附件 2-4

第二届全省高校青年教师教学竞赛决赛参赛课程教学大纲（简要信息表）

<table>
<tr><td>课程名称</td><td colspan="5">Mechatronics System Design（机电一体化系统设计 ）(双语 C 类)</td></tr>
<tr><td>上课对象</td><td>本科生</td><td>上课年级</td><td>三年纪</td><td>学分/周学时</td><td>2/2</td></tr>
<tr><td>课程类型</td><td colspan="5">□公共基础课□专业基础课 ■专业课</td></tr>
<tr><td>先修课程</td><td colspan="5">高等数学、机械制图、电子技术、机械设计、机械原理、自动控制原理、微机原理与接口技术、机械测试技术等。</td></tr>
<tr><td>选用教材</td><td colspan="5">● Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Second Edition. 2010932699 (英文原版)
● Devdas Shetty, Richard A. Kolk 著， 张树生译. 机电一体化系统设计，机械工业出版社，2006.1 （中文翻译版）</td></tr>
<tr><td>主要参考书</td><td colspan="5">● W. Bolton, Mechatronics: a multidisciplinary approach, 4th edition. 2008
● Rolf Isermann, Mechatronic systems fundamentals, Springer-verlag London limited, 2005
● Godfrey Onwubolu, Mechatronics Principles and Applications, Elsevier. 2005
● Robert H. Bishop, The Mechatronics Handbook, 2002 by CRC Press LLC
● David G. Alciatore and Michael B. Histand, Introduction to mechatronics and measurement systems. 清华大学出版社（影印版），2004.9
● 曾励. 机电一体化系统设计，高等教育出版社，2010.
● 张建民 等. 机电一体化系统设计（第三版），高等教育出版社，2008.
● 侯力，樊庆文，黄成详，向国齐. 机电一体化系统设计，高等教育出版社，2004
● 李建勇，机电一体化技术，科学出版社，2005
● 刘培基，王安敏，机械工程测试技术，机械工业出版社，2003.1</td></tr>
<tr><td colspan="6">一、课程性质、目的与任务（不少于 300 字）</td></tr>
<tr><td colspan="6">Mechatronics, as an engineering discipline, is the synergistic combination of mechanical engineering, electronics, control engineering, and computers, all integrated through the design process. It involves the application of complex decision making to the operation of physical systems. Mechatronic systems depend on computer software for their unique functionality. This course studies mechatronics at a theoretical and practical level; balance</td></tr>
</table>

between theory/analysis and hardware implementation is emphasized; emphasis is placed on physical understanding rather than on mathematical formalities. A case-study, problem-solving approach, with hardware demonstrations, either on video or in class, and hardware lab exercises, is used throughout the course. This course covers the fundamental areas of technology on which successful mechatronic system designs are based: physical modeling, from design model to truth model, and mathematical modeling of dynamic multidisciplinary physical systems; analysis of mathematical models through analysis and computer simulation; measurement systems (analog and digital sensor modeling, analysis, and implementation) for model validation and control; control actuator (electromechanical and fluid) modeling, analysis, and implementation; continuous controller design and real-time analog and digital implementation; analog and digital control and power electronics. Throughout the coverage the focus is kept on the role of each of these areas in the overall design process and how these key areas are integrated, from the very beginning of the design process, into a successful mechatronic system design. Starting at design and continuing through manufacture, mechatronic designs optimize the available mix of technologies to produce quality precision products and systems in a timely manner with features the customer wants. The real benefits to industry of a mechatronic approach to design are shorter development cycles, lower costs, and increased quality, reliability, and performance.

The integration of electronic engineering, electrical engineering, computer technology and control engineering with mechanical engineering is increasingly forming a crucial part in the design, manufacture and maintenance of a wide range of engineering products and process. A consequence of this is thus the need for engineers and technicians to adopt an interdisciplinary and integrated approach to engineering. The term ***mechatronics*** is used to describe this integrated approach. A consequence of this approach is that engineers and technicians need skills and knowledge that are not confined to a single subject area. They need to be capable of operating and communicating across a range of engineering disciplines and linking with those having more specialist skills. The course is an attempt to provide a basic background to mechatronics and provide links through to more specialized skills.

