# 课程大纲
# COURSE SYLLABUS

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| **1.** | **课程代码/名称**<br>**Course Code/Title** | 高等机器人控制 Advanced Control for Robotics |
| **2.** | **课程性质**<br>**Compulsory/Elective** | 专业课/**Elective** |
| **3.** | **课程学分/学时**<br>**Course Credit/Hours** | 3 学分/48 学时<br>3 Credits /48 Hours |
| **4.** | **授课语言**<br>**Teaching Language** | 英文<br>English |
| **5.** | **授课教师**<br>**Instructor(s)** | 张巍<br>Wei Zhang |
| **6.** | **是否面向本科生开放**<br>**Open to undergraduates or not** | 否 no |
| **7.** | **先修要求**<br>**Pre-requisites** | 研究生：无 |
| **8.** | **教学目标**<br>**Course Objectives** | |
| | 本课程主要目的是培养机器人方向的研究生数学、优化与控制基础。教学生如何辨识、刻化、和求解机器人中的优化问题。内容包括高等机器人动力学以及其与优化的关系、最优控制、轨迹优化、模型预测控制、足式机器人最优控制等。<br><br>The objective of this course is for students to develop the ability to recognize, formulate, and solve optimization problems within the context of robotics applications. We will consider a range of classical problems spanning dynamics, identification, control, and estimation, and show how they can be posed as constrained optimization problems. An emphasis will be placed on developing competency in control and optimization theory and on applications within legged robotics. | |
| **9.** | **教学方法**<br>**Teaching Methods** | |
| | 课堂讲授，课后习题，和大作业<br>Lecture and projects | |
| **10.** | **教学内容（需要写到 section 16）**<br>**Course Contents** | |
| | **Section 1** | 相关数学与优化背景介绍<br>Math and Optimization Review |
| | **Section 2** | 空间向量、空间力与空间动量<br>Spatial Vector, forces, and Momentum |
| | **Section 3** | 多刚体动力学<br>Multibody Dynamics |
| | **Section 4** | 接触模型<br>Modeling Contacts |
| | **Section 5** | 最优控制基础<br>Introduction to Optimal Control |

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| | **Section 6** | 多刚体动力学的最优控制解释<br>Rigid Body Dynamics as an Optimal Control Problem |
| | **Section 7** | ABA 算法<br>Articulated Body Algorithm |
| | **Section 8** | Pontryagin 最大值原理<br>Pontrayagin's Principle |
| | **Section 9** | 轨迹优化<br>Trajectory Optimization |
| | **Section 10** | 微分动态规划<br>Differential Dynamic Programming |
| | **Section 11** | 模型预测控制算法<br>Model Predictive Control Algorithm |
| | **Section 12** | 模型预测控制理论<br>Model Predictive Control Theory |
| | **Section 13** | 足式机器人简化模型<br>Simple models of locomotion |
| | **Section 14** | 足式机器人动力学分析<br>Dynamics of Legged robot |
| | **Section 15** | 足式机器人模型预测控制<br>Model Predictive Control for Legged Robot |
| | **Section 16** | 大作业项目汇报<br>Project Presentation |
| **11.** | **课程考核**<br>**Course Assessment** | |
| | Homework (30%), Programming Assignment (20%), Midterm (25%), Final Project 25% | |
| **12.** | **教材及其它参考资料**<br>**Textbook and Supplementary Readings** | |
| | Rigid-Body Dynamics Algorithms - Roy Featherstone<br>Calculus of Variations and Optimal Control Theory - Daniel Liberzon<br>A Mathematical Introduction to Robotic Manipulation - Richard M. Murray, Zexiang Li, S. Shankar Sastry | |