一、課程基本資訊

<table>
<tr><td>系所</td><td colspan="3">工程科學及海洋工程學系</td><td>授課教師</td><td colspan="3">吳文中、陳信樹、陳景然</td></tr>
<tr><td>課程名稱</td><td colspan="5">(中文)壓電能量擷取介面電路特論
(英文) Special Topic in Piezoelectric Energy Harvesting Interfacing Circuits</td><td colspan="2">■中文授課
□英文授課</td></tr>
<tr><td>課程編號</td><td>ESOE7038</td><td>班次</td><td></td><td>學分數</td><td>3</td><td>□必修
■選修</td><td>□全年
■半年</td></tr>
<tr><td>上課時間</td><td>週三 2.3.4</td><td>上課地點</td><td>工科 202 教室</td><td>人數上限</td><td>15</td><td>適修年級</td><td>碩士/博士班</td></tr>
<tr><td>課程網址</td><td colspan="7">https://ceiba.ntu.edu.tw/1071ESOE7038_EH/</td></tr>
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二、課程大綱內容 (對應 CEIBA 欄位，以中英並列為原則)

課程概述	本堂課將透過能量擷取介面電路相關研究及實務經驗探討，使學生能夠應用「能量擷取介面電路」、「切換式電容直流轉換器」、「切換式電源轉換器」等相關理論知識，並實際設計出能量擷取介面電路，並能在期末完成可下線之積體電路設計。 The aim of this course is to introduce the basic knowledge of energy harvesting interfacing circuit design, and related power converter issues, including ultra-low-power power converters and switched capacitor power converters. After learned the related basic knowledge, students enrolled have to finish a specific energy harvesting interfacing circuit design and tap-out the integrated circuit design before the end of the semester.
課程目標	1.了解「能量擷取介面電路」、「切換式電容直流轉換器」、「超低功耗切換式電源轉換器」等相關理論知識。 2.能根據理論知識，完成指定論文的系統層級行為模型以及電路分析。 3.能使用軟硬體工具模擬、檢測、設計，實際設計出一電路。 4.完成能量擷取介面電路設計，實際下線一顆晶片。 1. Learn the basic knowledge of energy harvesting, ultra-low power converter and switched capacitor power converter. 2. Based on the theoretical knowledge, finish the system level behavior models and circuit analysis of the assigned paper. 3. Be familiar with the design tools and techniques of integrated circuit design and finish an energy harvesting integrated circuit design and analysis. 4. Finish the implementation of a piezoelectric energy harvesting interface circuit and tape-out an integrated circuit design.
關鍵字	能量擷取系統介面電路、超低功耗電力轉換器、切換電容轉換器 Energy harvesting interfacing circuit, ultra-low-power power converter, switched capacitor power converter

課程要求 (先修科目或先備能力)	電子電路、電路學、電子學、電力電子與積體電路控制 Circuits and Electronics、Electric Circuits、Electronics、Power Electronics and Integrated Circuit control *此課程配合 CIC 晶片中心教育晶片實作規定，修課學生必須承諾在設計晶片完成之後，完成所設計晶片的量測報告(晶片製作完成時程預計在期末後 3 個月左右)。 *The circuit designed in this course will be taped-out and implemented through CIC (National Chip Implementation Center) education program. All students enrolled have to finish chip testing report after the taped-out chip fabrication is finished to fulfill the requirement of CIC education program (scheduled around 3 months after the end of the semester).
指定閱讀 (教科書)	
參考書目	1. Mickaël Lallart, “Small-Scale Energy Harvesting”, open access e-book, https://www.intechopen.com/books/small-scale-energy-harvesting 2. A. Erturk and D. J. Inman, “Piezoelectric energy harvesting”, Chichester : Wiley 2011. 3. R. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, 2nd Edition, Kluwer Academic Publishers, 2001. 4. B. Razavi, “Design of Analog CMOS Integrated Circuits”, McGRAW-Hill, 2001. 5. S. Sedra, and K. C. Smith, “Microelectronic Circuits”, 6th ed., Oxford Univ. Press, 2010. 6. A. B. Carlson, “Circuits-Engineering concepts and analysis of linear electric circuits”, Thomson 2005.
評量方式	Homework Project (40%) + Final Project (40%) + Attendance and Participation (20%)
助教資訊	鄭凱壬(博理館 415 室) r05943124@ntu.edu.tw
課程進度	
週次	單元主題
1	Course Overview
2	Introduction of energy harvesting
3	Introduction of switched capacitor power converters (1/2)
4	Introduction of switched capacitor power converters (2/2)
5	-

6	Bias-flip topologies of piezoelectric harvesting interfacing circuit (1/2)
7	Introduction of ultra-low-power high efficiency power converters (1/2) Paper study topic assignment
8	Introduction of ultra-low-power high efficiency power converters (2/2) Paper study topic assignment
9	Bias-flip topologies of piezoelectric harvesting interfacing circuit (2/2) Paper study progress report
10	TSMC 0.25μM HV-CMOS design and layout considerations (1/2) Paper study progress report
11	TSMC 0.25μM HV-CMOS design and layout considerations (2/2) Paper study progress report Final project topic assignment
12	Low power circuit design considerations (1/2) Paper study progress report Final project topic assignment
13	Low power circuit design considerations (2/2) Progress report of final project
14	Inductor-less bias-flip harvesting interfacing circuit implementation (1/2) Progress report of final project
15	Inductor-less bias-flip harvesting interfacing circuit implementation (2/2) Progress report of final project
16	Maximum Power Point Tracking (MPPT) methods and implementations (1/2) Design review of final project
17	Maximum Power Point Tracking (MPPT) methods and implementations (2/2) Design review of final project
18	Final presentation