Course Content
Department of Mathematics, National Chung Cheng University

<table>
<tr><td colspan="4">Course Name：Numerical Ordinary Differential Equations
課程名稱：數值常微分方程</td><td>Course Department /Program
開課單位</td><td>Institute of Applied Mathematics</td></tr>
<tr><td colspan="4"></td><td>Course Code
課程代碼</td><td>2105522</td></tr>
<tr><td>Credits
學分數</td><td>3</td><td>Required / Selected
必/選修</td><td>Selected</td><td>Grade
開課年級</td><td>Graduate</td></tr>
<tr><td>Course Types
課程類別</td><td colspan="5">☐Humanities and Caring ☐Competition Project ☐Problem Based
■ Project Based ☐Capstone ☐Practical ☐Internship
■ Others</td></tr>
<tr><td colspan="6">Teaching Objectives(教學目標): This course focus on the analysis and algorithms for numerical approximations of differential equations. Students learn to identify the types of problems that require numerical techniques for their solutions. They also learn typical techniques for estimating error bounds for the approximations.

Course Description(課程概述): Numerical Differentiation and Integration, Numerical Solution of Ordinary Differential Equations – IVP and BVP, Higher-Order Differential Equations

Prerequisites(先修科目或先備能力)：Differential Equations, Undergraduate Analysis</td></tr>
<tr><td>Textbooks
建議參考書目</td><td colspan="5">1. Kindcaid & Cheney, ,Numerical Analysis: Mathematics of Scientific Computing, 3rd ed., Brooks Cole, 2002
2. Bradie, A Friendly Introduction to Numerical Analysis, Pearson, 2006
3. Dormand, Numerical Methods for Differential Equations, CRC Press, 1996
4. Shampine, Numerical Solutions of Ordinary Differential Equations, Chapman & Hall,1994</td></tr>
</table>

Syllabus(課程大綱)

Topic 單元主題	Contents 內容綱要	Weeks 上課週數
Numerical Differentiation and Integration	Richardson extrapolation, Interpolation, Gaussian quadrature, Romberg integration, Euler-Maclaurin formula*	4
Numerical Solution of Ordinary Differential Equations for IVP	Existence and uniqueness for IVP, Taylor-series method , Runge-Kutta and Runge-Kutta-Fehlberg methods, Multistep methods, Local and global errors: Stability*	4-5
Runge-Kutta Method	step-size control, dense output*, stability and stiffness	4

Numerical Solution of Ordinary Differential Equations for BVP	Existence and uniqueness for BVP, shooting methods, Finite-differences, Collocation*	3
Higher-Order Differential Equations*	Higher-order system*, Linear Differential Equations*, Stiff equations*,	1-3

*: optional topics

Core competences, Institute of Applied Mathematics **應用數碩士班暨博士班核心能力**		**Degrees of related to core competencies** **本課程與核心能力關聯強度**				
		1	**2**	**3**	**4**	**5**
Specific Competency 專業能力	**Professional Skill 1:** Professional and advanced knowledge of Applied Mathematics related subjects: Analysis, Differential Equations, or Numerical Methods **專業能力 1**：具備紮實的分析、微分方程、或數值方法等應用數學相關主題專業及進階知識					✓
	Professional Skill 2: Writing programming language and computer aided calculation **專業能力 2**：具備撰寫程式語言與電腦輔助計算之優秀能力					✓
	Professional Skill 3: Discover, analyze, and solve professional problems **專業能力 3**：具備發掘、分析及解決專業問題之優秀能力					✓
	Professional Skill 4: Translating the knowledge of mathematics or probability and statistics into valuable additions to the natural sciences, engineering, or social sciences **專業能力 4**：具備能將數學或機率與統計知識轉化為自然科學、工程或社會科學領域工作助力之優秀能力			✓		
	Professional Skill 5: Mathematical logic, independent thinking, and technical report writing **專業能力 5**：具備優秀的數理邏輯、獨立思考及科技報告寫作能力					✓
General Competence 共通能力	**Common Ability 1:** Communication and teamwork **共通能力 1**：具備優秀的溝通及分工合作能力			✓		
	Common Ability 2: International perspective and lifelong self-development **共通能力 2**：具備良好的國際觀及終身自我學習成長之能力			✓		

Note: The strength of association is indicated by a five-point scale, where 1 indicates no association and 5 indicates a strong association.
註：關聯強度以五點量表標示，1 表示沒有關聯，5 表示非常有關聯。