專業必修/選修課程綱要表

課程名稱：（中文）**高等振動學** （英文）**Advanced Vibration Theory**				開課單位	能源電池科技博士班
				課程代碼	
授課教師：					
學分數	3	必/選修	選修	開課年級	
先修科目或先備能力：工程數學、工程力學或物理學、英文閱讀能力					
課程概述與目標：本課程以基礎振動學開始，複習基本振動觀念，包含單自由度振動系統運動方程式、阻尼、自然頻率、強制振動與自由振動等，然後講述多自由度離散振動系統、連續振動系統與非線性振動系統的振動分析方法。在線性振動系統部分課程會介紹以模態分析方法，找出工件的模態參數，包括共振頻率和模態。在連續振動系統方面，本課程除介紹解析解外，也將介紹多種近似解與有限元素法。本課程除理論與分析方法講授外，將搭配 MATLAB 套裝軟體進行數值模擬，期望透過模擬實驗讓學生能夠印證理論所學，加深學生之學習印象。					
教科書 [1]	Fundamentals of Vibrations, Leonard Meirovitch (McGRAW-Hill International Edition)				

課程綱要		核心能力達成指標	對應之學生核心能力
單元主題	內容綱要		
單自由度振動系統	複習單自由度具阻尼與無阻尼振動系統之強制振動與自由振動行為，介紹阻尼量測方法與不同阻尼特性。	1,2,3,4,5,6,7	1. 瞭解單自由度振動系統之數學模式、強制振動與自由振動特性與區別。2.能了解強制振動與自由振動之系統響應區別。3.能了解不同阻尼對系統之影響，進而了解不同阻尼之量測法則。
雙自由度振動系統	複習雙自由度振動系統之系統型式，介紹雙自由度振動系統之強制與自由振動響應特性。利用 MATLAB 進行數值模擬，以協助了解原理內涵。	1,2,3,4,5,6,7	1.能了解雙自由度振動系統數學模式。2.能了解雙自由度振動系統之強制與自由振動響應特性。3.能利用 MATLAB 進行雙自由度振動系統受外力或初始條件激發下之系統響應數值模擬，並解釋其物理意義。
解析動力學介紹	介紹解析動力學之各項基本觀念，包括自由度、通用座標、虛功原理、D'alembert、Hamilton 法則、Lagrange 方程式等。	1,2,3,4,5,6,7	1.能了解通用座標與自由度之定義 2. 能了解虛功原理、D'Alembert、Hamilton 等法則。3.能利用 Lagrange 方程式求解痛太系統之數學模式。

多自由度振動系統	介紹線性多自由度振動系統之形式，介紹多自由度振動系統之特徵值問題，介紹振動系統之振模與其正交特性，利用振動系統之振模正交特性分解系統響應與模態分析。透過 MATLAB 軟體進行多自由度振動系統之數值模擬。	1,2,3,4,5,6,7	1.瞭解多自由度振動系統之物理模式、數學模式特性。2.能了解多自由度振動系統之振模與正交特性 3.能利用振模正交性解析系統響應並進行模態分析。4.能利用 MATLAB 模擬多自由度振動系統之振動行為並說明其物理意義。
連續振動系統之解析解	介紹離散形式之多自由度振動系統與連續振動系統之關係，利用 Hamilton 法則建立弦振動方程式，介紹樑之彎曲振動問題，介紹桿件振動問題，介紹前述各種連續振動系統之解析解求法。	1,2,3,4,5,6,7	1. 了解離散形式多自由度振動系統與連續系統之區別與相互關係 2. 能瞭解各種連續振動系統數學模式與其物理意義。3.能利用數學工具求出前述連續振動問題之解析解。
連續振動系統之近似解	介紹如何利用 lumping 方式將連續振動系統予以離散化的作法，介紹 Holzer 近似法於柱之扭轉振動應用，介紹 Myklestad 近似方法於樑振動問題之應用，介紹 Rayleigh、Rayleigh-Ritz、Assumed-Modes、Galenkin 等近似法。	1,2,3,4,5,6,7	1.能了解如何以 lumping 方式將連續系統離散化，使其成為離散系統。2.能利用各種不同之近似法則求解連續體振動系統之各種響應，並了解其物理意義。3.能針對特定振動系統尋找合適之近似解求法。
有限元素法	介紹有限元素法與 Rayleigh-Ritz 近似法之關係，介紹如何利用有限元素法求解弦、樑、軸等之振動問題與其響應。利用 MATLAB 軟體與有限元素法求解振動問題。	1,2,3,4,5,6,7	1.能了解 Rayleigh-Ritz 近似法則與有限元素法間之關係。2.能以有限元素法求解各類連續體振動問題。3.能以 MATLAB 軟體與有限元素法實際解決連續體之簡單振動問題。
非線性振動系統	教授非線性振動系統與線性振動系統之區別，介紹非線性振動系統之振動響應特性。	1,2,3,4,5,6,7	1.能瞭解非線性振動系統與線性振動系統間之區別。2.能說明非線性振動系統之振動特性。

教學要點概述[2]：

參考教材：

Theory of Vibration with Applications, W. T. Thomson & M. D. Dahleh, 5th Edition, Prentice Hall.

