Remote Sensing and Geographic Information Systems (GIS) for Earth and Planetary Science (Short Course)

Course Code: PLANETSC 9606L

Centre for Planetary Science and Exploration (CPSX), Dept. of Earth Sciences - University of Western Ontario

Contacts: Dr. Livio L. Tornabene (livio@cpsx.uwo.ca; +1-519-661-2111 ext-81506)

When: June 14 – 20, 2014

Where: University of Western Ontario

Prerequisites/Antirequisite:

No specific prerequisites are required, but previous enrollment in at least one Earth Science or Planetary Science course is required.

Basic GIS skills and familiarity with image datasets are assumed.

Course Objectives

The main objective of this course is to provide a strong technical and conceptual grounding in remote sensing data and Geographic Information Systems (GIS) analysis with both terrestrial and planetary applications; ability to manipulate and analyze a wide variety of remote sensing data; competency with ENVI, ArcGIS, JMars and an ability to adapt to other similar software packages; practice in applying the learned techniques to diverse terrestrial and planetary data sets.

Course Description

This is an intensive 7-day short course for graduate students, researchers, industry, and government employees about remote sensing, GIS and its applications. The focus of the course will be on building a strong technical and conceptual grounding in image analysis; learning the ability to manipulate and analyze a wide variety of remote sensing data sets. Most of the material will be taught using the ENVI and ArcGIS program suites; however, the ability to incorporate other program packages will also be discussed (e.g., MapInfo; Oasis Montaj; JMars). Participants will get a hands-on experience applying the learned techniques to diverse terrestrial and planetary data sets and deriving meaningful geologic and environmental information.

The course will be suitable for advanced undergraduate students, graduate students and for professionals from industry and government. The course will feature both overview lectures on background theory, as well as hands-on exercises using satellite data, geological maps, and field data. This course is intended to provide the non-specialist analytical tools when working with various types of spatial and spectral data.
### Course Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Topics/Modules</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb. 14, 2014</td>
<td>Saturday</td>
<td>Welcome and Course Introduction</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Lecture 1:</strong> Introduction to Remote Sensing (L.L. Tornabene)</td>
<td>9:30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: Introduction to image visualization and manipulation using ENVI software</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 15, 2014</td>
<td>Sunday</td>
<td><strong>Lecture 2:</strong> Remote Sensing continued/applications (L.L. Tornabene)</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: Introduction to image processing techniques using ENVI software</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 16, 2014</td>
<td>Monday</td>
<td><strong>Lecture 3:</strong> Introduction to GIS (B. Shankar)</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: ArcGIS 10 (updates from v. 9.3); JMars; Planetary GIS tools overview</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 17, 2014</td>
<td>Tuesday</td>
<td><strong>Lecture 4:</strong> GIS continued/applications (B. Shankar)</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: Spatial analysis; field applications</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 18, 2014</td>
<td>Wednesday</td>
<td><strong>Lecture 5:</strong> Further GIS and remote sensing techniques (E. Jones)</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: Problem-based-learning exercise in advanced techniques (part 1)</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 19, 2014</td>
<td>Thursday</td>
<td><strong>Lecture 6:</strong> Further GIS and remote sensing techniques (E. Jones)</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab: Problem-based-learning exercise in advanced techniques (part 2)</td>
<td>13:30</td>
</tr>
<tr>
<td>Feb. 20, 2014</td>
<td>Friday</td>
<td>Lab Catch-Up Day</td>
<td></td>
</tr>
</tbody>
</table>

### Additional details on course topics:

**Lecture 1: Introduction to Remote Sensing**

- Course overview: Introduce course
- The electromagnetic spectrum
- Basics of remote sensing
- Remote sensing platforms and data collection
- Data storage
- Available multispectral sensors for earth, Mars and the moon

**Lecture 2: Remote Sensing continued/applications**

- Available planetary data sets and their uses: topographic, images, multispectral, radar
- Data Visualization
- Data processing techniques
- Data analysis techniques
• Data interpretation

Lecture 3: Introduction to GIS

• What is GIS; types of GIS and GIS software; why do we need GIS
• Spatial data models; raster and vector; comparison of data models and their attributes in a GIS; models for topographic data
• The spatial frame: map projections and co-ordinate systems; converting between systems; geographic projections; georeferencing; planetary coordinate systems and earth coordinate systems (UTM, etc.)
• Spatial resolution and resolving power

