FLORIDA ATLANTIC UNIVERSITY

Graduate Programs—PROGRAM CHANGE REQUEST

UGPC APPROVAL _____

UFS APPROVAL _____

CATALOG _____

DEPARTMENT: GEOSCIENCES

COLLEGE:SCIENCE

PROGRAM NAME: REMOTE SENSING CERTIFICATE

EFFECTIVE DATE
(PROVIDE TERM/YEAR)
JANUARY 2014

PLEASE EXPLAIN THE REQUESTED CHANGE(S) AND OFFER RATIONALE BELOW AND/OR ATTACHED:

WE NOW HAVE ENOUGH GRADUATE REMOTE SENSING COURSES THAT ARE OFFERED AT LEAST ONCE A YEAR THAT WE CAN PROPOSE A GRADUATE REMOTE SENSING CERTIFICATE. THIS WAS SUGGESTED TO US BY OUR FORMER GRADUATE STUDENTS WHO ARE NOW GIS PROFESSIONALS. WE CURRENTLY OFFER A GIS CERTIFICATE AT THE UNDERGRADUATE LEVEL THAT IS WELL KNOWN IN THE GIS COMMUNITY IN THE STATE.

Catalog Text:

The Department of Geosciences offers graduates a Graduate Certificate in Remote Sensing. Departmental majors or other students who complete the programs with a grade of "B" or better in each course are entitled to the Remote Sensing Certificate. Students should consult with the Director of GIS Center or the Graduate Advisor about registration for this program. Students may use these courses in the completion of a major.

Remote Sensing of the Environment	GIS 5038C	3
Digital Image Analysis	GIS 5033C	3
Hyperspectral Remote Sensing	GIS 6127 C	3
LiDAR Remote Sensing	GIS 6032 C	3
Notes: All courses are required		

Faculty contact, email and complete phone number:

croberts@fau.edu Charles Roberts 297-3254

Consult and list departments that might be affected by the change and attach comments.
No departments offer graduate remote sensing courses

Approved by:	*Date:*
Department Chair: _____	_____
College Curriculum Chair: _____	_____
College Dean: _____	_____
UGPC Chair: _____	_____
Graduate College Dean: _____	_____
UFS President: _____	_____
Provost: _____	_____

Email this form and syllabus to *UGPC@fau.edu* **one week before** the University Graduate Programs Committee meeting so that materials may be viewed on the UGPC website prior to the meeting.

GIS 5033C: Digital Image Analysis (3 credits)

Professor: Dr. Caiyun Zhang
E-mail: czhang3@fau.edu
Office Hours: SE 400 Thursday 2-5 PM
SE 400 Friday 2-5 PM
And by appointment
TA: Ms. Georgia H. De Stoppelaire
Email: gdestopp@fau.edu
Office Hours: SE 485 Tuesday 5-8 PM
SE 485 Thursday 5-8 PM
And by appointment

This on-line course was originally designed by Dr. Charles Roberts at FAU and improved by Dr. Caiyun Zhang and Ms. Georgia H. De Stoppelaire.

Prerequisite Courses:

Introduction to GIS Mapping (GIS 3015C)
Remote Sensing of Environment (GIS 4035C)

Course Organization:

This is the second course in a three course remote sensing sequence, based on the national model for remote sensing curriculum. It covers the basic principles of remote sensing technology applied to environmental and urban analysis, and includes a survey of remote sensing data sources. **THIS COURSE IS CONDUCTED FULLY ONLINE.**

Course Objectives:

Students will learn advanced theories and common applications for remote sensing of the earth, and they will go through a sequence of hands-on remote sensing procedures and projects with a variety of common remote sensing data sets. Preliminary exposure to digital image analysis procedures in Remote Sensing would have already prepared students for this second course, Digital Image Analysis.

Recommended Textbook:

Jensen, John, Digital Image Processing, Englewood Cliffs: Prentice-Hall, Latest edition.
Course Materials on Blackboard are located in Course Documents, including:

1. **Lecture Notes**: **THESE ARE THE BASIS FOR THE QUIZZES.** Study this, use the Power Points and the streaming videos as an aid, but study the lecture notes.

2. **Lecture Videos/Voice Over Power Point**: Links to streaming media that consist of the lectures given by Dr. Roberts and corresponding voice over power points for select lectures. In some cases the voice over power point is offered because no video lecture exists but normally the voice over power point acts as a supplement to video lecture. The voice over power point can be stepped through like a normal power point when watching video lecture. In addition, if parts of the video lecture are unclear (maybe less than optimal filming), the voice over power point will clear things up.

3. **Lab Tutorials and Lab Instructions**: This is the hands-on portion of the course. Course notes on blackboard. **The lecture notes rather than the Power Points or videos are the basis for the quizzes.** 60% of the course grade comes from successfully completing these labs in a timely manner.

Check each area every week.

Discussion Board on Blackboard: This is the interface medium for questions, discussions, and ancilliary information to complete labs, and helpful hints.

The lecture notes rather than the power points or videos are the basis for the quizzes.

