				
7.	授课语言 Teaching Language	英文 English				
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)	张巍, 机械与能源工程系 Wei Zhang (Department of Mechanical and Energy Engineering)				
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	无 NA (请保留相应选项 Please only keep the relevant information)				
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				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	ME307 控制工程基础 Fundamentals of Control Engineering
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	
14. 其它要求修读本课程的学系 Cross-listing Dept.	力学与航空航天系，电子与电气工程，计算机科学与工程系

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

This course will introduce the students to the fundamental concepts and methods in modern control and estimation theory. Topics include state-space modelling of dynamical systems, least square estimation and system identification, state-feedback and output-feedback controller design, observer design, linear quadratic regulators, and Kalman filter.

本课程将向学生介绍现代控制与估计理论的基本概念和方法。主题包括动态系统的状态空间建模，最小二乘估计和系统辨识，状态反馈和输出反馈控制器设计，观测器设计，线性二阶调节器和卡尔曼滤波器。

The course will also connect these control and estimation methods to applications in robotics, mechanical, electrical, and aerospace systems.

该课程还将这些控制和估算方法与机器人、机械、电气和航空航天系统中的应用相连接。

16. 预达学习成果 Learning Outcomes

1. Ability to derive state-space models for dynamical systems 能够对动态系统进行状态空间模型推导
2. Ability to use modern control methods to analyze the performance of a given dynamical systems 能够使用现代控制方法分析给定动力系统的表现
3. Ability to use modern control methods to design observer and controller for a given dynamical systems 能够使用现代控制方法为给定的动力系统设计观测器和控制器
4. Good understanding of Kalman filtering problem and algorithm 很好地理解卡尔曼滤波问题和算法
5. Familiar with MATLAB based simulation and control system design 熟悉基于 MATLAB 的仿真和控制系统设计
6. Strong background in linear algebra and applied probability for advanced studies in robotics, aerospace, and electrical engineering. 具有良好的线性代数和概率论背景，能在机器人、航空航天和电子工程领域从事高级研究。

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. **Overview of modern control theory (1h) 现代控制理论综述 (1 小时)**
2. **Review of Linear Algebra (3 h) 线性代数回顾 (3 小时)**
3. **Discrete Time State Space Models (3h) 离散时间状态空间模型 (3 小时)**
 - a) Digital control systems 数码控制系统
 - b) Transfer function model 传递函数模型
 - c) State space model 状态空间模型
4. **Data Driven Modelling (6h) 数据驱动建模 (6 小时)**
 - a) Linear least squares 线性最小二乘
 - b) Nonlinear least squares 非线性最小二乘
 - c) System identifications using least squares 使用最小二乘进行系统辨识
5. **System properties (8h) 系统属性 (8 小时)**
 - a) State space model solutions 状态空间模型解
 - b) Stability 稳定性
 - c) Controllability 可控性
 - d) Observability 可观性
6. **Controller Design (5h) 控制器设计 (5 小时)**
 - a) Controllable canonical form 可控正则形式
 - b) Pole placement/eigenvalue assignment problem 极点配置/特征值分配问题
7. **Observer Design and Output Feedback (4h) 观测器设计与输出反馈 (4 小时)**
 - a) Luenburger observer 龙伯格观测器
 - b) Output feedback controller design 输出反馈控制器设计
8. **Linear Quadratic Regulation (6h) 线性二次调节 (6 小时)**
 - a) Short introduction to optimal control and dynamic programming 简单介绍最优控制和动态规划
 - b) Linear quadratic regulator 线性二次调节器
 - c) Applications 应用
9. **Kalman Filtering (12h) 卡尔曼滤波 (12 小时)**

- d) Basic probability 基本概率
- e) Gaussian random vectors 高斯随机向量
- f) Fundamentals of mean squared estimation 均方估计的基本原理
- g) Kalman filter 卡尔曼滤波器
- h) Extended Kalman filter 扩展卡尔曼滤波器
- i) Applications 应用

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

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		5		
课堂表现 Class Performance				
小测验 Quiz		5		
课程项目 Projects		15		
平时作业 Assignments		15		
期中考试 Mid-Term Test		25		
期末考试 Final Exam		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

机械与能源工程系教学委员会

