Please complete this form and attach a copy of the syllabus for new courses. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. Complete the Coordinator Form on page 2, if changes in this course will affect other units.

Please indicate:  ____ NEW  ____ MODIFY  ____ DELETE

Local Unit: SCS  Graduate Council Approval Date:

Course Designation: EOS  Course Number: 758

Full Course Title: Quantitative Methods in Remote Sensing

Abbreviated Course Title (24 characters max.): Quantitative Remote Sensing

Credit hours: 3  Program of Record: ESS M.S. and CSI Ph.D.

Repeateable for Credit?  ___ D=Yes, not within same term  Up to hours
___ T=Yes, within the same term  Up to  hours  ___ N=Cannot be repeated for credit

Activity Code (please indicate):  ____ Lecture (LEC)  ____ Lab (LAB)  ____ Recitation (RCT)
___ Studio (STU)  ____ Internship (INT)  ____ Independent Study (IND)  ____ Seminar (SEM)

Catalog Credit Format  3: 3: 0  Course Level:  GF(500-600)  ____ GA(700+)  ____

Maximum Enrollment: 20  For NEW courses, first term to be offered: F04

Prerequisites: EOS 753 and GEOG 580 plus knowledge of a computer language, or permission of instructor

Catalog Description (35 words or less): An intermediate-advanced level course focusing on digital processing of Earth images, with significant coverage on the topics of hyperspectral images; mathematical and algorithmic foundations; analysis procedures; and computational implementations. Programming projects will be emphasized.

For MODIFIED or DELETED courses as appropriate:
Last term offered:  Previous Course Abbreviation:  Previous number:

Description of modification: Title, prerequisites, syllabus changed.

APPROVAL SIGNATURES:
Submitted by:  ________________________________ email: ________________
Department/Program:  ________________________________ Date: ________________
College Committee:  ________________________________ Date: ________________
Graduate Council Representative: ________________________________ Date: ________________
Approval from other units:

Please list those units outside of your own who may be affected by this new, modified, or deleted course. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

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Graduate Council approval: ___________________________________________ Date: __________

Graduate Council representative: __________________________________________ Date: __________

Provost Office representative: ______________________________ Date: __________
Course proposal to the Graduate Council
by
The School of Computational Sciences

1. COURSE NUMBER AND TITLE:

EOS 758 Quantitative Methods in Remote Sensing

Prerequisites: EOS 753 and GEOG 580 plus knowledge of a computer language, or permission of instructor

Catalog description: This course introduces students to the fundamental concepts underlying the digital processing of remote sensing imagery. Topics of the course will include radiometric and geometric corrections, image enhancement, transformation, segmentation, and classification. Feature extraction may also be included.

2. COURSE JUSTIFICATION:

Course objectives: This is an intermediate-advanced remote sensing course emphasizing digital processing of remote sensing imagery. Students will be introduced to various digital image processing techniques, their mathematical and computational foundations, and their applications to the Earth observing remote sensing data. Topics of the course will include radiometric and geometric corrections, image enhancement, transformation, segmentation, and classification. Image acquisition sensors, platforms and commonly used data formats, including binary, HDF, and geoTiff will also be introduced. Students are expected to develop their own tools (in self-written programs) to process and analyze Earth images. Hyperspectral image processing will also be emphasized.

Course necessity: In the School, we have several many courses addressing remote sensing topics, some are sensor specific, and some are application specific. However, we do not have a course addressing the technical aspects and mathematical foundations of processing images gathered from space and air-borne instruments, and focusing on the applications in Earth sciences and observing.

Course relationship to Exiting Programs: This course has been offered once as a section of CSI 759 Special Topics. It is not a required course for the Ph.D. in CSI in the Earth Observing track, but it will be an elective course for students in the Earth Observing track in Ph.D. in CSI or the MS ESS students. It will serve still not only in SCS, but also graduate students in the Electrical Engineering focusing on Signal Processing in IT&E and MS in Geography in CAS.

Course relationship to Other Existing Courses: There is no similar course in SCS. The Department of Electrical Engineering in IT&E offers courses in signal processing, which does not address specifically Earth images as in the proposed course. Also, it uses an engineering approach instead of an Earth science approach. The Geography Department in CAS offers GEOG 579 and GEOG 580, which treat similar topics at a lower level than the proposed course. In recognition of the relationship between these classes, GEOG 580 is included as a prerequisite for the proposed class.

3. APPROVAL HISTORY

4. SCHEDULING AND PROPOSED INSTRUCTORS

Semester of Initial Offering: Fall 2004.
**Proposed instructors:** Dr. Wenli Yang

**EOS:** 758

**Course title:** Quantitative Methods in Remote Sensing

**Course description:**

This is an intermediate-advanced remote sensing course emphasizing on digital processing of remote sensing imagery. Students will be introduced to various digital image processing techniques, algorithms, the mathematical and computational foundations of these procedures, and their applications to the earth observing remote sensing data. Topics of the course will include radiometric and geometric corrections, image enhancement, transformation, segmentation, and classification. Specifically, neural network approaches to image classification and their comparisons with traditional statistical approaches will be introduced. For each of these topics, focus will be on the algorithms and technical details on how these image processing capabilities are implemented (with one’s own program) so that after taking this class students will be able to actually implement their own image processing algorithms rather than just understand the fundamentals. The course is designed for 14-week semesters and consists of 12 lecture sessions and 2 student presentation sessions.

