

National Cheng Kung University

Modular Courses 2026 Summer Program

Academic Year : 115, Semester : 1

Category : Natural and Engineering Sciences

仿生飛行：從自然到工程實現

Bio-inspired Flight : From Nature to Engineering Realization

Instructor

Affiliation

Graduation (Ph.D.)

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Institute of Civil Aviation

National Cheng Kung University

National Cheng Kung University

Course
Type

Course
Credit

Student Size

(Maximum)

Lecture
+
Recitation

1.5

20

Student Background

College of Engineering

Difficulty

☐ Challenging ☒ Moderately Difficult ☐ Medium ☐ Entry Level (Basic)

Format of The Course

Lecture 50%, Hands-on Practice 40%, Discussion 10%

Grading Policy

Problem exam: 40%:

random quiz (there will be quizzes from Day 1 to Day 4, four times total)

Hands-on practice 50%:

complete the daily hands-on work (there will be practical exercises every day from Day 1 to Day 5)

Attendance 10%

Code of Conduct for The Course

None

Course Description

This course focuses on bio-inspired flight, introducing the flight mechanisms of birds and insects, and integrating fundamental concepts from aerodynamics, flight dynamics, and control engineering. The course covers flapping-wing kinematics, unsteady aerodynamics, simplified aerodynamic modeling, and basic control strategies. Through numerical simulations, system-level implementation and hands-on design practices, students will gain a comprehensive understanding of bio-inspired flying systems from physical principles to engineering implementation and develop interdisciplinary analytical and integration skills. This course is delivered as a five-day intensive modular program, progressing from fundamental principles to system integration and practical validation, enabling bio-inspired flight to become a realizable engineering solution.

Keywords: Bio-inspired flight, flapping-wing flight, unsteady aerodynamics, flight control, micro air vehicles

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Timetable and Syllabus

Period	Timetable	Syllabus
2026/8/3(Mon)	9:00-12:00	仿生飛行概論 (講義課)
	12:00-13:00	午休
	13:00-14:00	仿生翼型與拍動機構介紹 (講義課)
	14:00-15:30	實作演練：MATLAB 課程基礎語法講授，並使用 MATLAB 建立升力模型計算並進行隨堂測驗。(實作/考核)
2026/8/4(Tue)	9:00-12:00	拍翼運動學(講義課)
	12:00-13:00	午休
	13:00-14:00	簡化動態模型 (講義課)
	14:00-15:30	實作演練：使用 MATLAB 把升力模型與拍翼運動學整合並進行隨堂測驗。(實作/考核)
2026/8/5(Wed)	9:00-12:00	仿生飛行的穩定性問題 (講義課)
	12:00-13:00	午休
	13:00-14:00	基本控制方法 (講義課)
	14:00-15:30	實作演練：使用 MATLAB 把拍翼運動學與升力模型和姿態控制整合並進行隨堂測驗。(實作/考核)
2026/8/6(Thu)	9:00-12:00	仿生飛行器系統架構 (講義課)
	12:00-13:00	午休
	13:00-14:00	小型仿生飛行器設計流程 (講義課)
	14:00-15:30	小組設計任務與隨堂測驗。(實作/考核)
2026/8/7(Fri)	9:00-12:00	實作演練：依照小組設計製作拍撲翼模型 (實作)
	12:00-13:00	午休
	13:00-15:00	實作演練：製作拍撲翼模型與升力量測 (實作/考核)
	15:00-15:30	回顧課程學習重點

Goal of the Course

1. 理解仿生飛行之基本原理，包括非定常空氣動力學、拍翼運動學與生物飛行機制
2. 建立仿生飛行系統之基礎分析能力，能進行氣動力估算與拍翼參數對飛行性能之影響分析
3. 具備簡易仿生飛行控制模型之設計與模擬能力，理解其穩定性與控制特性
4. 能整合空氣動力、結構與控制概念，完成基礎仿生飛行器之系統設計與驗證。

The Importance, Cross-Over Disciplinary and Contemporary of The Curriculum

本課程以仿生飛行為核心，結合空氣動力學、飛行力學與控制工程，探討鳥類與昆蟲等自然飛行機制，並延伸至微型無人機與新型飛行載具之設計與應用。在無人機、自主系統與人工智慧快速發展的趨勢下，高機動性與複雜環境適應能力成為關鍵需求，而仿生飛行正提供突破傳統固定翼與旋翼限制的重要方向。本課程同時具備跨領域特性，整合機械設計、航太工程、控制理論

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與生物啟發概念，透過理論與實作並重的方式，培養學生系統整合與創新思維能力，以因應未來智慧飛行載具與前瞻工程科技之發展需求。

Remarks

參考書目：課程使用自編講義（投影片）授課為主

1. Wei Shyy, Hikaru Aono, Chang-kwon Kang, Hao Liu, "An Introduction to Flapping Wing Aerodynamics," Cambridge University Press.
2. Truong Q.T., Nguyen, Q.V., Truong Q.T., Park H.C., Byun D.Y., Goo N.S., " A modified blade element theory for estimation of forces generated by a beetle-mimicking flapping wing system," Bioinspiration & Biomimetics, Vol. 6, 2011.

本課程若因天災等不可抗力之因素或中央、地方政府公告停課，授課教師需依情況依建議補課方式調整課程進度與補課；若需使用假日、國定假日補課，則需與所有修課學生達成共識方能用例假日補課。

建議補課方式：

1. 線上授課方式補課；
2. 當預期可能會因天災(颱風、超大豪雨...等)宣佈停課時，建議老師先行調整加快課程進度或預先增加可能天氣預警之前幾次課程時數；
3. 停課後隔天起延後下課，補足停課延誤的進度；若停課超過1天，則在開始上課後延後下課補課，或當週星期六、日補課；

更改課程授課方式，例如：DEMO 改以考試、報告、作業取代。