課程簡介 Course Introduction

開課班級 Department	電機工程學系碩士班
授課方式 Instructional Method	課堂教學、中文
課程代號 Course Reference Number	182014
課程名稱(中文) Course Title (Chinese)	混沌控制系統
課程名稱(英文) Course Title (English)	Chaos Control Systems
學分數/時數 Credit Hours	3 / 3
必(選)修 Requirement / Elective Course	選修
授課老師 Instructor	蕭鳳翔

課程目標 Learning Objectives

教導學生明瞭渾沌系統之特性及渾沌運動所呈現之物理現象與形成機制；傳授學生描述與分析渾沌系統的方法與技巧，期使學生能將所學的知識應用於解釋與解決各個不同科技領域當中與渾沌相關的課題。

課程大綱 Course Syllabus

週次 Week	課程單元大綱 Unit	教學方式 Instructional Method/Style/ Teaching Style	參考資料或相關作業 References or Related Materials	評量方式 Grading
1	Introduction-What is chaos? Definition of the ‘deterministic chaos’, chaos and nonlinear dynamical system, brief history of chaos			
2	Phenomenology of chaos-three examples of chaotic systems, period doubling phenomenon, bifurcation diagram, universal features of chaos			
3	Phenomenology of chaos-other chaotic examples, summary of analytic tools；State-space dynamics of dynamical systems-state space, standard form of dynamical system, autonomous and non-autonomous systems, no-intersection rule, attractor			
4	1-D state-space dynamics-fixed point and stability, linear stability analysis of fixed point, structural			

	stability, dissipative system；2-D state-space dynamics-linear stability analysis of fixed point, eigenvalues & eigenvectors of the Jacobian matrix, dynamics of fixed point
5	2-D state-space dynamics-limit cycle, Poincare-Bendixson theorem, stability of limit cycle, Poincare map, Floquet multiplier, Lyapunov exponent, dissipative system in 2-D state space；Trajectories in 2-D state space-phase plane methods, phase portraits, conservative system
6	Trajectories in 2-D state space-index theorem, gradient system, Poincare-Bendixson theorem, trapping of limit cycle, applications in Biology；Bifurcation-normal form of bifurcation in 1-D & 2-D systems, saddle-node bifurcation, transcritical bifurcation, pitch-fork bifurcation, Hopf bifurcation
7	3-D state-space dynamics-linear stability analysis of fixed point, Poincare plane, stability of limit cycle, quasi-periodic motion, torus；Nonlinear stability-hyperbolic fixed point, persistence of hyperbolicity, Hartman & Grobman theorem, Lyapunov function, Lyapunov stability theorem
8	Routes to chaos (through bifurcation)
9	Diagnostic tools for chaos-Fourier spectrum, auto-correlation function；Diagnostic tools for

	chaos-Lyapunov exponent for trajectories, return map		
10	Measures of chaos: (identifying and quantifying chaos) Fourier spectrum, correlation function, Lyapunov exponent, Poincare section, return-map method.		
11	1-D iterated maps-Quadratic map, Feigenbaum constant, Li-Yorke theorem, Sarkovskii theorem, U-sequence, Schwarzian derivative & Singer' s theorem, critical point and supercycle, boundaries of attracting regions in bifurcation diagram ; 1-D iterated maps-size-scaling law, renormalization group theory, derivations of Feigenbaum' s universal constants, composition law, intermittency and crises revisited		
12	1-D iterated maps-Tent map, symbolic dynamics, Baker' s map and Bernoulli shift, concept of topological equivalency, Bernoulli shift and chaotic trajectory, definition of 'strong chaos', statistical description of deterministic chaos		
13	1-D iterated maps-Circle map, frequency locking, quasi-periodicity, Arnold' s tongues, Devil' s staircase ; 2-D iterated maps-Henon map, fractal attractor, Smale' s Horseshoe map, symbolic dynamics		
14	2-D iterated maps-topological equivalency between Horseshoe map and Bernoulli shift operation, Horseshoe map and homoclinic intersection		quiz

15	Fractals-fractals in Nature, self-similarity, fractal dimension；Fractals-capacity dimension, Cantor set, mathematical fractal sets, Hausdorff dimension, correlation dimension, Lyapunov dimension
16	Fractal basin boundaries-fractal basin boundaries for pendulum system, fractal basin boundaries for Henon map, Mandelbrot set, Julia set；Nonlinear time series analysis-embedding theorem, state-space reconstruction technique
17	Nonlinear time series analysis-implementation and application；Software and demonstration of computer simulation
18	Final term project presentation

單一課程對應校能力指標程度

The Degree to Which Single Course Corresponds to School Competence

編號 No.	校核心能力 School　Core Competencies	符合程度 Degree of conformity
1	道德力 (Morality)	1
2	自學力 (Self-learning)	2
3	創造力 (Creativity)	3
4	溝通力 (Communication)	2
5	就業力 (Employability)	4

單一課程對應院能力指標程度

The Degree to Which Single Course Corresponds to College Competence

編號 No.	院核心能力 College Core Competencies	符合程度 Degree of conformity
1	語文能力	2
2	溝通與合作能力	4
3	創新與實踐能力	1
4	專業知能	3

單一課程對應系能力指標程度

The Degree to Which Single Course Corresponds to Department Competence

代碼 No.	類別 Category	系核心能力 Department Core Competencies	符合程度 Degree of conformity
01	系所	具備專業知識運作及運用之能力	4
02	系所	發掘問題、實驗分析及驗證之能力	3
03	系所	創新思考開發之能力	4
04	系所	協調合作、領導團隊與管理規劃之能力	1
05	系所	中英文寫作與簡報之能力	3
06	系所	強化國際觀與國際交流之能力	2

教科書或參考用書(備註) Textbooks or Reference Books(Remarks)

自編講義

教學方法 Teaching Method

教學方法 Teaching Method	百分比 Percentage
講述	70.0
討論	30.0
總和 Total	100.0

成績評量方式 Grading

評量方式 Grading	百分比 Percentage
作業報告(short report)(3~4 次)	60.0
期末計劃(final term project)	40.0
總和 Total	100.0