



Digital Logic Design I

(SS3023)

Course Overview

Instructor: Chi-Kuang Chao

Department of Space Science and Engineering

National Central University

February 26, 2021

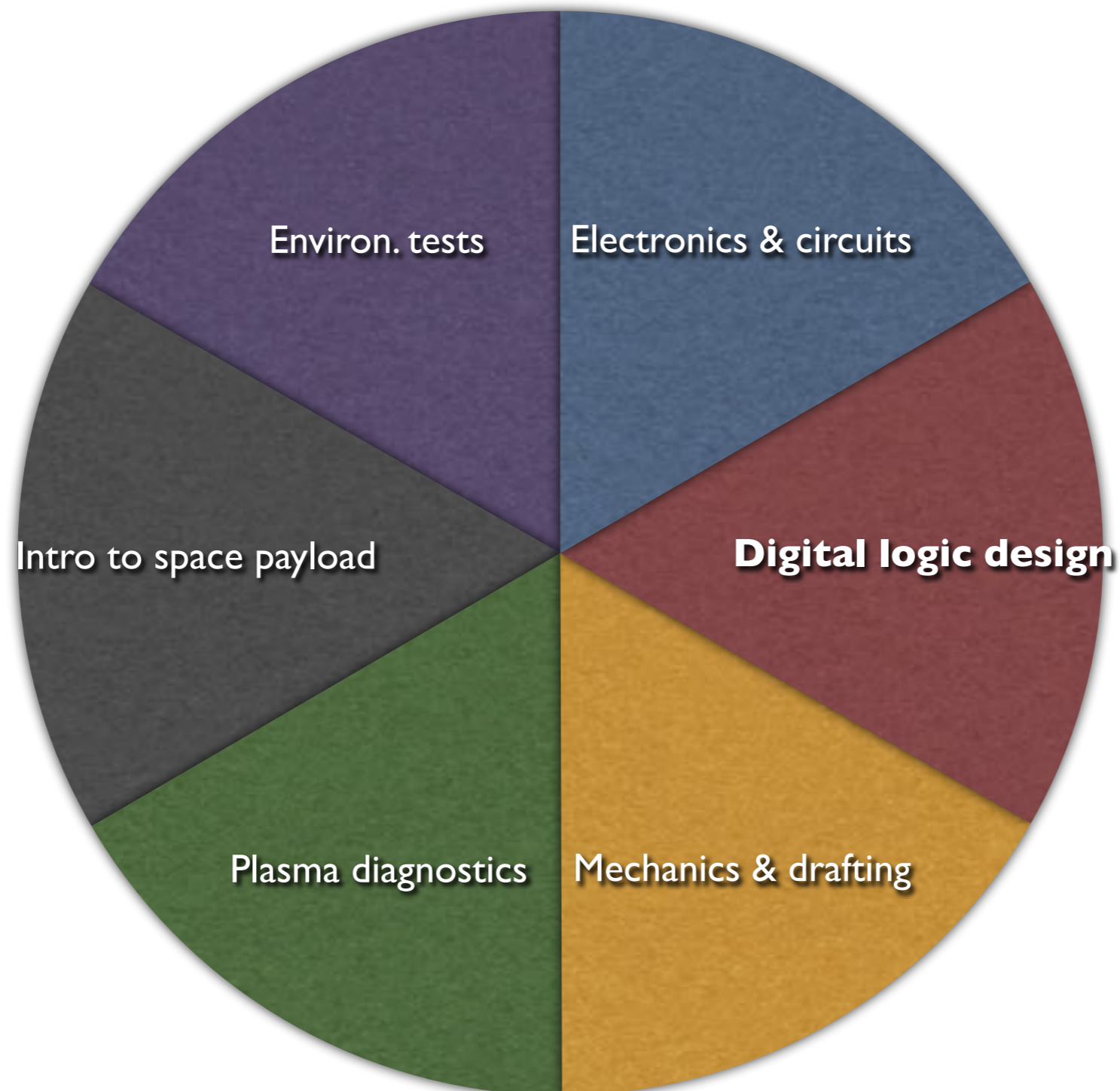
Syllabus

- Instructor: Chi-Kuang Chao
- Course type: elective course
- Classrooms: S4-805 electrical shop
- Lecture time: 3 hours/week
- Lecture hours: 10:00 - 12:50 (FRI)

Objectives

- A comprehensive coverage of basic to advanced digital concepts with an emphasis on problem solving, troubleshooting, and applications.
- Fundamental knowledge to build space payload.