Lecture 4: GIS continued/applications

• Where to obtain data for different bodies (Earth, Moon, Mars, etc.) and necessary processing to be GIS-ready
• Techniques for analyzing vector spatial data: spatial relationships, proximity, connectedness, attribute analysis, basic intersection logic AND/UNION, buffering, calculation of areas
• Techniques for raster analysis: map algebra, reclassification, zones, terrain analysis (contour, slope, aspect), interpolation
• Application of planetary data sets for geology within GIS, e.g. feature mapping, discriminating different types of mineralogy or terrain; data fusion.

Lecture 5: Further GIS and remote sensing techniques

• Daughter products derived from typical spatial and spectral data sets, and applications to environmental and planetary studies, specifically
  - hydrology models
  - vegetation and soil indices; the Tasseled cap
• Multispectral classification and its application to landcover and surface feature mapping; martian and terrestrial examples; classification of non-spectral data
• Thermal data; thermal inertia and application to remote sensing grain size

Lecture 6: Further GIS and remote sensing techniques

• Techniques in applying planetary data sets and their daughter products within a GIS, e.g. modelling fire intensity from a veg map, modelling flooding potential, modelling soil erosion, etc.
• Multi-criteria evaluation

Course Format

Each session will feature a series of presentations by the instructor, and hands-on exercises during laboratory sessions. Depending on participant interests, parallel laboratory sessions may be offered to provide a range of tutorials on the topics covered. Time will be allocated at the end of each day to
discuss materials presented in the class, examine sample suites where available and applicable, and assist with laboratory exercises.

**Course Materials**

The following references are recommended readings and can be used as guides during the duration of the course. Weblinks of GIS tutorials are provided below for those that need to refresh their memories or gain a little experience with GIS. Additional recommended readings may be provided at the time of the short course. Content covered in these lectures will form the basis for practical tutorials and exercises.


‘Getting to know ArcGIS Desktop’ by ESRI® ([http://tinyurl.com/ljcg32b](http://tinyurl.com/ljcg32b)), together with this YouTube playlist ([http://tinyurl.com/nj2ht6k](http://tinyurl.com/nj2ht6k)) can familiarize participants with the basic tools/features of ArcMap v.10.

**Course Evaluation**

This one week course is a 0.5 FCE credit. Students registered in the course will be evaluated as follows:

*Laboratory Exercises (6 labs at 15% of the total grade) 90%  
(*due latest by end of the course - *)
Class Attendance and Participation 10%

*To synthesize the skills learned during this course and develop an understanding of their broad applicability, the short course project will involve the participant working on a scientific question that combines the use of remote sensing and GIS applications on an Earth or planetary data set of their choice. Each project will be assessed on originality, understanding of hypothesis testing and proposed analytical methods. You will receive feedback on your research plan from the instructors during the week before the remaining assessment is due. Time will be made available to develop the group projects throughout the course in the mid-late afternoon; some evening work may also be required.*

**Academic Honesty Statements and Absences:**

Assignments: Assignments must be submitted both by hardcopy and electronically on the assigned due date and will not be accepted late, except under medical or other compassionate circumstances (see below). Submitting a late assignment without appropriate documentation will result in a zero (0) grade.
Accessibility

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 x 82147 for any specific question regarding an accommodation.

Absences/Missed Exams/Assignments: If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean’s office as soon as possible and contact your instructor immediately. It is the student’s responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean’s Office immediately. For further information please see: http://www.uwo.ca/univsec/handbook/appeals/medical.pdf

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean’s Office) for visits to Student Health Services. The form can be found here: https://studentservices.uwo.ca/secure/medical_document.pdf

Academic misconduct: Academic Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/handbook/appeals/scholoff.pdf
All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com). Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

Graduate Student Credit and Registration

This course will correspond to the University of Western Ontario PLANETSC 9606. Students from any university are eligible to take the course and may receive credit in their respective institutions, subject to approval from their home Department. Students enrolled at ONTARIO universities wishing to transfer credit for this course to their home institution must complete an Ontario Visiting Graduate Student form available here. For instructions on submission of this form, please contact Jen Heidenheim (cpsx@uwo.ca).