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**	**嵌入式系统与机器人** **Embedded System and Robotics**
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**	ME432
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业核心课 Major Core Course
6.	**授课学期** **Semester**	秋季学期 Fall
7.	**授课语言** **Teaching Language**	中英双语 Chinese-English bilingual
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）**	柯文德 机械与能源工程系 13809883997 Wende Ke Department of Mechanical and Energy Engineering 13809883997
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	32		32		64

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	ME306 机器人基础 或者 ME331 机器人建模与控制 ME306 Fundamentals of Robotics or ME331 Robot Modeling and Control
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.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

《嵌入式系统与机器人》是机器人工程专业的专业核心课程，其教学目标是介绍嵌入式系统基本原理及其在机器人控制中的应用，让学生深入了解构建机器人控制系统的原理、方法及前沿发展趋势，涉及嵌入式体系、处理器任务调度、运动控制、传感器、通信协议与机制、协同工作模式等，并以 STM32F 系列嵌入式控制器为开发平台，讲述寄存器/库函数下的控制算法及软件设计方法，在实际项目中，结合工程实践问题，设计开发满足特定行业需求的机器人系统。

该课程通过对机器人控制方法和嵌入式系统原理的讲解，结合前沿技术发展趋势，让学生对机器人技术的发展趋势形成系统性了解，掌握相关的原理与方法，培养学习兴趣，提高分析问题和解决问题的能力，为未来从事该领域的理论和应用研究打下坚实的基础。

Embedded System and Robotics is the core course of robot engineering. Its teaching goal is to introduce the basic principle of embedded system and its application in robot control, so that students can have a deep understanding of the principle, method and the development trend of building robot control system. It involves the embedded system, processor task scheduling, motion control, sensors, communication protocols and mechanisms, cooperative work mode, etc. Taking STM32F series embedded controllers as development platform, the control algorithm and software design method under register/library function are described. In practical projects, combined with engineering practice, a robot system is designed and developed to meet the needs of specific industries.

By explaining the principle of robot control method and embedded system, combining with the development trend of advanced technology, the course enables students to form a systematic understanding of the development trend of robot technology, master relevant principles and methods, cultivate interest in learning, improve the ability to analyze and solve problems, and build a solid foundation for future theoretical and applied research in this field.

16. 预达学习成果 Learning Outcomes

《嵌入式系统与机器人》课程通过系统性讲授机器人控制的嵌入式技术方面的理论、部件、子系统等知识，并采用课程分组项目同步推进课程学习。学生将掌握嵌入式系统的基本原理、处理器工作模式、运动控制、接口技术等方法，掌握嵌入式系统的开发工具 Keil uVision 以及在 STM32F 系列下的寄存器/库函数的软件开发方法，提高问题分析能力和解决能力，开发出满足特定行业要求的机器人样机作品，提高专业学习能力和逻辑思维能力，进而培养国际化思维以及团队协作管理复合能力，为未来从事该领域的理论和应用研究，培养兴趣并打下坚实的基础。

Embedded System and Robotics introduces the theories, components and subsystems of embedded technology of robot control, and synchronously promotes the course learning by grouping projects. Students will master the basic principles of embedded systems, the working modes of processors, motion control, interface technology and other methods. They will master the development tool of embedded systems, Keil uVision, and the software development methods of registers/libraries under STM32F series. They will improve the ability of problem analysis and solution, develop prototype robots to meet the requirements of specific industries, and improve professional learning. These will help to improve students' professional learning ability and logical thinking ability, cultivate their international thinking and team cooperation management ability, and build a solid foundation for future theoretical and applied research in this

field.

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.)

