

## **GEM 405 – ADVANCED REMOTE SENSING TECHNIQUES FOR ENVIRONMENTAL APPLICATIONS**

### **COURSE DESCRIPTION**

Building on the fundamental remote sensing concepts, techniques, and environmental applications introduced in the GEM 403- Environmental Remote Sensing course, this course aims at broadening with advanced and current topics in processing and analysis of remote sensing images for environmental applications. This course focuses on the use of hyperspectral, LiDAR and RADAR data to study land, ocean, and atmospheric environmental processes. Specific topics include, but are not limited to, hyperspectral image classification and accuracy assessment, multi-sensor thermal data analysis, air-borne LiDAR data processing, atmospheric laser profiling, application of LiDAR data for environmental studies.

The course includes lectures and lab assignments. Students will have the opportunity to deepen their hand-on experience in digital image processing using various image analysis packages. A series of laboratory works is designed to lead students through the key steps in processing of satellite images to detect, extract and evaluate quantitative information about different objects on the Earth. This course introduces advanced remote sensing techniques that are increasingly used in environmental research and applications.

### **LEARNING OUTCOMES**

The course gives students an insight into advanced Remote Sensing applications, both in theory and in practice. Upon successful completion of the course, students should be able to:

- Better understand the remote sensing approach to monitoring and mapping the Earth;
- Discuss relevant current topics of hyperspectral, LiDAR, and RADAR images;
- Perform spatial data processing, modeling and visualization procedures with hyperspectral, LiDAR and RADAR aerial and satellite images;
- Explore advanced strategies for image analysis including classification of hyperspectral and LiDAR data;
- Discuss geospatial accuracy of the source data as well as assess accuracy of classification;;
- Understand and apply advanced image analysis techniques in selected environmental applications such as derivation of temperatures or snow cover, parameterization of digital elevation models, topographic classification, detecting and quantifying forest cover or similar.

### **COURSE RESOURCES**

**Text:** Jensen, J. R., 2007 Remote Sensing of the Environment, 2nd ed., Pearson, New York.

**Supplemental readings:** The e-guides and tutorials from ESRI digital Library and Documentation. Additional Internet recourses and PDF manuals will be recommended for particular modules during the course.

Students will be provided with a variety of study materials (PPT presentations), handouts (PDF) and supplemental materials in digital form. Supplemental materials will be available on the Blackboard and GIS Server.

**Online resources:** ESRI's Virtual Campus online courses (see course Schedule).

**ACCESS TO SOFTWARE**

Course software packages run on the School of the Environment’s GIS server. This means that students can access their coursework from any computer using a regular web browser and a high-speed internet connection (i.e. DSL or cable).

**PREREQUISITE**

This course is designed for students who completed GEM403 course. Proficiency with the Microsoft Windows operating system and ArcGIS is required. A high-speed internet connection is required.

**EVALUATION**

Students complete five assignments designed to provide practical experience with Remote Sensing and GIS software while simultaneously illustrating and reinforcing theoretical concepts. Each assignment includes exercises accompanied by questions that encourage students to think about the underlying principles that affect the tasks they are performing.

Quizzes will take place during the week six and twelve of the course, and will cover all of the material discussed in the course.

Courses from the ESRI virtual campus will be assigned as additional homework. Proof (PDF copies of the certificates) of completion of these courses will be required.

*Overall Assessment*

This course requires that students maintain an average of 70% or greater in the course work for continuation in the course. There is an expectation for a high level of quality in the work produced by the student. For evaluation purposes, work will be graded under the following criteria:

**Overall assessment**

This program requires that students maintain a grade of 70% (B-) or higher in the course work to continue in the program. A high level of quality is expected in the work produced by students.

**Distance Education Certificate Program Grade Scale**

Letter Grade Scale	Numerical Scale of Marks
A +	90-100%
A	85-89%
A -	80-84%
B+	77-79%
B	73-76%
B-	70-72%
FZ	0-69%

## Student Obligations

### Participation and Assignments

a) Participation is worth 35% of your overall mark and will be based on regular contributions to both, asynchronous discussions (discussion forums). Students are expected to participate "in class" every week with a minimum participation of twice weekly in the discussion forum.

