



## 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

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( $\sim 1 \mu\text{m}$ )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。

### 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	<input type="circle"/>
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)	<input checked="" type="circle"/>
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	<input checked="" type="circle"/>

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 Industy-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
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.)

1. Peter Larkin (2011) Infrared and Raman Spectroscopy. Elsevier Inc.
2. Howell G.M. Edwards and John M. Chalmers (2005) Raman Spectroscopy in Archaeology and Art History. The Royal Society of Chemistry, Cambridge UK.
3. 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.
4. 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.
5. Colombari, 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. Trąbska, J., Weselucha-Birczyńska, A., Zięba-Palus, J. and Run, M.T. (2011) Black painted pottery, Kildehuse II, Odense County, Denmark. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 79(4), 824-830.
12. 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.
13. 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.
14. 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.
15. İssi, 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)