教學方法：本課程主要在講授原理與利用 MATLAB 套裝軟體進行數值模擬為主，教學以課堂理論講授為主，學生作業則須利用軟體進行模擬。

評量方法：(1)平時成績: 30%、(2)書面作業: 30%、(3)期末考試: 40%

教學相關配合事項：可透過網路大學學習平台取得課程輔助教材及授課相關資料。

註：1. 教科書請註明書名、作者、出版社、出版年等資訊。

2. 教學要點概述請填寫教材編選、教學方法、評量方法、教學資源、教學相關配合事項等。

3. 學程所有開設之課程皆須填寫此表格或提供原有格式之課程綱要表，並呈現於實地訪評現場。

COURSE SYLLABUS

Course Title： Advanced Vibration Theory				
Credits / Hours	3/3	**Course Number**		**□Required ■Elective**
This course firstly reviews some fundamental vibration concepts, especially those related to single-degree-of-freedom vibration system such as the equation of motion, natural frequency, damping, stiffness and the difference between forced and free vibration. Then it reviews features of the forced and free vibration responses of the single and double degree-of-freedom vibration systems. Secondly, the course proceeds to introduce the system features, forced and free responses of a multi-degree-of-freedom vibration system. Modal analysis will be introduced when one deals with the multi-degree-of-freedom vibration system. Then, it discusses some concepts regarding analytical dynamics. These concepts include generalized coordinates, virtual work principle, Hamilton's principle, D'Alembert principle and Lagrange equation. The class will also cover vibration problems of distributed systems. Equation of motion of the distributed system will be derived while their analytical solutions will be solved. Approximate methods in finding the vibration responses of the distributed system are also introduced. The approximate methods include the finite element approach. Finally, special features of nonlinear vibration systems are introduced while the difference between linear and nonlinear vibration problems is explained.				

Topic	**Content**
Review of the single degree-of-freedom vibration system	This topic reviews fundamental vibration concepts, especially those related to single degree-of-freedom vibration system such as the equation of motion, natural frequency, damping, stiffness and the difference between the features of the forced and free vibration.
Review of the two degree-of-freedom vibration system	This topic reviews concepts regarding two degree-of-freedom vibration systems, especially those towards natural frequencies, mode shapes and the difference between forced and free vibration responses. The students will have chances in using MATLAB software to do numerical simulations on vibration response of two degree-of-freedom systems.
Introduction to analytical dynamics	This topic introduces fundamental concepts regarding analytical dynamics. These include the definition of degree of freedom, generalized coordinates, virtual work principle, D'alembert principle, Hamilton principle and Lagrange equation..

Introduction to multi-degree-of-freedom vibration system	This topic introduces concepts related to multi-degree-of-freedom vibration systems. These include modal analysis, physical meaning of mode shapes, natural frequencies, orthogonality property of the mode shapes and its application in decomposing the vibration response. The students will have chances in exploring vibration problems using MATLAB software in order to gain more insights regarding the topic.
Introduction to distributed vibration systems	This topic explains the difference between a discrete vibration system and a continuous vibration system. Mathematical models of the continuous vibration systems such as string, beam and rod are derived while their analytical vibration responses are solved.
Introduction to the approximate method in solving vibration responses of the continuous vibration systems.	This topic explains how a distribute system can be discretized using lumping approach. Different approximate methods including Holzer method using in the torsional vibration problem, Myklestad's method using in beam vibration and more generalized ones such as Rayleigh、Rayleigh-Ritz、Assumed-Modes、Galenkin methods will all be introduced in this session.
Introduction to finite element method	This topic firstly describes the relationship between the finite element method and the Rayleigh-Ritz method. The class then introduces how the finite element method can be applied in solving string, beam, and rod vibration problems. The students will have chances to employ MATLAB software to solve vibration problems of distributed systems.
Introduction to nonlinear vibration systems	This topic describes the specific features of nonlinear vibration systems. More emphasis will be put on explaining the difference between linear and nonlinear vibration systems.