The overall aims of the course are to help the students:

（1）Acquire a mix of skills in mechanical engineering, electronics and computing which is necessary if he/she is to be able to comprehend and design mechatronics systems;

（2） Become capable of operating and communicating across the range of engineering disciplines necessary in mechatronics.

机电一体化是一种在设计过程中将机械工程、电子技术、控制技术和计算机技术有机地结合的工程学科。机电一体化系统依赖于计算机软件来实现其独特的功能。

本课程从理论和实践层次出发研究机电一体化系统；兼顾理论分析和硬件实现；重点放在物理上的认知而不是数学公式的推导。在整个课程的学习过程中，我们通过视频和课堂上硬件演示以及硬件实验练习来寻求解决问题的方法。为了给机电一体化系统的设计提供理论基础，本课程涵盖了以下的基础技术领域:

（1）从设计模型到实际模型的物理建模，以及动态的跨学科的物理系统的数学建模；通过分析和计算机仿真分析数学模型;

（2）为了模型的验证和控制而构建测量系统（模拟和数字传感器的建模、分析和实现）；执行机构(机电系统和液压系统)的建模、分析和实现；模拟、数字控制和电力电子技术。从设计过程的开始到一个成功的机电一体化系统的完成，这整个过程的

重点在于每个基础技术领域对整个设计过程的作用，以及如何将这些关键技术领域集成在一起，**也就是用系统的思想，借助相应的软件分析和硬件设计方法，实现机电一体化系统的设计、分析是本课程讲授的核心，而不是仅关注具体知识的讲解。**

因为电子工程、电气工程、计算机技术、控制工程和机械工程的一体化逐渐成为工程产品的设计、制造和维修过程的重要组成部分。这就要求学生必须采用多学科的综合的方法来进行设计，**所以在这一过程中，掌握具体学习和分析思路比掌握一种简单的具体方法更重要**。

图 1 为机电一体化系统设计的知识构架图，本课程主要围绕知识构架组织教学，具体包括机械设计设计、传感和检测系统、执行系统、信息处理系统、系统建模与仿真、机电一体化系统设计、以及案例学习与实验。

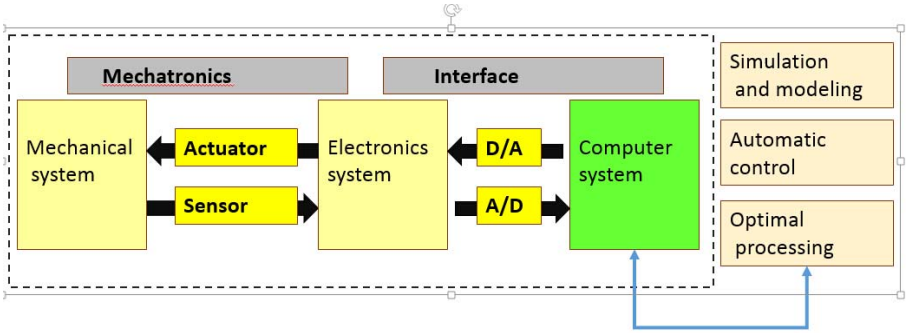

图 1 机电一体化系统的知识构架

在组织教学过程中，非常重视知识点的衔接以及新知识的讲解，具体可见下图:

