# Modern Control Theory Teaching Conspectus

**Course Code：231071** **Course Name：Modern Control Theory**
**Course Hours：48** **Credits：3**

## Teaching Conspectus Instruction

**1. Course Attribute, Teaching Target and Task**

**Course Attribute:** This course is required, specialized basic subject and that mainly introduces the basic knowledge of modern control theory for undergraduate students of all specialized subjects in automation.

Modern control theory based on classical control theory has been developing with the development of science technology and the requirement of engineering since 1960s. This course is based on the method of state-space. It contains the control system problem about the analysis and the design, such as multi-input and multi-output, variable parameter, nonlinear, higher precision, higher efficiency etc. This field includes many subjects, for example the optimal control, the adaptive control and so on. Especially modern control theory has made great progress in studying enormous system engineering macro-system and brain control, biography control, fuzzy control with the development of computer and applied mathematics.

**Teaching Goal and Task:** The key point of teaching this course is to make students grasp at the method of expressing the system structure, solve the system response, and judge the system controllability, observability and stability of complication systems. Students can design the control system including state feedback pole placement, observer design and linear quadratic optimal control by themselves.

**2. Basic Teaching Requirement:**

This course includes teaching, practice, homework and experiment. Adopting bilingualism teaching, Multimedia and the blackboard writing teaching unifies.The target is to train students in grasping at modern control theory by all steps. The ability of students learning, analyzing problem and solving problem can be improved.

**3. Pre-studied Courses:**Advance math, Principal of Automatic Control

**Following Courses:**Intelligent Control

**4. Conspectus Instruction**

Adopting bilingualism teaching :English and Chinese

**Teaching Conspectus**

### 1．Course Contents of Theory:

Chapter 1 Introduction

Main Contents: Introducing control theory, the development of classical control theory and modern control theory.

Teaching goal: Know the control theory history.

Chapter 2 State-space description of the linear control system

Main Contents: Basic concept, representations of system from time-domain to state-space, representations of system from frequency-domain to state-space, representations of system

state-space based on the figure of state variable, representations of system state-space based on the block figure, the norm pattern of the state-space equation.

Emphasis: Representations of system from time-domain to state-space, representations of system from frequency-domain to state-space.

Teaching goal:

1) Grasping several kinds of expression methods of the state space.

2) Know several kinds of methods of the changing from state-space equation into norm pattern.

Chapter 3: Movement and discrete of the linear control system

Main Contents: Linear time-invariant system free movement, the computing method of matrix exponent $e^{A(t-t_0)}$（or $e^{At}$）, linear time-invariant system movement in controlling, representations of discrete system state-space, solving of discrete system state-space equation , discrete system from linear continuous system .

Emphasis: The computing method of matrix exponent $e^{A(t-t_0)}$（or $e^{At}$）, discrete system from linear continuous system.

Teaching goal:

1) Grasping linear time-invariant system free movement, the computing method of matrix exponent $e^{A(t-t_0)}$（or $e^{At}$）.

2) Understanding linear time-invariant system movement in controlling.

3) Know representations of discrete system state-space, solving of discrete system state-space equation , discrete system from linear continuous system .

Chapter 4: Lyapunov stability of control system

Main Contents: Summarize of Lyapunov 2nd method, Lyapunov stability, Lyapunov stability theorem, Lyapunov stability analysis of linear system.

Emphasis: Summarize of Lyapunov 2nd method, Lyapunov stability, Lyapunov stability theorem.

Difficulty: Lyapunov stability.

Teaching goal: Understanding Lyapunov stability, Lyapunov stability theorem, Lyapunov stability analysis of linear system.

Chapter 5: Linear control system controllability and observability

Main Contents: Controllability base of linear time-invariant system, observability base of linear time-invariant system, controllability base of linear time-invariant discrete system, norm pattern of controllability and observability, correlation principle of controllability and observability.

Emphasis: Controllability base of linear time-invariant system, observability base of linear time-invariant system.

Teaching goal:

1) Grasping controllability base of linear time-invariant system, observability base of linear time-invariant system.

2) Understanding the conversion method of the ontrollability norm and the observability norm.

3) Know correlation principle of controllability and observability.

Chapter 6: State feedback and state observer

Main Contents: State feedback and output feedback, single input-single output state feedback system pole assignment, state reconstruction, and observer pole assignment.

Emphasis: State feedback and output feedback, single input-single output state feedback system pole assignment.

Difficulty: Single input-single output state feedback system pole assignment, state reconstruction.

Teaching goal:

1) Grasping state feedback and output feedback, single input-single output state feedback system pole assignment method.

2) Understanding state reconstruction and observer pole assignment.

Chapter 7: Optimal control system design

Main Contents: Optimal control basic concept, unconstraint optimal control variational method, constraint optimal control principle of minimum.

Emphasis: Unconstraint optimal control variational method.

Difficulty: Unconstraint optimal control variational method, constraint optimal control principle of minimum.

Teaching goal:

1) Grasping the basic concept of optimal control.

2) Understanding unconstraint optimal control variational method.

3) Know constraint optimal control principle of minimum.

## 2. Course Contents of Experiment:

**Experiment names and main contents:**

Experiment. 1th Linear system dynamics characteristic and stability analysis

Experimental contents

(1) Control system analysis and simulation

(2) System characteristic analysis based on simulation result

Experiment. 2th Discrete system dynamics characteristic and stability analysis

Experimental contents

(1) Discretization of continuous control system and simulation

(2) System characteristic analysis based on simulation result

Experiment. 3th Pole assignment of state feedback control system

Experimental contents

(1) Pole assignment and choose

(2) Analysis system similarities and differences based on simulation result

3. Class hour assignment table

| Serial number | Contents | Class hour assignment table | | | |
|---|---|---|---|---|---|
| | | teaching | experiment | computer | subtotal |
| 1 | Chapter 1 Introduction | 2 | | | 2 |
| 2 | Chapter 2 State-space description of the linear control system | 8 | | | 8 |
| 3 | Chapter 3: Movement and discrete of the | 6 | 2 | | 8 |

| | | | | | |
|---|---|---|---|---|---|
| | linear control system | | | | |
| 4 | Chapter 4: Lyapunov stability of control system | 4 | 2 | | 6 |
| 5 | Chapter 5:Linear control system controllability and observability | 8 | | | 8 |
| 6 | Chapter 6: state feedback and state observer | 8 | 2 | | 10 |
| 7 | Chapter 7: optimal control system design | 6 | | | 6 |
| total | | 42 | 6 | | 48 |

**4. Examination and evaluation mode:**

Examination： The total score five-grade includs the final score of the test, other times score and the experiment score.And other times score includes going out on duty, homework.The experiment score includes experimental operation score. and the result of the report.

**Evaluation mode:**The final score of the test 100-grade occupies the overall result 80%, other times score occupies the overall result 10%.Average result of 3 experimental results takes the final experiment result. The experiment score five-grade occupies the overall result 10%.

**5. Textbook and reference Books:**

**Textbook:**

1) Modern Control Theory. Yu Changguan. Harbin Institute of Technology University Press，2005.8 3th edition.

**2)** Modern Control Theory Experiment Cui Xinzhong DaLian Fisheries University

**Reference Books:**

1) Modern Control Theory. Wu Junfeng. Harbin Engineering University Press，2003.7 2th edition

2) Modern Control Systems.( English copy version) (American) RICHARD C.DORF，ROBERT H BISHOP. Science Press 2005.9 10th edition.

3) Modern Control Theory. Liu Bao. Machine Press，2005.3 2th edition.

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| | 院长（系主任）签字： | | | 日期：2006.8.20 |