

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.

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| 1. | 课程名称 Course Title | 机器人基础 Fundamentals of 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 | ME306 | | | | |
| 4. | 课程学分 Credit Value | 3 | | | | |
| 5. | 课程类别 Course Type | 专业核心课 Major Core Courses | | | | |
| 6. | 授课学期 Semester | 春季 Spring | | | | |
| 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) | 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 | 需助教1人，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 |

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| 12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements | ME303 机械设计基础 Fundamentals of Machine Design 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 | ME403 智能机器人技术 Intelligent Robot Technology |
| 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

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| <p>机器人基础是机械制造领域内的专业核心课程，该课程为中英双语授课，详细讲授机器人设计、控制、编程和使用的技术要点和基础理论，如位姿描述和齐次变换、操作臂的运动学、雅可比、动力学、轨迹规划、控制、机器人语言和离线编程等。</p> <p>课程分组项目能够实现以学生掌握知识为目标、通过实验课程项目提高学生实际能力、培养学生国际化思维以及团队协作管理复合能力的目标。</p> <p>Fundamentals of Robotics is the core course in the field of mechanical manufacturing. The course will be taught in both English and Chinese. The technologies in design, control, programming and application will be described in detail, such as posture description and homogeneous transformation, kinematics, Jacobian, dynamics, trajectory planning, control, robot language and offline programming, etc.</p> <p>The projects based on experiments help students to master the corresponding knowledge, improve their practical ability and train their international thinking method and team cooperation.</p> |
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16. 预达学习成果 Learning Outcomes

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| <p>机器人基础是机械制造领域内的专业核心课程，主要讲授机器人设计、控制、编程和使用的技术要点和基础理论等方面的内容。该课程采用中英文授课、课程分组项目能够实现以学生掌握知识为目标，通过实验课程项目提高学生实际能力、培养学生国际化思维以及团队协作管理复合能力，培养具有原始创新能力的人才、具有集成创新能力的人才。</p> <p>Fundamentals of Robotics is a core course in the field of mechanical manufacturing. Its main topics are about of robotics design, control, programming and application concern to technologies and fundamental theories. This course will be taught in both English and Chinese. The projects based on experiments help students to master the corresponding knowledge, improve their practical ability and train their international thinking method and team cooperation.</p> |
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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.)

| Week | 内容 Contents |
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| 1 (2 课时) 1 (2 hours) | 机器人基础介绍 Introduction to fundamental of robotics |
| 2 (2 课时) 2 (2 hours) | 空间位姿描述与齐次变换（第 1 部分） 1. 刚体；2. 坐标变换；3. 齐次坐标与齐次变换；4. 齐次变换矩阵计算 Pose description and homogeneous transformation (part 1) |

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| | 1. Pose of rigid body; 2. coordinate transformation; 3. homogeneous coordinate and homogeneous transformation; 4. calculation of homogeneous transformation matrix. |
| 3 (2 课时) 3 (2 hours) | 空间位姿描述与齐次变换 (第 2 部分) 1. 变换等式; 2. 欧拉角与 RPY 角; 3. 旋转变换广义公式 Pose description and homogeneous transformation (part 2) 1. Transformation equation; 2. Euler angle and RPY angle; 3. general formula of rotation transformation. |
| 4 (2 课时) 4 (2 hours) | 操作臂运动学 1. D-H 变换 2. 机器人逆运动学; 3. 逆运动学关键问题; 4. 关节空间和工作空间 Manipulator kinematics (part 2) 1. D-H transform ; 2. Inverse kinematics; 3. key problems in inverse kinematics; 4. joint space and working space. |
| 5 (2 课时) 5 (2 hours) | 微分运动和速度 1. 雅克比矩阵; 2. 微分变换; 3. 雅克比矩阵求逆 Differential motion and velocity 1. Jacobian matrix; 2. Differential transformation; 3. Inversion of Jacobian matrix |
| 6 (2 课时) 6 (2 hours) | 操作臂动力学 1. 拉格朗日动力学; 2. 多自由度机器人的动力学方程; 3. 坐标系间力和力矩的变换 Manipulator dynamics 1. Lagrange dynamics; 2. Dynamics equations of Multi-DOF Robots; 3. Transformations of forces and torques between coordinate systems |
| 7 (2 课时) 7 (2 hours) | 轨迹规划 1. 轨迹规划问题; 2. 关节轨迹插值 Trajectory planning 1. Problems in trajectory planning; 2. joint trajectory interpolation. |
| 8 (2 课时) 8 (2 hours) | 驱动器控制 1. 驱动系统; 2. 电动机; 3. 伺服电机; 4. 减速器 Driver control 1. Driving system; 2. Motor; 3. Servo motor; 4. Reducer |
| 9 (2 课时) 9 (2 hours) | 机器人控制系统 1. 非线性控制; 2. 多关节控制; 3. 工业机器人控制系统 Robot Control System 1. Nonlinear control; 2. Multi-joint control; 3. Industrial robot Control System |
| 10 (2 课时) 10 (2 hours) | 机器人的传感器技术-常用的传感器及其原理 (一) Sensor technology in robot-common sensors and principles (part 1) |

