

 **國立東華大學**  
**教學計劃表 Syllabus**

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| 課程名稱(中文)<br>Course Name in Chinese                                                                                                                                                                                                                                                                                                                   | 應用3D雷射掃描儀於地表調查專題                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |    | 學年/學期<br>Academic Year/Semester    | 114/1                                                                               |
| 課程名稱(英文)<br>Course Name in English                                                                                                                                                                                                                                                                                                                   | Seminar on the Application of 3D Laser Scanner to Earth Surface Surveys                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |    |                                    |                                                                                     |
| 科目代碼<br>Course Code                                                                                                                                                                                                                                                                                                                                  | NRESM0490                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 系級<br>Department & Year     | 碩士 | 開課單位<br>Course-Offering Department | 自然資源與環境學系                                                                           |
| 修別<br>Type                                                                                                                                                                                                                                                                                                                                           | 選修 Elective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 學分數/時間<br>Credit(s)/Hour(s) |    | 3.0/3.0                            |                                                                                     |
| 授課教師<br>Instructor                                                                                                                                                                                                                                                                                                                                   | /張有和                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |    |                                    |                                                                                     |
| 先修課程<br>Prerequisite                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |                                    |                                                                                     |
| 課程描述 Course Description                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |                                    |                                                                                     |
| <p>利用陸地三維雷射掃描技術進行地表資訊收集，本課程除了讓學生學習最新之技術也讓學生實際進行環境學院建築之掃描與後處理工作，使學生能由資料收集與資料處理過程中學習建立3D模型之方式</p> <p>Introduction to terrestrial LIDAR techniques. this course will focus on collecting and analysing earth surface data collecting from using ground based Lidar. Following by data processing lab. in order to create 3D virtual reality models.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |                                    |                                                                                     |
| 課程目標 Course Objectives                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |                                    |                                                                                     |
|                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |    |                                    |                                                                                     |
| 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                                                                                                                                                                                                                                                                                                                                                    | <p>課程簡介: Introduction to terrestrial LIDAR techniques: Laser Scanning: Evolution of the Discipline , Chapter 8 Laser Scanning. In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。 .</p> <p>三維雷射掃描理論：Chapter 8 Laser Scanning: Evolution of the Discipline . In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。 .</p> <p>Basic of surveying using total station (測量學：測距、測角度與全測站簡介): Introduction to Nikon DTM A10 and Topcon GPT 3003LN Long distance and Non-Prism Total Station (遠距雷射免稜鏡全站儀)</p> |                             |    |                                    | Introduction to Terrestrial Laser Scanning<br>Topcon Lase total station             |
| 2                                                                                                                                                                                                                                                                                                                                                    | <p>Introduction to Riegl LMS Z360I 3D laser scanner (陸地光達系統簡介)：http://www.riegl.com/terrestrial_scanners/lms-z360i_/360i_all.htm。 .</p> <p>Point clouds post-processing software: Riscan Pro and MeshLab (點雲後處理軟體簡介Riscan Pro and MeshLab)</p>                                                                                                                                                                                                                                                                                                                                  |                             |    |                                    | Time Of Fly (TOF) and Triangulation/Trilateration                                   |
| 3                                                                                                                                                                                                                                                                                                                                                    | <p>3D model from photos: Introduction of Photogrammetry and Visual SFM ( Visual Structure from Motion System)</p> <p>Assignment 1: Build a 3D color point cloud using Visual SFM(作業一：利用Visual SFM與照片建立3D點雲)!</p>                                                                                                                                                                                                                                                                                                                                                                |                             |    |                                    | VisualSFM：A Visual Structure from Motion System<br>(http://ccwu.me/vsfm/index.html) |