Section	内容 Contents
1（2 课时） 1 (2 hours)	嵌入式系统及 ARM 处理器体系基本架构 Basic framework of embedded system and architecture of ARM processing unit
2（2 课时） 2 (2 hours)	STM32 IO 口与串口通信 STM32 IO Port and Serial Port Communication
3（2 课时） 3 (2 hours)	STM32 中断方式、原理与控制 STM32 Interruption mode, principle and Control
4（2 课时） 4 (2 hours)	系统自启动与看门狗管理模式 System Self-startup and Watchdog Management Model
5（2 课时） 5 (2 hours)	通用定时器模式、原理与控制 Mode, Principle and Control of Universal Timer
6（2 课时） 6 (2 hours)	PWM 信号原理、生成方式及应用 Principle, Generation and Application of PWM Signal
7（2 课时） 7 (2 hours)	数据输入捕获及电容触摸相应 Data Input Capture and Capacitance Touch Correspondence
8（2 课时） 8 (2 hours)	内存数据保护及系统安全性分析 Memory Data Protection and System Security Analysis
9（2 课时） 9 (2 hours)	TFTLCD 控制方式及图形图像显示原理 TFTLCD Control Mode and Graphic and Image Display Principle
10（2 课时） 10 (2 hours)	SDRAM 存储原理、接口及控制 SDRAM Storage Principle, Interface and Control
11（2 课时） 11 (2 hours)	RTC 实时时钟原理与控制方式 RTC Real-time Clock Principle and Control Mode
12（2 课时）	系统硬件随机数生成及待机唤醒模式

12 (2 hours)	System Hardware Random Number Generation and Standby Wake-up Mode
13（2 课时） 13 (2 hours)	ADC（模数转换）/DAC（数模转换）原理与控制方法 ADC/DAC Principle and Control Methods
14（2 课时） 14 (2 hours)	DMA（直接存储器存取）原理与工作模式 The Principle and Working Mode of DMA (Direct Memory Access)
15（2 课时） 15 (2 hours)	IIC（Inter-integrated circuit）与 CAN（Controller area network）总线原理与控制模式 IIC（Inter-integrated circuit）and CAN（Controller area network）Bus Principle and Control Mode
16（2 课时） 16 (2 hours)	专题讲座 Special lecture

实验 Experiments

1. MDK5 开发环境安装与配置（第 1 周，2 节课）

1. MDK5 installation and configuration of development environment (week 1. 2 hours)

2. 跑马灯、按键输入实验（第 2 周，2 节课）

2. Running Horse Lamp and Keyboard Input Experiments (week 2. 2 hours)

3. 串口通信、外部中断实验（第 3 周，2 节课）

3. Serial Communication and External Interrupt Experiments (week 3. 2 hours)

4. 独立看门狗、窗口看门狗实验（第 4 周，2 节课）

4. Independent Watchdog and Window Watchdog Experiments (week 4. 2 hours)

5. 定时器中断实验（第 5 周，2 节课）

5. Timer interrupt experiment (week 5. 2 hours)

6. PWM 输出实验（第 6 周，2 节课）

6. PWM output experiment (week 6. 2 hours)

7. 电容触摸按键实验（第 7 周，2 节课）

7. Capacitance touch key experiment (week 7. 2 hours)

8. 内存保护实验（第 8 周，2 节课）

8. Memory protection experiment (week 8. 2 hours)

9. TFTLCD 实验（第 9 周，2 节课）

9. TFTLCD experiment (week 9. 2 hours)

10. SDRAM 实验（第 10 周，2 节课） 10. SDRAM experiment (week 10. 2 hours)
11. RTC 实时时钟实验（第 11 周，2 节课） 11. Real time experiment (week 11. 2 hours)
12. 硬件随机数、待机唤醒实验（第 12 周，2 节课） 12. Hardware Random Number and Standby Wake-up Experiments (week 12. 2 hours)
13. ADC 实验（第 13 周，2 节课） 13. ADC experiment (week 13. 2 hours)
14. 内部温度传感器、DAC 实验（第 14 周，2 节课） 14. Internal Temperature Sensor and DAC Experiments (week 14. 2 hours)
15. DMA 实验（第 15 周，2 节课） 15. DMA experiment (week 15. 2 hours)
16. 项目展示与答辩（第 16 周，2 节课） 16. Presentation and dissertation of projects (week 16. 2 hours)

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

1. STM32F7原理与应用——HAL库版，北京航空航天大学出版社， 2017年07月

Principle and Application of STM32F7 - HAL Library Edition, Beijing University of Aeronautics and Astronautics Press, July 2017

2. 嵌入式系统原理及接口技术，刘彦文，清华大学出版社，ISBN：9787302240303，2011年3月第1版

Principle of embedded system and interface technology. Yanwen Liu, Tsinghua press, ISBN：9787302240303, 1st edition in 2011.03

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				
课程项目 Projects		70		
平时作业 Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam				
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)		30（实验部分）		

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