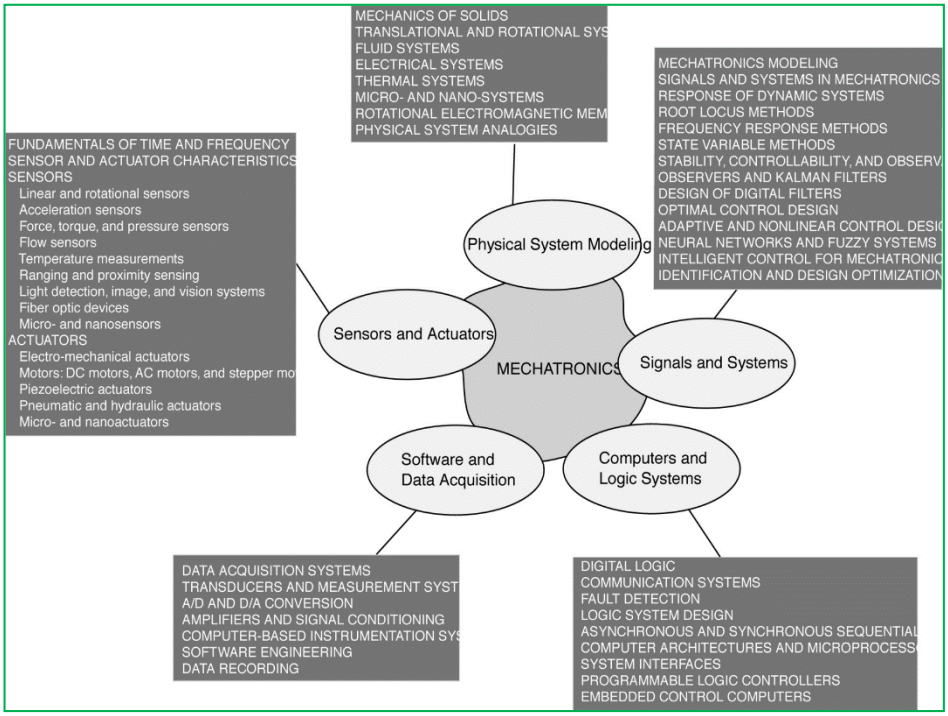

图 2: 具体部分涉及到的相关知识点拓扑图

二、教学基本要求（不少于500字）

- Understand the importance of the integration of modeling and controls in the design of mechatronic systems.
  （理解机电一体化系统设计过程中建模和控制相集成的重要性。）
- Understand the dynamic system investigation process and be able to apply it to a variety of dynamic physical systems.
  （理解对动态系统的研究方法并将其运用于各种动态物理系统。）
- Understand the importance of physical and mathematical modeling (both from first principles and using system identification experimental techniques) in mechatronic system design and be able to model and analyze mechanical, electrical, magnetic, fluid, thermal, and multidisciplinary systems and identify the analogies among the various physical systems.
  （理解机电一体化系统设计中物理和数学建模的重要性，并能对机械、电学、磁学、流体、热学和多学科的系统进行建模和分析，明确各种物理系统之间的类比。）
- Be able to develop a hierarchy of physical models for a dynamic system, from a truth model to a design model, and understand the appropriate use of this hierarchy of models.
  （能够为动态系统建立一个从实际模型到设计模型的逻辑层次结构，并理解模型的正确使用）
- Become proficient in the use of MatLab/Simulink and LabVIEW to model and analyze linear mechatronic systems.
  （熟练使用MatLab / Simulink和LabVIEW来建模和分析线性机电一体化系统。）
- Understand the key elements of a measurement system and the basic performance specifications and models of a variety of analog and digital mechatronic sensors.
  （了解测量系统的关键要素以及各种模拟和数字机械电子传感器的基本性能规格和型号。）
- Understand the characteristics and models of various electromechanical actuators stepper motor and hydraulic and pneumatic actuators.
  （了解典型机电执行器、步进电机和液压、气压执行器的特性）
- Understand analog and digital circuits and components and semiconductor electronics as they apply to mechatronic systems.
  （了解应用于机电一体化系统的模拟、数字电路组件以及半导体电子产品。）
- Understand and be able to apply, with the use of the MatLab and LabVIEW, various control system design techniques: open-loop feedforward control, classical feedback control (rootlocus and frequency response), and state-space control.
  （理解并能够通过MatLab和LabVIEW使用各种控制系统设计技术：开环前反馈控制、经典反馈控制（根轨迹法和频率响应法），以及状态控制。）
- Understand the digital implementation of control and basic digital control design techniques.
  （了解控制的数字实现以及基本的数字控制设计技术。）
- Become proficient in the use of MatLab and LabVIEW to design and analyze analog controllers and verify their digital implementation.
  （熟练使用MatLab和LabVIEW设计和分析模拟控制器并验证它们的数字实现）