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| 4  | 3D model of small status (10-50 cm) using triangulation 3D laser scanner: David laser scanner (Now HP laser scanner)<br>Coordinate Transformation(座標轉換：利用兩已知點藉由Backsighting方法進行大地座標之建立、高程測量)：Introduction to Leveling and height measurement using Sokkia SDL 30 Digital Level (水準測量原理與Sokkia SDL 30電子水準儀簡介)                                                                                                                                                                                   |                                                                                                                                                                                                            |
| 5  | Davidlaser handheld laser scan practicing Lab A222!<br><br>3D laser scanning and camera calibration (三維雷射掃描與相機校正)：Triangulation Lases Scanner: Davidlaser camera calibration<br>TOF Laser Scanner: Riegl LMS Z360I and Nikon D100/20mm fixed lens (使用Riegl LMS Z360I與Nikon D100 /20 mm定焦鏡頭)。                                                                                                                                                                                                   | 作業一繳交                                                                                                                                                                                                      |
| 6  | Davidlaser II scan practicing Lab A222!<br><br>Point clouds: object within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：How to 3D scan a small object? 計劃包括解析度、準確度評估、掃描對象與控制點擺放與測量大地座標等規劃<br>Revopoint pop 2<br>eGNSS介紹<br>Assignment 2: Build a 3D color point cloud using Davidlaser II (作業二:利用Davidlaser II建立3D點雲)!                                                                                                                                                                                        | <a href="https://www.revopoint3d.com/pop-3d-scanner-2/">https://www.revopoint3d.com/pop-3d-scanner-2/</a><br>作業二                                                                                           |
| 7  | Revopoint pop 2 scan practicing Lab A222!<br><br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：Lab. of 3D laser scanning within 10 m (實際現地掃描與攝影)。(環境學院前雕塑：掃描距離6-8公尺、6個掃描位置)<br>Assignment 3: Build a 3D color point cloud using Revopoint pop 2 (作業三:利用Revopoint pop 2建立3D點雲)!                                                                                                                                                                                                             | 作業二                                                                                                                                                                                                        |
| 8  | Introduction of Solid State Lidar: Introduction to Livox Mid-40/Mid-70 lidar<br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：indoor 3D scan<br>Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 1 (實際現地掃描與攝影之資料後處理一：座標轉換、雜訊去除、點雲連結與上色、誤差評估與資料輸出。)<br>Assignment 4: Build a 3D color point cloud using Livox solid state scanner (作業三:利用Livox solid state scanner建立3D點雲)!                                                                             | <a href="https://www.livoxtech.com/mid-40-and-mid-100">https://www.livoxtech.com/mid-40-and-mid-100</a><br><a href="https://www.livoxtech.com/mid-70">https://www.livoxtech.com/mid-70</a><br>作業二繳交<br>作業四 |
| 9  | Introduction of Solid State Lidar: Introduction to Livox Mid-40/Mid-70 lidar<br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：indoor 3D scan<br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 2 (實際現地掃描與攝影之資料後處理二：3D建模)。                                                                                                                                                                         | 作業三繳交                                                                                                                                                                                                      |
| 10 | Introduction of Solid State Lidar: Introduction to Livox Mid-40/Mid-70 lidar<br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：indoor 3D scan<br>Point clouds within 10 m(三維雷射掃描 (一) 十公尺內目標三維點雲掃描)：Lab. of 3D laser scanning within 10 m Point cloud process and 3d model reconstruction 2 (實際現地掃描與攝影之資料後處理二：3D建模)。<br>Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 1-scanning (三維雷射掃描 (二) 10-50公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(環院建築) |                                                                                                                                                                                                            |
| 11 | Introduction to Structure Core Lidar<br>Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 2- scanning (三維雷射掃描 (二) 10-50公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(環院建築)                                                                                                                                                                                                                                                                                  | 作業四繳交<br><a href="https://www.youtube.com/watch?v=nlzP9BP3168&amp;t=5s">https://www.youtube.com/watch?v=nlzP9BP3168&amp;t=5s</a>                                                                           |

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| 12 | Introduction to Mechanical 3D Scanner: Riegl LMS Z360i<br>Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 3- scanning(三維雷射掃描 (二) 10-50公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(環院建築) |  |
| 13 | Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 4- point cloud processing(三維雷射掃描 (二) 10-50公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(環院建築)                                             |  |
| 14 | Point clouds: scanning distance between 10 m and 50m, 3D reconstruction of Environment College building 5- point cloud processing(三維雷射掃描 (二) 10-50公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(環院建築)                                             |  |
| 15 | Point clouds: scanning from 50m to 200 m and airborne LIDAR-1(三維雷射掃描 (三) 50-200公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(地形)                                                                                                                  |  |
| 16 | 12/25行憲紀念日(放假)<br>Point clouds: scanning from 50m to 200 m and airborne LIDAR-2(三維雷射掃描 (三) 50-200公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(地形)                                                                                                |  |
| 17 | 中華民國開國紀念日(放假)<br>Point clouds: scanning from 50m to 200 m and airborne LIDAR-3(三維雷射掃描 (三) 50-200公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(地形)                                                                                                 |  |
| 18 | 教師彈性補充教學<br>Point clouds: scanning from 50m to 200 m and airborne LIDAR-4(三維雷射掃描 (三) 50-200公尺內目標三維點雲掃描：計劃、掃描與建立3D模型。)(地形)                                                                                                      |  |

#### 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: 野外測量工作

#### 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<br>Items                                                                                                                      | 配分比例<br>Percentage | 多元評量方式 Assessments |          |          |          |          |          |          |    |
|                                                                                                                                    |                    | 測驗<br>會考           | 實作<br>觀察 | 口頭<br>發表 | 專題<br>研究 | 創作<br>展演 | 卷宗<br>評量 | 證照<br>檢定 | 其他 |
| 平時成績(含出缺席)<br>General Performance<br>(Attendance Record)                                                                           | 20%                |                    |          |          |          |          |          |          |    |
| 期中考成績 Midterm Exam                                                                                                                 |                    |                    |          |          |          |          |          |          |    |
| 期末考成績 Final Exam                                                                                                                   |                    |                    |          |          |          |          |          |          |    |
| 作業成績 Homework and/or<br>Assignments                                                                                                | 80%                |                    |          |          |          |          |          |          |    |
| 其他 Miscellaneous<br>(_____)                                                                                                        |                    |                    |          |          |          |          |          |          |    |
| <p style="text-align: center;">評量方式補充說明</p> <p style="text-align: center;">Grading &amp; Assessments Supplemental instructions</p> |                    |                    |          |          |          |          |          |          |    |