Space payload



Course outline

- Digital fundamentals
 - Introductory concepts
 - Number system, operations, and codes
 - Logic gates
 - Boolean algebra and logic simplification
 - Combinational logic analysis
 - Functions of combinational logic
 - Latches, flip-flops, and timers

Course outline (cont.)

- Digital fundamentals
 - Counters
 - Shift registers
 - Memory and storage
 - Programmable logic and software
 - Signal interfacing and processing
 - Computer concepts
 - Integrated circuit technologies

Course outline (cont.)

- Basic Verilog topics
 - Overview of digital design with Verilog HDL
 - Hierarchical modeling concepts
 - Basic concepts
 - Modules and ports
 - Gate-level modeling
 - Dataflow modeling
 - Behavioral modeling
 - Tasks and functions
 - Useful modeling techniques

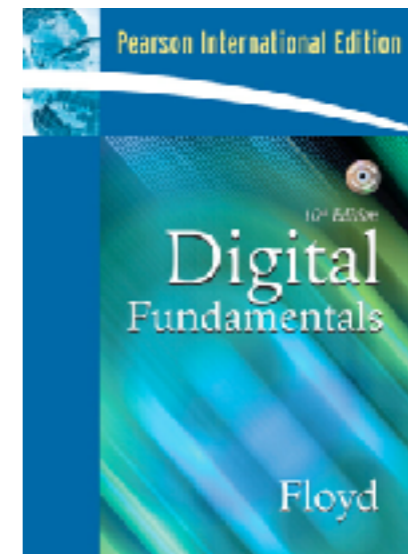
Course outline (cont.)

- Advanced Verilog topics
 - Timing and delays
 - Switch-level modeling
 - User-defined primitives
 - Programming language interface
 - Logic synthesis with Verilog HDL
 - Advanced verification techniques

Course materials

- Textbooks

- Floyd, Thomas L., **Digital Fundamentals**, 10/E, Pearson Education, Inc., 2010. ISBN-10: 0-13-814646-2.



- Palnitkar Samir, **Verilog HDL: A Guide to Digital Design and Synthesis**, 2nd ed., 2003.



S4-805 電路設計實習教室



S4-805 electrical shop

- 5 x NI ELVIS, 5 x NI ELVIS II+, and **10 x NI ELVIS III**
- **10 x NI myRIO-1900**
- **10 x Digilent ZYBO Zynq-7000**
- **5 x NI USRP 2900**
- **10 x ASUS Desktop PC**
- 10 x anti-static pads
- PCB prototyping: circuit board plotter, through-hole conductivity/plating, multilayer prototyping, surface mount technology/finishing, screen printing and solder-resist masks, SMT solder paste printer, pick and place assembly system, and lead-free reflow oven.

Devices for learning



- **NI myRIO-1900**

- NI LabVIEW Academic Site License - Department Teaching License: Control and Embedded Systems Software Option

- **Digilent ZYBO Zynq™-7000 Development Board**

- Xilinx Vivado Design Suite: System Edition University Licenses
25 Licenses



NI myRIO-1900

- Featuring NI industry-standard reconfigurable I/O (RIO) technology, the enclosed version of myRIO (myRIO-1900) places three I/O connectors, wireless capabilities, **a dual-core ARM real-time processor**, and **a customizable Xilinx FPGA** in the hands of students. With its onboard devices, seamless software experience, and library of courseware and tutorials, myRIO provides an affordable tool that helps students and educators “do real engineering” in one semester. Box contents
 - Driver and software evaluation DVDs
 - USB cable
 - Power supply with international adapters
 - 1 MXP protoboard accessory
 - NI screwdriver and MSP screw-terminal connector



NI myRIO starter accessory kit

- The NI myRIO starter accessory kit includes everything you need to get started connecting to and programming the I/O of NI myRIO. NI myRIO starter accessory kit contents:
 - Barrel connector with leads
 - Assorted capacitors
 - Diodes
 - 7-segment display
 - Mechanical rotary encoder
 - Photo interruptor (light sensor with LED)
 - Assorted op-amps
 - Assorted LEDs
 - Small DC motor (1 VDC to 3 VDC, no load speed: 6600 rpm)



NI myRIO starter accessory kit (cont.)

