

研究生课程教学大纲（Syllabus）

课程代码 Course Code	ME6401	*学时 Teaching Hours	48	*学分 Credits	3
*课程名称 Course Name	(中文) 汽车系统动力学				
	(English) Vehicle System Dynamics				
*授课语言 Instruction Language	English				
*开课院系 School	School of Mechanical Engineering				
先修课程 Prerequisite					
授课教师 Instructors	姓名 Name	职称 Title	单位 Department	联系方式 E-mail	
	喻凡	教授	机动学院	fanyu@sjtu.edu.cn	
*课程简介 (中文) Course Description	<p>系统介绍车辆动力学的基本内容，即驱动与制动动力学、行驶动力学和操纵动力学及其相关控制系统；运用多体建模方法和先进的控制理论进行汽车动力学仿真及控制系统设计。</p> <p>课程内容主要包括六大模块：</p> <ol style="list-style-type: none">1. 车辆动力学简史和发展、设计思想、特性及要求、术语、试验及法规；2. 轮胎的物理特性、轮胎模型及其在车辆动力学仿真中的应用3. 驱动与制动动力学及其控制，如ABS、TCS与ESP（VSC）等；4. 行驶动力学及其控制：随机路面模型、行驶动力学模型、人体对振动的反应、悬架控制系统设计；5. 操纵动力学及其控制：轮胎特性、人-车闭环系统、基本操纵模型及其扩展、操纵响应分析、转向控制系统(4WS和AFS)设计；6. 车辆动力学控制系统、多体系统建模方法及常用车辆动力学分析软件介绍及特点比较，通过三个实例介绍建模、仿真、性能分析以及控制系统设计等整个过程，具体包括：1）随机路面噪声激励下的两自由度单轮行驶动力学建模、性能仿真及最优主动悬架（LQG）控制器设计；2）两自由度单轨模型操纵动力学性能仿真及四轮转向控制器设计；3）结合非线性轮胎模型及两自由度单轮模型的制动动力学建模、分析及基于最优滑转率门限值的 ABS 控制器设计； <p>车辆动力学的发展、车辆控制系统集成技术、未来的发展及相关讨论。</p>				

<p>*课程简介 (English) Course Description</p>	<p>The fundamentals of vehicle dynamics are systematically introduced including traction and braking dynamics, ride and handling dynamics as well as related control system. The multi-body modeling approach and advanced control theory are applied to the simulations of vehicle dynamics and design of control system. The main contents includes six modules as below,</p> <ol style="list-style-type: none"> 1. Introduction: brief history and development of the subject, desirable vehicle properties, vehicle design philosophy, tests, terminology and legislation; 2. Fundamentals of tyre mechanics: structure and function of tyre, tire physical properties, tyre moles, Magic formula, some consideration of tyre model in vehicle simulations; 3. Braking and Traction: basic equation of motion, aerodynamic forces and moment, tyre rolling resistance, acceleration and grading capability performances, braking performances and ABS design, introduction to TCS and ESP(VSC); 4. Ride: road roughness and measurement techniques, road input modelling, suspension components and modelling, vehicle ride models (2,4 and 7 DOFs), human response to vibration, ISO 2631, suspension control system and design; 5. Handling: tyre properties, driver-vehicle close loop system, basic handling model, linear handling results, extensions to the basic handling model, introduction to steering control systems, including 4WS and AFS; 6. Vehicle motion control systems and the integration technique, Computer modelling and Simulation and Controller Design, introduction and comparison of some purpose-designed simulation codes, multi-body system dynamics packages and toolkit, Three case studies in Matlab/Simulink software environment as assignments. Future developments and discussion. 			
<p>*教学安排 Schedules</p>	<p>教学内容 Content</p>	<p>授课学时 Hours</p>	<p>教学方式 Format</p>	<p>授课教师 Instructor</p>
	<p>Module I: Introduction</p>	<p>3</p>	<p>Lecture</p>	<p>Yu Fan</p>
	<p>Module T: Fundamentals of Tyre Mechanics</p>	<p>3</p>	<p>Lecture</p>	<p>Yu Fan</p>
	<p>Module R: Ride Dynamics</p>	<p>6</p>	<p>Lecture</p>	<p>Yu Fan</p>
	<p>Assignment One</p>	<p>3</p>	<p>Lecture</p>	<p>Yu Fan</p>
	<p>Module H: Handling Dynamics</p>	<p>6</p>	<p>Lecture</p>	<p>Yu Fan</p>

	Assignment Two	3	Lecture	Yu Fan
	Module L: Longitudinal Dynamics(Traction and Braking)	6	Lecture	Yu Fan
	Assignment Three	3	Lecture	Yu Fan
	Module C: Modeling and analysis, Control systems and Integration	6	Lecture	Yu Fan
	Student Presentation and Discussion	6		
	Examination	2		
*考核方式 Grading Policy	<ol style="list-style-type: none"> Course activities (weighting 20%) Three Assessments (optional, each team selects one assignment, presentation + report) (weighting 50%) <ol style="list-style-type: none"> An optimal (LQG) controller design for active suspension design based on 2-dof single wheel station ride model; Comparison and analysis of handling performance based on a 2-dof single-track handling model ABS controller design based on a 2-dof single wheel model and a non-linear tyre model by using threshold algorithm. Exam at the end of term (30%): two hours, open-booked. 			
*教材或参考资料 Textbooks & References	<ol style="list-style-type: none"> Fundamentals of Vehicle Dynamics, T. Gillespie, SAE Press, 1996. Vehicle Handling Dynamics--Theory and Application, Masato Abe, Elsevier, 2015. Automotive System Dynamics (2nd), Yu Fan and Lin Yi, China Machine Press, 2017 (in Chinese). Vehicle Dynamics and Control, Yu Fan, China Machine Press, 2010 (in Chinese). Automotive Theory (5th Edition), Yu Zhisheng, China Machine Press, 2011 (in Chinese). 			
备注 Notes				

备注说明:

- 带*内容为必填项;
- 课程简介字数为 300-500 字; 教学内容、进度安排等以表述清楚教学安排为宜, 字数不限。