

國家理論科學中心（南區）暑期課程： 數學模式與科學研究 (Mathematical Models and Scientific Research)

10:00-16:00, July 21-24, 2009

R204, 2F, NCTS, NCKU

主講人：郭鴻基教授
教育部國家講座教授
台灣大學大氣科學系終身特聘教授

內容與目的：

電腦科學家Turing曾說過『數學模式是對問題的簡化與理想化（甚至虛假化）。但數學模式在現有知識架構下，保留最重要的問題特性以供討論，進而協助研究未知瞭解科學。』數學模式就是以數學符號與觀念對自然界事物進行表達與分析的工具，我們透過模式觀察周遭事物。

本短課程透過簡單數學模式與重要實用例子說明：1)控制方程式的尋求；2)解與分析；3)科學詮釋等三個建模過程。模式例子包含物理科學、生命科學、防疫學、生態學、地球科學以及人文社會科學等領域；除此之外課程也將討論掠食與被掠食交互作用，魚獲生態影響，以及消耗戰等重要古典數學模式。數學函數本身是無因次，科學量化卻有單位，課程也將介紹因次分析與尺度分析於科學研究的應用。課程先需為微積分與基礎微分方程式知識。

本課程的目的是以數學模式強化科學研究能力，協助學生學習數學模式，並且學習從資料建立理論，以及對理論的數值量化。

As Turing once said" This model will be a simplification and an idealization, and consequently a falsification. It is to be hoped that the features retained for discussion are those of greatest importance in the present stage of knowledge." Mathematical model is a representation and analysis of reality through mathematical symbols and concepts. We will see reality through models!

This short course teaches how simple mathematics can help formulate, solve, and interpret real problems of current interest. The model examples cover a wide range of fields, including biology, ecology, geophysics, engineering, and social sciences. Classical modeling topics such as predator-prey interaction, disease control, harvesting and wars of attrition are also included. Moreover, the dimensional analysis and scale analysis of scientific problem will be discussed. The prerequisites of the course are calculus and elementary differential equations.

This short course is aim to give a college-level science student how to use differential equations to facilitate the scientific research. The students will learn the usage of mathematical model to distill theories from empirical data and to quantify the theories with a set of governing mathematical equations.

Contents:

1. Calculus—the Mathematics of Change
2. Commonly Occurring Functions
3. Introduction to Dynamic Modeling
4. Equilibriums and Stabilities
5. Phase Plane and Intuitive Approach
6. Equations of Exponential and Periodic Solutions
7. e^{-1} scale, Residence Time, and Relaxation
8. Dating Games and the HIV problem
9. Feedback, Fast and Slow Scales,
10. Nonlinear Dynamic Modeling
11. Nonlinear Dynamical Model Examples
12. Writing the Equations of Marriage Model
13. Synchronization Examples
14. Chaos and Catastrophic Change Examples
15. Dimensional Analysis
16. Examples in Dimensional Analysis
17. Multiple Scale Phenomena and Non-dimensional Parameters
18. Partial Differential Equation Models
19. Pattern Formation and Traveling Wave Solution Optional

Contact

Ms. Fu
Tel : 06-2757575 ext.65010
E-mail : etoile@phys.ncku.edu.tw