

國立中正大學機械工程學系 115 學年度第 1 學期教學大綱表

課稱名稱：(中文) 熱聲動力與控制 (英文) Thermoacoustic Dynamics and Control					開課單位	機械系
					課程代碼	4208751
授課教師	洪博雄 (B.-S. Hong)	學分數	3	選修	開課年級	研究所
全英文授課 EMI	☐ 是 ☒ 否					
先修科目或先備能力：College-level dynamics, thermodynamics, fluid dynamics, heat transfer, continuum mechanics, circuits, and control systems.						
課程概述： Thermoacoustic dynamics is governed by the perturbation of conservation laws. In the field of fast-time acoustics, rather than the field of bulk motions of fluid, elastic behavior happens, which generates mechanical and thermal potentials due to compressibility. In uniform flow, the mechanical energy and disturbance energy therefrom are conserved storages, being able to be served for functional analysis. However, as the mean-flow is of spatial variations, the mechanical or disturbance energy is no longer conserved storage, but surprisingly the dynamics is still in harmonics. It is therefore necessary to define new storages for thermoacoustics and to derive the conservation laws based thereon. Such storages also lead to the least-action principle that widens application scope. Once thermoacoustics has its own conservation laws and least-action principles, it is heightened up to be an independent branch of science. This course will present this new science within one semester of context.						
目標： 1. Reaching the laws of thermoacoustics needs college-level background on thermodynamics, fluid mechanics, structural mechanics, and analytical mechanics. In the first few weeks, this course will provide quick recitation on fundamentals of these aspects of mechanics. 2. Two famous applications will be deeply investigated: thermoacoustic propulsion and combustion instabilities. 3. Likely, thermal-inertial characteristic in some materials, besides thermal potential, will appears in the fast-time heat transfer. Therein, entropy-flow replaces the heat-flux as the thermal flow in the fast-time field. 4. Compute thermoacoustic responses with commercial application packages such as COMSOL.						
教科書	1. College textbooks of the assembly of mechanics 2. A series of research papers related to thermoacoustics, thermoacoustic engines, and combustion instabilities.					
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 www.tfa-1985.org					
課程大		分配時數				可達成核心能力
單元主題	內容綱要	講授	示範	習作	其他 ₁	
Introduction	- Historical accounts on the theory of thermoacoustics - Historical accounts on applications of thermoacoustics	3				D1,D2,D4
Laws of Thermoacoustics	- Reynolds transport on mass - Hook's theorem on gas medium - Hamilton's principle on gas medium - Reynolds transport on entropy	6				D1,D2,D4
Functional Analysis	- Uniform mean-flow - Mean-flow effects - Mechanical energy - The least action principle	12				D1,D2,D3, D4,
Thermoacoustic engines	- Feedback realization of dynamics - Porous media dynamics - Onset non-dimensional parameter - Frequency responses -based design	8	2	1		D1,D2,D3, D4
Combustion instabilities	- Thermal-acoustic coupling loop - Flame dynamics - Swirling condition - Describing function	8				D1,D2,D3, D4
Laws of Thermoacoustics	- Reynolds transport on mass - Hook's theorem on gas medium - Hamilton's principle on gas medium - Reynolds transport on entropy	6				D1,D2,D4
Functional Analysis	- Uniform mean-flow - Mean-flow effects - Mechanical energy - The least action principle - The Rayleigh criterion - The Reynolds-Rayleigh criterion	12				D1,D2,D3, D4,
Thermoacoustic engines	- Feedback realization of dynamics - Porous media dynamics - Onset non-dimensional parameter - Frequency responses -based design	8	2	1		D1,D2,D3, D4
Combustion instabilities	- Thermal-acoustic coupling loop - Flame dynamics - Swirling condition - Describing function	8				D1,D2,D3, D4
可達成核心能		核心能力達成指標				
D1	具機械領域之專業知識。	具熱聲動力之更專業知識。				

D2	策劃及執行機械及其相關領域專題研究之能力。	策劃執行熱聲動力專題之能力。
D3	撰寫機械專業論文之能力。	撰寫熱聲動力專題之能力。
D4	創新思考及獨立解決機械問題之能力。	思考解決熱聲動力問題之能力。

教學要點概述： 理論闡述加實作範例				
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
一 10-12	工學院 B 館 117	兩次考試，期中考四十分，期末考四十分。作業二十分。點名加二十分，總分一百分。	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	Thermoacoustics and its hisortical accounts and modern significances			
2	Thermodynamics recitation			
3	Fluid dynamics recitation			
4	Heat-to-sound dynamics 1			HW#1 assignment distributed
5	Heat-to-sound dynamics 2			
6	Rayleigh Criterion 1			
7	Rayleigh Criterion 2			
8	Modal analysis			
9	Midterm examination			
10	Mechanics in porous media			
11	Heat transfer in porous media			
12	Sound-to-heat dynamics in porous media			
13	Numerical solver of COMSOL			HW#2 assignment
14	Feedback dynamics of self-excited thermoacoustic engines			
15	Design self-excited thermoacoustic engine based on frequency-domain technique			
16	Thermoacoustic dynamics in combustion chamber			
17	Demonstration of combustion instability			
18	Final examination			
其他：				