國立中正大學機械工程學系 114 學年度第二學期教學大綱表

<table>
<tr><td colspan="5" rowspan="2">課程名稱：(中文)數位控制
(英文) Digital Control</td><td>開課單位</td><td>機械系</td></tr>
<tr><td>課程代碼</td><td>4205776</td></tr>
<tr><td>授課教師</td><td>洪博雄</td><td>學分數</td><td>3</td><td>選修</td><td>開課年級</td><td>碩士/
大三、大四
可修</td></tr>
<tr><td>全英文授課 EMI</td><td colspan="6">■是　　□否</td></tr>
<tr><td colspan="7">先修科目或先備能力：自動控制（大學部課程）、線性系統（研究所課程）</td></tr>
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課程概述：

In Digital Control, we will learn how to digitally implement the continuous dynamics synthesized by classical control or modern control to function as controllers, observers, filters, or phase-compensators. The implementation is finished in two stages: discrete equivalency and DSP programming. That is, the to-be-implemented continuous-dynamics is firstly transformed into a discrete-equivalent, which is then programmed into some microcontroller as a real-time processor. Unlike most of engineering curriculums that are computer-time technologies, Digital Control is a real-time technology.

The contents of the course are listed as follows.

6-3 IIR-P: memorization of past inputs and outputs (violates the principle of causality)
6-4 IIR-AC: iterative recursion of controllability canonical computer
6-5 IIR-AO: iterative recursion of observability canonical computer
6-6 IIR-S: Decomposition into a series of subsystems
6-7 FIR: finite impulse response
Chapter 7: Special Issue on Half-a-sample Delay Embedded in ZOH
7-1 Viewpoints from temporal signal
7-2 Frequency responses of equivalents
7-3 Nonlinear digital control: Tustin equivalent plus IIR-AC for van der Pol oscillators
Chapter 8: DSP-Programming into Microcontroller
8-1 Introduction to special-purpose and general-purpose microcontrollers
8-2 Overview of Microchip-dsPIC chips
8-3 Peripherals and interruption
8-4 Matlab-to/from-dsPIC
8-5 Coding of IIRs
8-6 Coding of signal generators
8-7 Example1: Firmware-based instruments
8-8 Example 2: Drivers/controllers of DC motors

目標：

This course is mixed with theory and practice suitable for our smart students. To be sure, they are able to catch this attractive and important real-time technology. In the industry of servo-controlled machines, currently we are always the manufacture rather than the designer. Via this course, it is expected that our new generation is encouraged to start changing this situation. Of course, they will be getting to know how to change with this course and the like.

教科書	1. 自編教科書與講義 2. Norman S. Nise, Control Systems Engineering, 6th ed., John Wiley & Sons, Inc., 2011, Chap 13 3. Karl J. Astrom and Bjorn Wittenmark, Computer-Controlled Systems – Theory and Design, 3rd ed., Prentice-Hall, 1997

教學要點概述

教材編選 teaching materials	■ 自製簡報(ppt)	■課程講義	■自編教科書	
	■ 教學程式	■自製教學影片	□其他	
教學方法 teaching methods	■講述	■小組討論	■學生口頭報告	■問題導向學習
	■個案研究	□其他		
評量工具 Evaluation tools	■期中考	■期末考	□隨堂測驗	□隨堂作業
	■課後作業	□期中報告	□期末報告	■專題報告
	■評量尺規	□其他		
教學資源 teaching resources	■課程網站	■教材電子檔供下載	■實習網站	
教師相關訊息 instructor's information	洪博雄 https://www.tfa-1985.org			

課程大綱	分配時數	

單元主題	內容綱要	講授	示範	習作	其他[1]	可達成核心能力
Introduction	1. Discrete equivalent versus discrete synthesis 2. Sampling and holding	3				
Z-Transform	1. Convolution 2. State-space realization	3				D1, D2
Frequency Response	1. Bode plots 2. Nyquist criterion 3. System identification 4. Stability and robustness	3				
Discrete Equivalents	1. A series of discrete equivalents 2. Demo by Matlab	6				D1, D2
Discrete Equivalents Practice	1. Examples study 2. Closed-loop discretization	3				
DSP Programming	1. FIR 2. Analog computer 3. IIR	6				D1, D2, D4
Special Issues	1. Discretization induced instability 2. Nonlinear systems	6				
Microcontroller Coding	1. Peripheral and interruption 2. DPS-programming 3. Examples	6	6	6		D1, D2, D4

可達成核心能力		核心能力達成指標
D1	具機械領域之專業知識	具備分析數位系統以及設計數位控制的能力
D2	策劃及執行機械及其相關領域專題研究之能力	具備策劃及執行數位控制及其相關領域專題研究之能力
D4	創新思考及獨立解決機械問題之能力	具備獨立分析並解決數位控制相關問題之能力

教學要點概述:

上課時間	上課地點	學習成果評量方式	Office hour	教學品質評量方式
二 10-12	工學院 B 館 116	● Midterm exam (30%) ● Final exam (40%) ● Homework (10%) ● Appearance in class (20%)	星期五 19:00-21:00	教學意見調查核心能力重要性及達成度分析問卷

週次	教學與作業進度	備註
1	Chapter1: Introduction to Digital Control	
2	Chapter 2: Z Transform	
3	Chapter 3: Frequency Domain	
4	Chapter 4: Discrete Equivalents Part I	
5	Chapter 4: Discrete Equivalents Part II	

6	Chapter 5: Practice in Discrete Equivalence Part I	
7	Chapter 5: Practice in Discrete Equivalence Part II	
8	Chapter 6: DSP Programming Part I	
9	Chapter 6: DSP Programming Part II	
10	Chapter 7: Special Issues Part I	
11	Chapter 7: Special Issues Part II	
12	Chapter 8: DSP-Programming into Microcontroller (Lecture)	
13	Chapter 8: DSP-Programming into Microcontroller (Lecture)	
14	Chapter 8: DSP-Programming into Microcontroller (Demonstration)	
15	Chapter 8: DSP-Programming into Microcontroller (Demonstration)	
16	Chapter 8: DSP-Programming into Microcontroller (Practice)	
17	Chapter 8: DSP-Programming into Microcontroller (Practice)	
18	Final exam	