國立中正大學課程大綱

National Chung Cheng University Syllabus

課號 course code	115_1_2157001_01	全英文授課 EMI	■是 □否
課程類別 course type	□人文關懷課程 □競賽專題課程 ■問題導向課程 ■專題導向課程 □總整課程 □實作課程 □實習 □其他		
課程名稱（中文） Chinese course name	地震電磁學		
課程名稱（英文） English course name	Seismo-electromagnetics		
學年/學期 academic year /semester	115/1	學分 credits	3
學系（所） department	Earth and Environmental Sciences	必選修 required/selected	□必修 ■選修
上課時間 class hours	Thursday E, F	上課地點 classroom	Seismology 301
教師 instructor	Hong-Jia Chen (陳宏嘉)	教師 email Instructor's email	hongjia@ccu.edu.tw
助教 teaching assistant		助教 email TA's email	
先修科目或先備能力 prerequisites	No prerequisites.		
課程概述 course descriptions	Seismologists typically use statistical methods to analyze how seismic activity evolves to predict when and where strong earthquakes might occur. However, these approaches often fall short of accurately forecasting the timing and magnitude of major earthquakes. Traditionally, earthquake prediction has focused on mechanical factors such as stress, strain, and seismicity, interpreting their variations as warning signs of impending large events. In contrast, for decades, an alternative approach has emerged outside mainstream seismology, centered on observable tracers like electromagnetic and chemical signals. These non-mechanical phenomena, though often considered unconventional by traditional seismologists, have been observed days or even weeks before major earthquakes. Statistical analyses suggest that among these precursors, electromagnetic signals show the greatest promise for short-term earthquake forecasting. This perspective is grounded in a sophisticated atomic-level mechanism based on defects in solid materials, drawing from extensive laboratory research in physical chemistry and solid-state physics. The		

	theory proposes that as tectonic stress accumulates, electron-hole pairs are generated within the Earth's crust. While electrons remain confined within the stressed rocks, positively charged holes migrate into surrounding, less stressed regions, generating electrical currents that can travel across vast distances. These currents, in turn, can trigger a range of secondary effects, including the emission of low- to ultra-low-frequency electromagnetic radiation, spectroscopically distinct thermal infrared signals from the Earth's surface, and detectable changes in the atmosphere and ionosphere.
學習目標 learning objectives	This course explores seismo-electromagnetics, focusing on the electromagnetic phenomena that occur during the preparation and occurrence of earthquakes. It introduces the solid-state theory proposed by Friedemann Freund, along with other potential mechanisms for generating electromagnetic precursors. Additionally, the course reviews key research articles on the subject and examines findings from scientists worldwide who have used both ground-based and satellite observations to link these non-seismic signals to major earthquakes. Students will also gain insight into global efforts to monitor the Earth for these precursors, which are often weak and sporadic, yet crucial for advancing short-term earthquake forecasting.
教科書及參考書 textbooks and references	1. Ouzounov, D., Pulinets, S., Hattori, K., & Taylor, P. (Eds.). (2018). Pre-Earthquake Processes: A Multidisciplinary Approach to Earthquake Prediction Studies. Hoboken, New Jersey, U.S.A.: John Wiley & Sons. 2. Freund, F., Mignan, A., Ouillon, G., & Sornette, D. (Eds.). (2021). The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes. Berlin/Heidelberg, Germany: Springer.

教學要點概述	
教材編選 teaching materials	■自製簡報(ppt) □課程講義 □自編教科書 □教學程式 □自製教學影片 □其他
教學方法 teaching methods	■講述 ■小組討論 ■學生口頭報告 ■問題導向學習 □個案研究 □其他
評量工具 Evaluation tools	□期中考 □期末考 □隨堂測驗 □隨堂作業 ■課後作業 □期中報告 ■期末報告 ■專題報告 □評量尺規 □其他
教學資源 teaching resources	□課程網站 ■教材電子檔供下載 □實習網站

教師 相關訊息 instructor's information	Research interests: Seismo-electromagnetics, statistical seismology, geophysical exploration https://www.researchgate.net/profile/Hong-Jia-Chen

每週課程內容 weekly scheduled contents
Week 1 Introducing this course
Week 2 Historical Development of Pre-Earthquake Phenomena Studies
Week 3 Latest Physical Models and Concepts of Pre-Earthquake Processes
Week 4 Pre-Earthquake Seismic Phenomena
Week 5 Ground Geochemical and Electromagnetic Observations of Major Seismicity
Week 6 Atmospheric/Thermal Signals Associated with Major Earthquakes
Week 7 Ionospheric Processes Associated with Major Earthquakes
Week 8 Students' Progress Report
Week 9 Interdisciplinary Approach to Earthquake Forecasts/Predictions
Week 10 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 11 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 12 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 13 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 14 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 15 The Global Earthquake Forecasting System: Towards Using Non-seismic Precursors for the Prediction of Large Earthquakes
Week 16 Students' Final Report
Week 17 Flexible Class
Week 18 Flexible Class
核心能力 core competencies

核心能力 Core competency		本課程與核心能力關聯強度 Degrees of related to core competencies				
		1	2	3	4	5
專業能力 Specific competency	1.熟悉臺灣能源結構與氣候調適策略、貢獻所學於極端氣候減災工作。			V		
	2.操作地熱及碳封存之科學調查方法。			V		
	3.掌握淨零轉型關鍵戰略之發展與契機。			V		
	4.具備地震活動監測與防減災專業能力。					V
	5.強化實作、分析與整合實驗數據能力。					V
	6.具備操作儀器原理及操作儀器設備之能力。				V	
共通能力 General Competence	1.增進外語能力及培育國際觀。					V
	2.建立科學思考、邏輯推理能力及獨立研究能力。					V
	3.具備文獻資料蒐集及整合能力。					V

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。