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| 11 (2 课时) | 机器人的传感器技术-常用的传感器及其原理 (二) |
| 11 (2 hours) | Sensor technology in robot-common sensors and principles (part 2) |
| 12 (2 课时) | 机器人图像处理原理及其方法 |
| 12 (2 hours) | Principle of image processing and methods in robotics |
| 13 (2 课时) | 机器人智能控制原理及其方法 (一) |
| 13 (2 hours) | Principles of intelligent control and methods of robotics (part 1) |
| 14 (2 课时) | 机器人智能控制原理及其方法 (二) |
| 14 (2 hours) | Principles of intelligent control and methods of robotics (part 2) |
| 15 (2 课时) | 机器人编程语言及离线编程 |
| 15 (2 hours) | Programming language for robot and off-line programming |
| 16 (2 课时) | 复习与项目答辩 |
| 16 (2 hours) | Review and dissertation of project |
| 实验 Experiments | |
| ABB 串联工业机器人仿真 (第 1、2、3、4 周, 8 节课) | |
| 1. 基本模型构建; 2. 工作空间建模; 3. 基本动作设计 | |
| Simulation of ABB serial industrial robot (week 1, 2, 3, 4. 8 hours) | |
| 1. Basic motions; 2. Modeling of workspace; 3. Design of basic motions | |
| ABB 串联工业机器人仿真 (第 5、6、7、8 周, 8 次课) | |
| 1. 基本路径规划; 2. 基本流水线工作台设计 | |
| Simulation of ABB serial industrial robot (week 9, 10, 11, 12. 8 hours) | |
| 1. Basic trajectory planning; 2. Basic design of streamline platform. | |
| ABB 串联工业机器人仿真 (第 9、10、11、12 周, 8 次课) | |
| 1. 路径规划; 2. 流水线工作台设计; 3. 仿真项目演示 | |
| Simulation of ABB serial industrial robot (week 9, 10, 11, 12. 8 hours) | |
| 1. Trajectory planning; 2. Design of streamline platform; 3. Demonstration of simulation project | |
| ABB 串联工业机器人实物样机操作 (第 13、14、15、16 周, 8 次课) | |
| 1. 编程语言设计; 2. 设计效果评价; 3. 实物样机演示 | |
| ABB serial industrial robot (week 13, 14, 15, 16. 8 hours) | |
| 1. design of basic programming language; 2. Evaluation of design; 3. Demonstration of physical prototype. | |

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

1. 机器人技术基础, 熊有伦, 华中科技大学出版社, 1996年8月第一版, 2016年8月第22次印刷
Technological fundamental of robotics, 1th- ed. By Youlun Xiong, Aug. 1996
2. 机器人建模和控制, 马克 W. 斯庞, 机械工业出版社, 2016年07月第一版
Robot modeling and control, 1th- ed. By Spong W. Mark, China machine press, Jul. 2016
3. 机器人建模、规划与控制. 西西利亚诺, 等. 机械工业出版社, 2013年01月第一版
Robotics - Modelling, Planning and Control. Bruno Siciliano, et al. Springer press, 2009

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 | | 30 | | |
| 平时作业 Assignments | | 10 | | |
| 期中考试 Mid-Term Test | | | | |
| 期末考试 Final Exam | | 40 | | |
| 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 (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