FAU Geosciences Computer Resources

The Geosciences Lab is located at the FAU Boca Raton Campus in the Science and Engineering Building (SE) 483, and is available to students taking this course. Systems are available on a first come first serve basis when a scheduled class does not occupy the room. The Geoscience Lab is staffed with Graduate Teaching Assistants and instructors to assist students taking this course. Check the schedule posted outside the lab for lab hours. Each Wednesday from 6:00 PM to 7:00 PM, a GIS lab is held with GIS course instructors available to assist and meet with students.

For more information about the Geosciences Computer Lab, go to http://www.geosciences.fau.edu/ and click on the Computer Resources link.

Working from Home or Other Computer

Thousands of students have successfully used our online system for distance learning. However, should a student experience technical difficulties if remotely accessing the course from home or other locations outside the Geosciences Lab, it is up to each student to solve their own technical issues.

If students experience technical problems, information technology support can be found at the following resources:

FAU's Online Computing Support Center allows you to search the Knowledge Base for answers to common questions. Submit your own help ticket by clicking on "Submit a ticket". If the Blackboard server is not available at night or on the weekend, please contact the FAU Help Desk at 561-297-3999.

FAU's Geosciences Help Desk provides support for the Geosciences remote applications as well as the department's network drives (e.g., student G: drive). Submit your own help request via e-mail to GeoHelpDesk@fau.edu.

Students should contact the course instructor for assistance with course-related software questions.

1	**1**	**January 7**	**Introduction (Chapters 2, 3)** **Lecture Topics:** History of Digital Image Analysis Systems Digital Image Analysis System Considerations Unique to Remote Sensing Understanding Imagery as Digital Data
2	**2**	**January 14**	**Project Design and Image Preprocessing (Chapters 1, 6, and 7)** **Lecture Topics:** Designing a Remote Sensing Project Advantages and Disadvantages of Digital Data Digital Image Analysis Techniques Theory and Problems of Machine Interpretation vs. Human Interpretation Image Preprocessing Radiometric Corrections Radiometric Effects of the Atmosphere Geometric Corrections
3	**3**	**January 21**	**QUIZ 1 (Unit 1) and**

			Contrast Enhancement (Chapter 8) **Lecture Topics:** Linear Contrast Stretch Histogram Equalization Percentage Stretch Standard Deviation Stretch Piecewise Stretch
4	**4**	**January 28**	**Spatial Filtering (Chapter 8)** **Lecture Topics:** Moving Window Concept Low Frequency Filtering High Frequency Filtering Edge Detector
5	**5**	**February 4**	**Image Ratioing (Chapter 8)** **Lecture Topics:** 2 Band Ratioing Normalized Difference Indexing Ratioing Vegetation Indices AVHRR data Tasseled Cap Transformation
6	**6**	**February 11**	**QUIZ 2 (Units 2, 3, and 4) and Change Detection and Time Series Analysis (Chapter 12)** **Lecture Topics:** Image Differencing Image Ratioing Post classification Comparisons Comparisons of Preprocessed Imagery Change Vector Analysis Designing a Baseline study for past and future comparison
7	**7**	**February 18**	**Spatial Resolution Tools and** **Lecture Topics:** Image Display Image Subsetting Image Resampling

8	**8**	**February 25**	**Unsupervised Classification (Chapter 9)** **Lecture Topics:** Unsupervised Classification Cluster Analysis Histogram Peak Technique Isodata Clustering
9	**9**	**March 11**	**Supervised Classification 1: Parallel Piped Classification** **Lecture Topics:** Supervised Classification Training Field Selection Parallel Piped Classification
10	**10**	**March 18**	**Supervised Classification 2** **Lecture Topics:** Minimum Distance Classification Textural Classification
11	**11**	**March 25**	**QUIZ 3 (Units 5, 6, 7, 8, 9, and 10) and Supervised Classification 3** **Lecture Topics:** Maximum Likelihood Classifier Fuzzy Classification
12	**12**	**April 1**	**Principal Components Analysis**
13	**13**	**April 8**	**Image Retrieval: Feature Extraction using spatial frequency and image texture**
14	**14**	**April 15**	**Ground Truthing and Accuracy Assessment**
15		**April 25**	**QUIZ 4 (Units 11, 12, 13, and 14)**

Labs and Due Dates

The objective of the lab assignments is to expose students to wide-ranging, advanced concepts of digital image analysis of remotely sensed data. Students are expected to complete tutorial image processes and experiment with tools to learn techniques, procedures and data organization skills to manage and manipulate imagery and geospatial data as well as to discern patterns and spatial relationships through image enhancement, image classification and time series analysis. The importance of data standards, following complex instructions and independent trouble-shooting are reinforced and emphasized more greatly in the grading than the actual lab results. For more information, see section on Lab Grading.

Most labs will become available Mondays at 5 PM and will be closed on Mondays at 11:59 PM. Be sure to check the syllabus each week as some labs dates are scheduled to accommodate for larger assignments. Please make all efforts to complete and submit labs assignments via Blackboard Assignments by 11:59 PM on the due date. If this time is passed, Blackboard (Bb) will accept your assignment; however, it will be considered late and a late penalty will apply of a 10% reduction in grade per day.