- Microphone with audio jack
- MXP Breadboard Accessory
- Potentiometer (500 k Ω)
- Relay
- Assorted resistors
- Piezoelectric sensor
- Photocell
- 2 Hall effect sensors (latch and switch)
- Buzzer
- Assorted switches (DIP, slide, and rotary)
- Thermistor (NTC: 10 k Ω , 25 degrees)
- Assorted transistors
- Force sensing resistor
- Wire kit



NI myRIO embedded systems accessory kit

- The NI myRIO embedded systems accessory kit contains common sensors, devices, and a display.
 - Keypad
 - Digital temperature sensor (I2C)
 - Character LCD (I2C, SPI, and UART)
 - Digital potentiometer (SPI)
 - Bluetooth interface (UART)
 - EEPROM (SPI)
 - LED matrix



Digilent ZYBO Zynq™-7000 Development Board

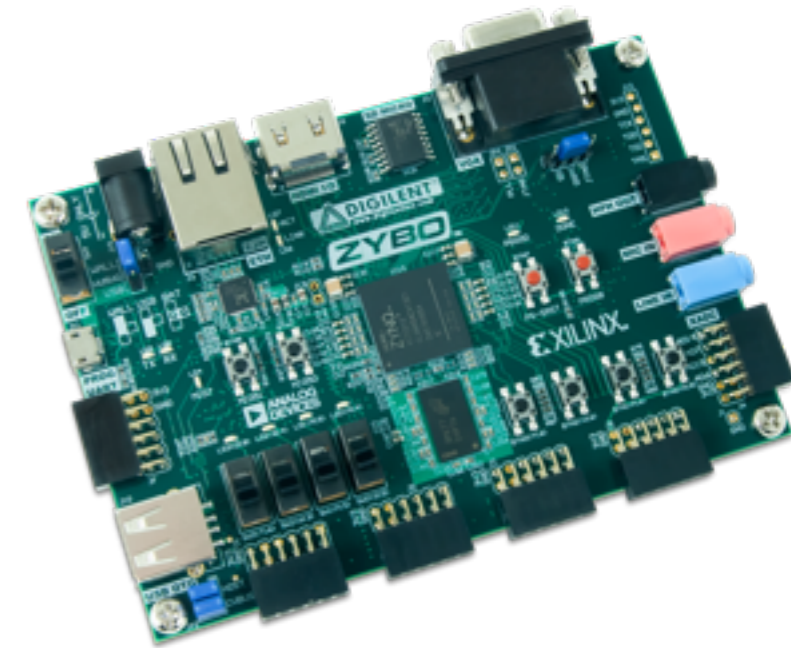
- The ZYBO (Zynq Board) is a feature-rich, ready-to-use, entry-level embedded software and digital circuit development platform built around the smallest member of the Xilinx Zynq-7000 family, the Z-7010. The Z-7010 is based on the Xilinx All Programmable System-on-Chip (AP SoC) architecture, which tightly integrates a dual-core ARM Cortex-A9 processor with Xilinx 7-series Field Programmable Gate Array (FPGA) logic. When coupled with the rich set of multimedia and connectivity peripherals available on the ZYBO, the Zynq Z-7010 can host a whole system design. The on-board memories, video and audio I/O, dual-role USB, Ethernet and SD slot will have your design up-and-ready with no additional hardware needed.

Z-7010

- 650Mhz dual-core Cortex-A9 processor
- DDR3 memory controller with 8 DMA channels
- High-bandwidth peripheral controllers: 1 G Ethernet, USB 2.0, SDIO
- Low-bandwidth peripheral controller: SPI, UART, I2C
- Reprogrammable logic equivalent to Artix-7 FPGA
 - 28K logic cells
 - 240KB Block RAM
 - 80 DSP slices
 - On-chip dual channel, 12-bit, 1 MSPS analog-to-digital converter (XADC)

ZYBO

- ZYNQ XC7Z010-1CLG400C
- 512MB x32 DDR3 w/ 1050Mbps bandwidth
- Dual-role (Source/Sink) HDMI port
- 16-bits per pixel VGA output port
- Trimode (1 Gbit/100Mbit/10Mbit) Ethernet PHY
- MicroSD slot (supports Linux file system)
- OTG USB 2.0 PHY (supports host and device)
- External EEPROM (programmed with 48-bit globally unique EUI-48/64™ compatible identifier)
- Audio codec with headphone out, microphone and line in jacks
- 128Mb Serial Flash w/ QSPI interface
- On-board JTAG programming and UART to USB converter
- GPIO: 6 pushbuttons, 4 slide switches, 5 LEDs
- Six Pmod connectors (1 processor-dedicated, 1 dual analog/digital)





