



## 教學計劃表 Syllabus

課程名稱(中文) Course Name in Chinese	拉曼光譜分析技術		學年/學期 Academic Year/Semester	113/1
課程名稱(英文) Course Name in English	Analytical Methods of Raman Spectroscopy			
科目代碼 Course Code	ES_50600	系級 Department & Year	碩士	開課單位 Course-Offering Department
自然資源與環境學系				
修別 Type	選修 Elective	學分數/時間 Credit(s)/Hour(s)	3.0/3.0	
授課教師 Instructor	/劉瑩三			
先修課程 Prerequisite				
課程描述 Course Description				
<p>拉曼光譜分析方法自從1928年由拉曼博士(PhD V. C. Raman)發現拉曼效應以來，1960年之後，雷射的出現為拉曼光譜儀提供了理想的光源，因而造成了拉曼光譜分析技術的起飛。到了90年代，隨著較新的探測器和探測技術的革新，顯微拉曼光譜儀被研發形成。由於顯微拉曼光譜儀具有不破壞分析標本、快速及空間解析度佳(<math>\sim 1 \mu\text{m}</math>)的特性，近年來被應用在許多不同的領域，如物理、化學、地球科學、環境科學、生物、醫學、考古、犯罪學...等，不僅奠下了堅實的基礎，且有許多重大的突破與進步。顯微拉曼光譜儀是一種正在快速發展的分析研究工具，非常值得應用在各學科的研究題材上。本課程希望透過課程的講授及實際的儀器操作，使學生瞭解拉曼光譜的原理及實務的應用。</p>				
課程目標 Course Objectives				
顯微拉曼光譜儀是一種正在快速發展的分析研究工具，非常值得應用在各學科的研究題材上。本課程希望透過課程的講授及實際的儀器操作，使學生瞭解拉曼光譜的原理及實務的應用				
系專業能力 Basic Learning Outcomes				課程目標與系專業能力相關性 Correlation between Course Objectives and Dept.'s Education Objectives
A	能覺知多元的自然科學與社會科學理論並具備研究能力 To have knowledge of natural and social science theories			
B	具備自然資源與人類社會議題之調查分析、規劃與經營之能力 To be able to investigate, analyze, plan, and manage both natural resource and human social issues			○
C	具備將環境倫理與生態思想落實於永續性生活型態的能力 To implement sustainable lifestyles based on environmental ethics and ecological principles			
D	能以整全式的觀點來解析環境問題，並具備發展系統性解決方案的能力 To resolve environmental issues and develop systematic solutions with a global perspective			
E	具備系統分析、未來思考、溝通協調與團隊合作的能力 The ability to analyze, plan, communicate, and coordinate with others (teamwork)			●
F	具備終身學習、國際視野與外語溝通的能力 To instill the values of lifelong learning, an international perspective, and the ability to communicate in a foreign language			●
圖示說明 Illustration : ● 高度相關 Highly correlated ○ 中度相關 Moderately correlated				
授課進度表 Teaching Schedule & Content				
週次 Week	內容 Subject/Topics			備註 Remarks
1	拉曼光譜基本原理介紹			課程演講
2	中秋節補假一天			課程演講

3	拉曼光譜的應用簡介及拉曼光譜儀的設備	課程演講
4	不上課(11/9或11/10野外考察)	課程演講
5	拉曼光譜案例分析(1)顏料	課程演講
6	拉曼光譜案例分析(2)石器與玉器	課程演講
7	拉曼光譜案例分析(3)陶器-1	課程演講
8	不上課(11/9或11/10野外考察)	課程演講
9	期中考試	
10	拉曼光譜案例分析(4)陶器-2	課程演講
11	拉曼光譜案例分析(5)瓷器	課程演講
12	拉曼光譜案例分析(6)玻璃	課程演講
13	拉曼光譜儀實務操作-1	實務操作
14	拉曼光譜儀實務操作-2	實務操作
15	拉曼光譜儀實務操作-	實務操作
16	實驗分析結果報告	
17	期末評量	
18	教師彈性補充教學	

#### 教學策略 Teaching Strategies

- 課堂講授 Lecture
  分組討論 Group Discussion
  參觀實習 Field Trip
  其他 Miscellaneous: 實驗室分析操作

#### 教學創新自評 Teaching Self-Evaluation

創新教學(Innovative Teaching)

- 問題導向學習(PBL)
  團體合作學習(TBL)
  解決導向學習(SBL)
  翻轉教室 Flipped Classroom
  磨課師 Moocs

社會責任(Social Responsibility)

