机械与动力工程学院博士生资格考试笔试大纲

Syllabus of Ph.D. Qualification Examination (SJTU-ME)

*笔试主题 **Exam Topic**	（中文）自动控制理论
	（English）Automatic control theory
*考核形式 **Exam Format**	闭卷考试，1 小时 Closed-book exam, 1 hour
*考核目标 **Exam Target**	《自动控制理论》是机械工程专业重要的控制专业课程之一，通过该课程的考核，能够评价考生掌握自动控制理论基础和分析处理实际自动控制问题的能力。 "Automatic control theory" is one of the important specialized control courses for the Mechanical Engineering. Through the examination of this course, we can evaluate the candidates' ability to master the theoretical basis of automatic control, analyze and deal with practical automatic control problems.
*考核内容 **Exam Contents**	考核内容主要包括：自动控制的基本概念；控制系统的状态空间表达式描述；控制系统的时域分析、频域分析分析、稳定性分析；控制系统的校正、极点配置；能控性与能观测性；稳定性；状态反馈，观测器;最优控制等基本内容。具体涵盖： 1、掌握自动控制的基本概念和术语，能理解和说明其含义； 2、熟悉自动控制系统数学模型的建立和不同形式数学模型的相互关系，能按要求用数学模型准确描述控制系统； 3、掌握控制系统的各种分析方法和应用，能选择合适的分析方法解决所提出的问题； 4、了解控制系统的性能指标及意义，能合理运用性能指标分析评价系统；熟悉状态向量与状态方程；模拟结构图的绘制；状态方程的建立；状态空间表达式的线性变换；传递函数和状态空间表达式的相互转化。 5、熟悉状态转移矩阵的概念、含义以及对应的各种求解方法；线性定常系统非齐次方程的求解。 6、了解能控性与能观测性的概念，掌握控制系统能控性与能观测性判别方法，以及能控标准形与能观测标准形和分解方法。 7、了解并掌握李亚普诺夫意义下的稳定性含义，李亚普诺夫第二方法（直接法）及其物理意义；掌握线性定常系统稳定性分析的李亚普诺夫第二方法。

8、了解线性定常系统的综合方法，掌握状态反馈及输出反馈的概念；掌握状态反馈对原系统的影响及具体设计方法。

9、掌握 LQR 最优控制，熟悉黎卡提方程、欧拉方程。

Topics included in the assessment:

The basic concepts of automatic control, the state-space representation of the control system, the time domain analysis, frequency domain analysis and stability analysis of the control system, the design of compensators and pole configuration of the control system, controllability and observability, stability, state feedback control design, observer design, optimal control etc.

Specified requirements:

1. Comprehend the basic concepts and terms of automatic control, and be able to interpret them.

2. Be acquainted with the formulation of the mathematical model of the automatic control system and the relationship between different forms of mathematical models, and be able to accurately represent the control system with the required mathematical model.

3. Comprehend the theory and usage of various analysis methods of the control system, and be able to select appropriate analysis methods to solve the given problem.

4. Understand the performance indicators of the control system, and be able to use the performance indicators to evaluate the system. Be acquainted with the state vector and state equations, the drawing of the simulated system structure diagram, the obtain of the state equations, the linear transformation of the state-space representation, and the transformation between the transfer function and the state-space representation.

5. Be acquainted with the concept of the state-transition matrix and the corresponding solving methods. Be able to solve the inhomogeneous equations of linear time-invariant systems.

6. Understand the concepts of controllability and observability, and comprehend the methods of evaluating the controllability and observability of control systems, as well as the controllable standard form and the observable standard form of the state-space representation and the decomposition method.

7. Comprehend the meaning of stability in the domain of Lyapunov theory, the second method of Lyapunov (direct method) and its physical meaning. Comprehend the second method of Lyapunov for the stability analysis of linear time-invariant systems.

8. Understand the comprehensive method of linear time-invariant system, and comprehend the concepts of state feedback and output feedback. Be aware of the influence of state feedback on the original system and comprehend the specific design methods of state feedback control.

9. Know well LQR optimal control, familiar with Riccati equation and Euler equation.

| *参考书目
References | [1]现代控制理论，付庄，贡亮，王尧，机械工业出版社，ISBN：9787111726487，2023
[2]刘豹，唐万生主编：《现代控制理论》，机械工业出版社，2006。
[3] Katsuhiko Ogata 著，卢伯英，佟明安 译，现代控制工程（第五版），2017
[1]Liu Bao, Tang Wansheng, **Modern Control Theory**，China Machine Press，2006 |

	[2] Katsuhiko Ogata , **Modern Control Engineering, Fifth Edition,** 2017
e 备注 Notes	