Quote(Taiwan) 179130

Print Date: 2015-01-09 15:58:44

國家發展儀器股份有限公司
台北市大安區敦化南路二段216號12樓
TEL: 02-2377-2222 FAX: 02-2377-7676

新竹縣竹北市自強南路8號14樓之3
TEL: 03-657-6222 FAX: 03-657-6066
FAX: 07-537-5111(高雄辦事處)

Contact ID: 75873	Zip Code: 320
Name: 趙吉光	Payment: Net30
Company: 國立中央大學 太空科學研究所	Quote Date: 2015-Jan-9
Address: 桃園縣 中壢市 五權里2鄰中大路300號 科學四館805室-1	Quoted By: 曹 斯皓
Tel: 886-03-422-7151-65754/65781	Extension: 7145
Fax: 886-03-422-4394	Email: Szu-Hao.Tsao@ni.com

Product PN	Description	Unit Price [TWD]	QTY.	Amount [TWD]
1 -----	NI MyRIO-1900 包含入門組合與嵌入式系統組合	33,333	1	33,333
One set of ----- includes the following items:				
782692-01	NI myRIO-1900. Includes WIFI and MSP Connector.		1	
783068-01	NI myRIO Kits: Starter Kit Includes 5 MXP protoboard x5, Basic sensors, Battery holder, and parts		1	
783070-01	NI myRIO Kits: Embedded Kit - Includes display, VGA/HDMI, audio codec		1	

SUBTOTAL [TWD]:	33,333
VAT [TWD]:	1,667
TOTAL [TWD]:	35,000



一元素科技股份有限公司
E-Elements Technology Co., LTD

DATE: 2015/1/9

公司地址
統一編號

台北市內湖區瑞光路76巷61號5樓
27729833

TEL:(02) 2791-8139
FAX:(02) 2792-6942

TO: 國立中央大學 太空科學研究所
ATTN: 趙吉光 老師
TEL: 03-4227151x65754
FAX: 03-4224394

OUR REF: ej2015010903
QUOTED BY: 林宗賢 Jason Lin
Mobile : 886-988810039
Email : jason.lin@e-elements.com.tw

QUOTATION

Item	Vendor	PART NUMBER	Q'TY	UNIT/NTD\$	TOTAL/NTD\$	DELIVERY
1	Digilent	ZYBO Zynq™-7000 Development Board	1	\$5,200.00	\$5,200.00	4weeks

- 1 本報價有效期限90天
- 2 付款條件：月結30天
- 3 以上報價已含稅及運費

台幣匯款帳號 (TWD)

銀行名稱：台灣中小企銀-東湖分行
台幣銀行戶名：一元素科技股份有限公司
台幣匯款帳號：111-12-009101



Resources provided by SPL

	myRIO-1900	ZYBO Zynq-7000	LabVIEW for control & embedded systems software option	Vivado Design Suite	Total
1 set	NTD35,000	NTD5,200	—	0	NTD40,200
10 sets	NTD350,000	NTD52,000	NTD52,800 for new option and NTD16,200 for renewal	0	NTD418,200

NCU undergraduate tuition for one semester

國立中央大學103學年度學雜費收費標準

103年6月23日第596次行政會議通過

一、學士班

院系所		工、資電學院 (含資管系、工管所、 藝研所)	理、地科學院 (含生科系)	管理學院 (資管系、工管所 除外)	文、客家學院 (藝研所除外)、總 教學中心
身份及費用別	學費	17,490	17,490	17,330	17,330
	雜費	11,170	10,950	7,540	7,180
	總計	28,660	28,440	24,870	24,510
	學分費	1,110	1,110 (除數學系1,050)	1,020	1,000
100學年度起 入學之陸生及 外籍生	學費	33,181	33,505	29,037	28,785
	雜費	19,487	19,678	17,054	16,906
	總計	52,668	53,183	46,091	45,691
	學分費	2,220	2,220 (除數學系2,100)	2,040	2,000