| 教科書與參考書目 (書名、作者、書局、代理商、說明)<br>Textbook & Other References (Title, Author, Publisher, Agents, Remarks, etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
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| <p>第一、二週 (1)Kraus, K. (2004)Chapter 8 Laser Scanning. In Photogrammetry: Geometry from images and laser scans (2004) 2nd edition by Karl Kraus。(2)曾義星與史天元(2003)三維雷射掃描技術及其在工程測量上之應用, <a href="http://web1.nsc.gov.tw/public/Data/popsc/2003_222/9205-02.pdf">http://web1.nsc.gov.tw/public/Data/popsc/2003_222/9205-02.pdf</a>。(3) <a href="http://www.oocities.com/adaptive_geoservices/MPES2000_ISITE.pdf">http://www.oocities.com/adaptive_geoservices/MPES2000_ISITE.pdf</a>。(4) <a href="http://www.fig.net/pub/bratislava/papers/ts_02/ts_02_stanek.pdf">http://www.fig.net/pub/bratislava/papers/ts_02/ts_02_stanek.pdf</a>。(5) Airborne Laser Scanning: Basic Relations and Formulas, ISPRS Journal of Photogrammetry &amp; Remote Sensing, 54: pp. 199-214. Baltsavias, E.P., 1999 (<a href="http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.42.1900&amp;rep=rep1&amp;type=pdf">http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.42.1900&amp;rep=rep1&amp;type=pdf</a>)</p> <p>第三、五週 Riegl (<a href="http://www.riegl.com/">http://www.riegl.com/</a>) 與Rapidform (<a href="http://www.rapidform.com/">http://www.rapidform.com/</a>) 網站、Elementary surveying: An introduction to geomatics by Wolf, P. R and Ghilani, C. D. (2006), 11th edition, Pearson Prentice Hall, London。Chapter 4-5, p.72-125 and chapter 8, p.187-226。</p> <p>第六、八週 (1) <a href="http://www.menci.com/services/camera-calibration.html">http://www.menci.com/services/camera-calibration.html</a>。(2) Riegl tutorial video and manual: <a href="http://www.riegl.com/downloads/http://www.riegl.com/download/?nav=browse&amp;category=TRAINING">http://www.riegl.com/download/?nav=browse&amp;category=TRAINING</a> (3) Rapidform: <a href="http://www.rapidform.com/portal/Iframe/evaluation.papers">http://www.rapidform.com/portal/Iframe/evaluation.papers</a></p> <p>(1) <a href="http://www.tu-dresden.de/ipf/photo/publikationen/2006/Bienert_Maas_Scheller_ForestryVienna2006.pdf">http://www.tu-dresden.de/ipf/photo/publikationen/2006/Bienert_Maas_Scheller_ForestryVienna2006.pdf</a> (2) <a href="http://www.photogrammetry.ethz.ch/general/persons/henri/EISE_649.pdf">http://www.photogrammetry.ethz.ch/general/persons/henri/EISE_649.pdf</a> (topography) (3) Sternberg, H., Kersten, Th., Jahn, I., and Kinzel, R.(2004) Terrestrial 3D laser scanning - data acquisition and object modeling for industrial as-built documentation and architectural applications. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 35 (B7), 942-947. (4) Gruen, A., and Akca, D., 2005. Least squares 3D surface and curve matching. ISPRS Journal of Photogrammetry &amp; Remote Sensing, 59(3), 151-174. (5) <a href="https://www.fig.net/commission6/baden_2006/PDF/LS2/Sternberg.pdf">https://www.fig.net/commission6/baden_2006/PDF/LS2/Sternberg.pdf</a> (building) (6) <a href="http://www.rieglusa.com/applications/geology/index.shtml">http://www.rieglusa.com/applications/geology/index.shtml</a></p> <p>Geology<br/>         TLS in the national park Saxon Switzerland - T. Martienben, K.H. Lobel<br/>         Landslide Monitoring Visualization and Quantification of Material Movement - Multiple Authors<br/>         Glacier Monitoring Sulzbachkees, Alps. Austria Monitoring Campaign 2008 using LPM-321 - Multiple Authors<br/>         Glacier Monitoring Sulzbachkees, Alps, Austria - Multiple Authors<br/>         Geology Outcrop Modelling and Interpretation Using Ground Based Hyperspectral and Laser Scanning Data Fusion - T. Kurz, S. Buckley, J. Howell, D. Schneider<br/>         Building Pit Surveying - Austria - Multiple Authors</p> <p>Buildings and Architecture<br/>         Please click on the link below each project to view the project PDF:<br/>         Melk Monastery<br/>         Keola Condo Tower</p> |  |
| 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)<br>Teaching Aids & Teacher's Website(Including online teaching information. Personal website can be listed here.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| <p>ftp site: 134.208.103.43</p> <p>login name: user</p> <p>password: 8227106</p> <p>/study/3d_laser_scan</p> <p>只能在校內下載</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| 其他補充說明 (Supplemental instructions)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
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