**Required text book:**

Remote sensing digital image analysis: an introduction, 3rd edition  
By John A. Richards and Xiuping Jia, Springer, 1999

**Reference books:**

Digital image processing, 2nd edition  
By Rafael C. Gonzalez and Richard E. Woods, Addison-Wesley, 2001

Introductory digital image processing: a remote sensing perspective, 2nd edition  
By John R. Jensen, Prentice-Hall, 1996

**Instructor:**

Dr. Wenli Yang  
Phone: 301-552-9360  
Email: yang@rattler.gsfc.nasa.gov  
9801 Greenbelt road, Suite 316  
Lanham, MD 20706

**Prerequisites:**

EOS 753 and GEOG 580 plus knowledge of a computer programming language, or permission of instructor.
Lecture outlines:

Lecture 1  Remote sensing data acquisition systems and data formats

This lecture will briefly review the history of the earth observing remote sensing systems, including platforms and sensors, with an emphasis on the recent sensor systems such as Landsat-7 ETM+ and EOS Terra/Aqua MODIS. The lecture will also introduce commonly used remote sensing data formats, such as binary, HDF, and geoTiff.

Lecture 2  Radiometric correction of remote sensing data

This lecture will talk about sources of distortions introduced into remote sensing data, including atmospheric effects, platform and instrumentation errors, and methods to identify and correct these distortions.

Lecture 3  Geometric correction of remote sensing data

This lecture will talk about sources of geometric distortions introduced into remote sensing data and methods to identify and correct these distortions. It will also cover image to image and image to map registrations.

Lecture 4  Enhancing Remotely Sensed Imagery

This lecture will focus on radiometric and geometric enhancement techniques for space-borne and air-borne images. The materials covered in this lecture will include contrast enhancement, image to image histogram matching, low and high pass filtering and general convolution filtering, edge detection and enhancement, and line detection and extraction.

Lecture 5  Remote Sensing Image Transformation – Part I

This lecture will discuss image spectral transformations such as band ratio, vegetation indices, the principal component transformation, and the Kauth-Thomas tasseled cap transformation.

Lecture 6  Remote Sensing Image Transformation – Part II

This lecture will discuss image spatial transformation, with an emphasis on the Fourier transformation, including convolution, sampling theory, properties of Fourier transformation, and the image filtering in frequency domain.

Lecture 7  Image Segmentation

This lecture will introduce autonomous segmentation of remote sensing imagery processes to identify geographic features. These processes include detection of discontinuities on Earth surface, edge linking as ground features, boundary detection of biophysical regions, region splitting and merging.

Lecture 8  Earth Surface Feature Selection

This lecture will discuss techniques of selecting feature space for multispectral imagery, including those based on Jeffries-Matusita distance, principal component transformation, and canonical analysis.

Lecture 9  Surface Feature Classification – Part I
This lecture will focus on image statistical classification. Topics will include maximum likelihood classification, minimum distance classification, parallelepiped classification, spectral clustering, etc.

Lecture 10 Surface Feature Classification – Part II

This lecture will discuss neural network classification algorithms such as Kohonen self-organizing maps, learning vector quantization, adaptive resonance theory, the back propagation algorithm, classification labeling techniques such as pixel unmixing, fusion of multisource classification results, and knowledge-based image analysis.

Lecture 11 Hyperspectral Image Processing I

The lecture will focus on the process of hyperspectral remote sensing imagery, including the characteristics, calibration, interpolation, classification, feature reduction and data compression of hyperspectral image data.

Lecture 12 Hyperspectral Image Processing II

The lecture will focus on the advanced techniques in processing hyperspectral remote sensing imagery. Topics include various spatial and spectral reduction algorithms, techniques in identifying targets (e.g., SAM, LSU, PU, and MTMF).

Assignments:

Students are required to complete two course projects. The projects will focus on digital image processing problems for the earth observing remote sensing data and will consist of experiment designs, algorithm implementations, and result analyses. A report will be written for each project and the report will include a statement of the problem, a brief review of the topic, an algorithm discussion, a result analysis, and a summary/conclusion. The report should be 10 to 15 double spaced pages (not including maps and computer programs). The project will be presented to the class.

Sample projects:

1. Comparison of different geometric correction algorithms.
2. Image to image or image to map registration.
3. Histogram match between images
4. Radiometric correction for a granule of real data.
5. Evaluation of image enhancement techniques (e.g., spatial vs. frequency domain).
6. Application of principal component analysis to time series imagery
7. Linear feature extraction using Hough transformation.
8. Feature selection and its application in hyperspectral imagery
10. Classification difference among multisource data and class fusion
11. Analysis of vegetation indices in mapping landcover types.
12. Change detection for the state of Maryland (Virginia, Eastern US, etc).

Grading:

A: 90-100
B: 80-90
C: 70-80
D: 60-70

Grades are based on the following:

Project paper 1: 40%
Project presentation 1: 10%
Project paper 2: 40%
Project presentation 2: 10%