- Have an awareness of more advanced control design techniques, e.g., model predictive control, adaptive control, fuzzy logic control, and multivariable control.
  （认识和了解更高级的控制设计技术：模型预测控制、自适应控制、模糊逻辑控制以及多参数控制。）
- Be able to implement a real-time controller through the use of National Instruments control hardware and LabVIEW programming.
  （能够使用NI的控制硬件和LabVIEW程序实现实时控制。）
- Be able to apply all these skills to the design and analysis of a mechatronic system.
  （能够运用以上这些技能来设计和分析机电一体化系统。）

三、主要内容及学时安排

章或节	主要内容	学时安排
Chapter 1: Mechatronics system design （概论） 2 Hours	● What is mechatronics (机电一体化的概念) ● Mechatronics key element （机电一体化系统的关键要素） ● Basic theory and key technology （基本理论和关键技术）	1
	● The mechatronics design process （系统设计方法和过程） ● The state of art of the mechatronics system （机电一体化系统发展现状） ● Syllabus introduction （课程大纲介绍）	1
Chapter 2: Sensors and Transducers （传感器） 4 Hours	● Sensor and transducers （传感器介绍）	1
	● The key specifications （传感器关键性能指标）	1
	● Measuring in mechatronics system （机电一体化系统中典型参数的测量）	1
	● Uncertainty analysis of sensor or measurement system （测量的不确定性分析）	1
Chapter 3: Signal Conditioning and Data Acquisition （信号调理和数据采集） 3 Hours	● Introduction (信号调理介绍) ● The operation amplifier (放大器)	1
	● Filtering (滤波)	1
	● Digital Signals (数字信号) ● A/D Conversion (模拟量和数字量变换)	1

Chapter 4: Mechanical system and Actuation Device (机械系统和执行器) 4 Hours	● Introduction (介绍) ● Mechanical System and Basic Requirement (机械系统及其基本要求)	1
	● Mechanical Actuation and Guide/ Transportation system (机械执行机构和导向及传动系统)	1
	● Fluid Power System （Pneumatic and hydraulic） (流体动力系统)	1
	● Director Current Motors and Stepper Motors (直流电机和步进电机)	1
Chapter 5: Mechatronics system Modeling and Simulation (系统建模和仿真) 4 Hours	● Introduction (介绍) ● Establish the Model （Mechanical/Fluid/Electrical/Coupling） (建模)	2
	● Simulation based on MATLAB/Simulink (系统仿真分析)	2
Chapter 6: Mechatronics system Design (机电一体化系统设计) 8 Hours	● Introduction (介绍) ● The Steady-state design (稳态设计)	2
	● Dynamic Design (动态设计)	2
	● Dynamic Design (动态设计)	2
	● Reliability and Safety (可靠性和安全性)	2
Chapter 7: Case studies and Lab experiment (案例学习与试验) 6 Hours	● DAQ and data analysis (数据采集和不确定度分析) ● Lab VIEW programming （LabVIEW 编程）	2
	● Modeling and simulation （建模和仿真分析）	2
	● Robotics system （机器人系统）	2
Chapter 8: Review(复习) 1 Hours		1
Total		32

四、考核方式:

1. Homework and Teamwork : 30%
2. Lab experiment: 20%
2. Final Exam: 50 %

五、面向专业：机械设计制造及其自动化、测控技术与仪器等相关专业

六、其它信息: 无