The following grid will be used to evaluate the quantity and quality of your participation in the discussion forums.

Promptness and Initiative	Does not respond to most postings; rarely participates freely	Responds to most postings several days after initial discussion; limited initiative	Responds to most postings within a 24 hour period; requires occasional prompting to post	Consistently responds to postings in less than 24 hours; demonstrates good self-initiative
Delivery of Post	Utilizes poor spelling and grammar in most posts; posts appear "hasty"	Errors in spelling and grammar evidenced in several posts	Few grammatical or spelling errors are noted in posts	Consistently uses grammatically correct posts with rare misspellings
Relevance of Post	Posts topics which do not relate to the discussion content; makes short or irrelevant remarks	Occasionally posts off topic; most posts are short in length and offer no further insight into the topic	Frequently posts topics that are related to discussion content; prompts further discussion of topic	Consistently posts topics related to discussion topic; cites additional references related to topic
Expression Within the Post	Does not express opinions or ideas clearly; no connection to topic	Unclear connection to topic evidenced in minimal expression of opinions or ideas	Opinions and ideas are stated clearly with occasional lack of connection to topic	Expresses opinions and ideas in a clear and concise manner with obvious connection to topic
Contribution to the Learning Community	Does not make effort to participate in learning community as it develops; seems indifferent	Occasionally makes meaningful reflection on group's efforts; marginal effort to become involved with group	Frequently attempts to direct the discussion and to present relevant viewpoints for consideration by group; interacts freely	Aware of needs of community; frequently attempts to motivate the group discussion; presents creative approaches to topic

b) Students are also expected to meet deadlines for written assignments to ensure the proper pace of learning takes place. The assignments will have specific due dates. If you are unable to meet one of the deadlines (for a legitimate reason such as illness), you need to email the instructor before the deadline.

If you do NOT notify the instructor of late assignment in advance, your paper will still be accepted, but 25% of the final mark will be deducted from the shorter essays and 50% for the longer essay

**Forum Etiquette**

In discussion forums, remember to *think, discuss, and debate* from a multitude of perspectives. Both the instructor and the student will use language that is scholarly and professional.

Express yourself *clearly, accurately, and in an intellectual* rather than in a personal fashion. Discussion forums are designed for you to ask questions and gain further knowledge. Remember to reason intelligently with the instructor and other students. As the study of environmental management is a broad field and is continually evolving, please feel free to give your view or interpretation based on your own experiences.

Develop *awareness* of your own ethnocentrism and make conscious efforts to ameliorate it. Keep in mind that the course materials will come from a wide cross-section of fields of study and may use jargon that is not familiar to you. Seek to understand the subtleties of these new terms to gain a deeper understanding of the material being presented. Please ask about concepts or terms that you do not understand.

Remember, if you have a question, it is likely someone else has the same question. Also, be conscious of the language you use when you speak about race, ethnicity, and gender. And be careful to avoid any bigoted or exclusive language.

Students who express themselves *inappropriately* or attack others personally in the discussion forums will lose their points for participation, and possibly their privilege to continue. Most students are considerate and respectful of others, but every now and then, someone is abusive and it ruins the experience for everyone.

**SEMESTER SCHEDULE (PROPOSED)**

WEEK	LECTURE TOPICS	LAB/ASSIGN TOPICS	TEST
1	Principles of Hyperspectral Remote Sensing	Lab 1 Advanced image classification and accuracy assessment	
2	Hyperspectral RS Applications		
3	Thermal RS Principles and Applications	Lab 2 Temperature extraction from multi-source RS images	
4	<i>Reading week</i>		
5	Microwave RS Principles		
6	Microwave RS Applications	Lab 3 Working with multi-sensor RS data: snow and ice detection; daytime clouds mapping	Quiz 1

7	Airborne LiDAR Remote Sensing		
8	Applications of Airborne LiDAR	Lab 4 Working with airborne LiDAR data	
9	<i>Reading week</i>		
10	Principles of Atmospheric LiDAR Sensing		
11	Atmospheric LiDAR for environmental applications	Lab 5 Biomass estimation using LiDAR	
12	Remote Sensing and Global Climate Change		Quiz 2