Our cost: NTD40,200 > Your payment: NTD28,440

Features

- Lecture a two-semester course in one semester. → **Pre-study and self-learning are required.**
- Use myRIO and ZYBO Zynq-7000 with industrial development tools, LabVIEW and Vivado, for intense practices during/after the courses. → **Hand-on practices are extremely important. 12 practices will be used for grading.**
- The ugly truth is resources are limited. For best practice, each student had better to use his/her own devices. → **Only 10 students are allowed to participate this course. You shall pay great attentions on this course to get a pass.**

Grading

- 12 practices: 100%

Evaluation

Semester	2009/09	2010/03	2010/09	2011/03	2011/09	2012/03	2012/09	2013/03	2013/09	2014/03	2014/09	2015/03
Course	N/A	Circuits I	N/A	Circuits II (DLD I)	Circuits I	Circuits II	Digital Logic Design I	Digital Logic Design II	Circuits I	N/A	N/A	Digital Logic Design I
Students	N/A	6	N/A	21	42	22	29	11	47	N/A	N/A	28→11
Failed	N/A	0	N/A	0	0	14	0	1	1	N/A	N/A	0
Evaluation	N/A	4.15	N/A	4.38	4.3	3.91	4.15	4.19	4.14	N/A	N/A	4.51
Semester	2015/09	2016/03	2016/09	2017/03	2017/09	2018/03	2018/09	2019/03	2019/09	2020/03	2020/09	2021/03
Course	N/A	Circuits I	N/A	Digital Logic Design I	N/A	Circuits I	N/A	Digital Logic Design I	N/A	Circuits I	N/A	Digital Logic Design I
Students	N/A	7	N/A	15→10	N/A	16→10	N/A	9	N/A	10	N/A	--
Failed	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	--
Evaluation	N/A	4.29	N/A	4.24	N/A	4.91	N/A	4.9	N/A	4.9	N/A	--

My courses

Semester	Undergraduate core courses	Undergraduate selective courses	Graduate selective courses	Hours
Fall 2018	Engineering Laboratory (1/1) Introduction to Space Science and Engineering (1/2)	--	Space Environment and Exploration I (1/3) Plasma Measurement I (3/3)	6
Spring 2019	--	Hands-on Satellite System (2/2) Digital Logic Design I (3/3) Application and Practice of Space (2/2)	Plasma Measurement II (3/3)	10
Fall 2019	Engineering Laboratory (1/1) Introduction to Space Science and Engineering (1/2)	Application and Practice of Space (2/2)	Space Environment and Exploration I (1/3) Calibration and Test for Space Instruments I (3/3)	8
Spring 2020	--	Hands-on Satellite System (2/2) Circuits I (3/3)	Calibration and Test for Space Instruments II (3/3)	8

Week #	1st session	2nd session	3rd session
1 (2/26)	Course overview	Selection test - from Chapter 1 to 6 of Digital Fundamentals	
2 (3/5)	Digital concepts	Number system, operations, and codes	Practice 1
3 (3/12)	Logic gates	Boolean algebra and logic simplification	Practice 2
4 (3/19)	Combinational logic analysis	Functions of combinational logic	Practice 3
5 (3/26)	Latches, flip-flops, and timers	Counters	Practice 4
6 (Spring break, 4/2)	Break		
7 (4/9)	Shift registers	Memory and storage	Practice 5
8 (4/16)	Programmable logic and software	Signal interfacing and processing	Practice 6
9 (mid-term, 4/23)	Break		
10 (4/30)	Computer concepts	Integrated circuit technologies	Practice 7
11 (5/7)	Overview of digital design with Verilog HDL	Hierarchical modeling concepts	Practice 8
12 (5/14)	Basic concepts	Modules and ports	Practice 9
13 (5/21)	Gate-level modeling		
14 (5/28)	Dataflow modeling		Practice 10
15 (6/4)	Behavioral modeling	Tasks and functions	Practice 11
16 (6/11)	Useful modeling techniques	Timing and delays	Practice 12
17 (6/18)	Switch-level modeling.	User-defined primitives.	Programming language interface
18 (final, 6/25)	Break		

For more information

- Please visit the course web page at <http://athena.ss.ncu.edu.tw/>
- Contact me
 - By phone: 03-4227151
 - Ext.65754 at S4-804 (Office)
 - Ext.65781 at S4-805-1 (Core facilities)
 - Ext.36755 at S4-820 (Learning facilities)
 - By e-mail: ckchao@jupiter.ss.ncu.edu.tw