- 在地實踐 Community Practice
  產學合作 Industry-Academia Cooperation

跨域合作(Transdisciplinary Projects)

- 跨界教學 Transdisciplinary Teaching
  跨院系教學 Inter-collegiate Teaching

- 業師合授 Courses Co-taught with Industry Practitioners

其它 other:

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學期成績計算及多元評量方式 Grading & Assessments

配分項目 Items	配分比例 Percentage	多元評量方式 Assessments							
		測驗 會考	實作 觀察	口頭 發表	專題 研究	創作 展演	卷宗 評量	證照 檢定	其他
平時成績 General Performance	30%	✓		✓					
期中考成績 Midterm Exam	30%	✓							
期末考成績 Final Exam	0%								
作業成績 Homework and/or Assignments	40%		✓		✓				
其他 Miscellaneous (_____)									

評量方式補充說明

Grading & Assessments Supplemental instructions

教科書與參考書目 (書名、作者、書局、代理商、說明)

Textbook & Other References (Title, Author, Publisher, Agents, Remarks, etc.)

- Peter Larkin (2011) Infrared and Raman Spectroscopy. Elsevier Inc.
- Howell G.M. Edwards and John M. Chalmers (2005) Raman Spectroscopy in Archaeology and Art History. The Royal Society of Chemistry, Cambridge UK.
- Akyuz, S., Akyuz, T., Basaran, S. Bolcal, C. and Gulec, A. (2008) Analysis of ancient potteries using FT-IR, micro-Raman and EDXRF spectrometry: Vibrational Spectroscopy, 48(2), 276-280.
- Clark, R.J.H (2007) Raman microscopy as a structural and analytical tool in the fields of art and archaeology: Journal of Molecular Structure, 834-836, 74-80.
- Colomban, Ph. (2008) On-site Raman identification and dating of ancient glasses: A review of procedures and tools: Journal of Cultural Heritage, 9, Supplement 1, e55-e60.
- Legodi, M.A. and Waal, D. (2007) Raman spectroscopic study of ancient South African domestic clay pottery: Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 66(1), 135-142.
- Lofrumento, C., Zoppi, A. and Migliorini, M.G. (2004) Micro-Raman spectroscopy of ancient ceramics: a study of French sigillata wares: Journal of Raman Spectroscopy, 35, 650-655.
- Ospitali, F., Sabetta, T., Tullini, F., Nannetti, M.C. and Lonardo, G.D. (2005) The role of Raman micro spectroscopy in the study of black gloss coatings on Roman pottery: Journal of Raman Spectroscopy, 36, 18-23.
- Zoppi, A., Lofrumento, C., Castellucci, E.M. and Migliorini, M.G. (2005) The Raman Spectrum of Hematite: Possible Indicator for a Compositional or Firing Distinction among Terra Sigillata Wares: Annali di Chimica, 95(3-4), 239-246.
- Tomasini, E.P., Halac, E.B., Reinoso, M., Di Liscia, E.J. and Maier, M.S. (2012) Micro-Raman spectroscopy of carbon-based black pigments, Journal of Raman Spectroscopy, 43, 1671-1675.
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- Striova, J., Lofrumento, C., Zoppi, A. and Castellucci, E.M. (2006) Prehistoric Anasazi ceramics studied by micro-Raman spectroscopy. Journal of Raman Spectroscopy, 37(10), 1139-1145.
- Parras, D., Vandenabeele, P., Sánchez, A., Montejo, M., Moens, L. and Ramos, N. (2010) Micro-Raman spectroscopy of decorated pottery from the Iberian archaeological site of Puente Tablas (Jaen, Spain, 7th-4th century B.C.): Journal of Raman Spectroscopy, 41(1), 68-723.
- Iordanidis, A. and Garcia-Guinea, J. (2011) A preliminary investigation of black, brown and red coloured potsherds from ancient upper Macedonia, northern Greece, Mediterranean Archaeology and Archaeometry, 11(1), 85-97.
- Issi, A. Raškovska, A., Kara, A., Grupce, O., Minčeva-Šukarova, B. and Okyar, F. (2011) Scanning electron microscopy and micro-Raman spectroscopy of slip layers of Hellenistic ceramic wares from Dorylaion/Turkey. Ceramics International, 37(6), 1879-1887.

課程教材網址(含線上教學資訊,教師個人網址請列位於本校內之網址)  
Teaching Aids & Teacher's Website(Including online teaching information.  
Personal website can be listed here.)

其他補充說明 (Supplemental instructions)