Labs	**Date Available**	**Due date**
Lab 1	January 7	January 14
Lab 2	January 14	January 21
Lab 3	January 21	January 28
Lab 4	January 28	February 4
Lab 5	February 4	February 18
Lab 6	February 18	February 25
Lab 7	February 25	March 11
Lab 8	March 11	March 18
Lab 9	March 18	March 25
Lab 10	April 15	April 22

Lab Grading

Grading Criteria	Penalty for Noncompliance
Lab submitted on time via Blackboard Assignments. Labs are only accepted via Blackboard Assignments.	10% deduction of points for each day late. After ten days, the lab is worth zero points.
Location of original work files on G:drive. (G:\SemesterTempDrive).	"F" Grade if original work files are not saved to folder to support lab.
File path to original work files is listed in "Comments" field of Blackboard Lab Assignments submission of completed lab document.	10% deduction of points for omission or wrong path location.
Correct File Format.	10% deduction of points for wrong format.
Completion of actual digital analysis work as assigned in lab.	Varies with each lab assignment.
Individual work only.	All work must be your original work, not a copy of group or team project you did with someone else.

Grading:

Course grading is worth 100 points.
Late Submission Projects: -10% off per day late, including weekends, rigidly enforced.

Lab Participation and Projects:	**60 points (final project: 20, labs: 40)**
QUIZ 1:	**10 points**
QUIZ 2:	**10 points**
QUIZ 3:	**10 points**
QUIZ 4:	**10 points**

Quizzes are based on labs and lecture notes associated with units.

Graduate final project instruction will be distributed in the blackboard.

Grading Scale:

93-100	**A**
90-92	**A-**
87-89	**B+**
83-86	**B**
80-82	**B-**
77-79	**C+**
73-76	**C**
70-72	**C-**
67-69	**D+**
63-66	**D**
60-62	**D-**
less than 60	**F**

Incomplete Grades are awarded only under extreme circumstances at the discretion of the instructor. The University policy is that candidates for an Incomplete Grade must have extreme circumstances that hinder the completion of the course AND must be passing the course at the time of the occurrence of the extreme circumstance.

Students with Disabilities

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodations due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) located in Boca Raton,-SU133(561-297-3880), in Davie-MOD 1 (954-236-1222), in Jupiter SR117 (561-799-8585) or at the Treasure Coast- CO 128 (772-873-3305), and follow all OSD procedures.

Honor Code

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty, including cheating and plagiarism, is considered a serious breach of these ethical standards, because it interferes with the University mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the University community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see
http://www.fau.edu/regulations/chapter4/4.001 Honor Code.pdf

GEO 6032 C LiDAR Remote Sensing (3 credits)

Instructor: Dr. Caiyun Zhang

Office: SE 400

Phone: (561) 297-2648

Fax: (561) 297-2745

Email: czhang3@fau.edu

Webpage: http://home.fau.edu/czhang3/web/

Office hour: Monday, 10:00 AM– 12:00 PM (other times by appointment)

Class meeting: Boca Raton, SE 483, Wednesday, 6:30 – 9:20 PM

Teaching Assistant: None.

Prerequisite: None.

Bibliography (Reference Textbooks):

1) Popescu, S. C. 2012. *LiDAR: Remote Sensing of Terrestrial Environments.* 1st edition, CRC Press. ISBN 978-1420047639.
2) Shan, J., and C. Toth. 2008. *Topographic Laser Ranging and Scanning, Principles and Processing.* Boca Raton, FL. Taylor & Francis Group. ISBN 9781420051421. (Free Digital One)
3) Maune, D. F. 2007. *Digital Elevation Model Technologies and Applications: The DEM Users Manual.* 2nd edition. Bethesda, MD. American Society for Photogrammetry and Remote Sensing. ISBN 1-57083-082-7.
4) National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, 2008. *LiDAR 101: An Introduction LiDAR Technology, Data, and Applications.* Charleston, SC: NOAA Coastal Services Center. (Free Digital One)
5) Campbell, J.B. 2007. *Introduction to Remote Sensing.* 4th edition. The Guilford Press. ISBN 978-1606230749.

6) Congalton, R., and K. Green. 2009. *Assessing the Accuracy of Remotely Sensed Data.* 2nd edition. CRC Press. ISBN 978-1-4200-5512-2.
7) Jensen, J.R. 2007. *Remote Sensing of the Environment: An Earth Resource Perspective.* 2nd edition. Prentice Hall. ISBN 978-0131889507.
8) Wolf, P., and B. Dewitt. 2000. *Elements of Photogrammetry.* 3rd edition. Boston. McGraw-Hill. ISBN 0-07-292454-3.

Course Description:

This course will introduce principles of LiDAR, LiDAR sensors and platforms, LiDAR data view, processing, and analysis, and LiDAR applications. Students will master basic skills of LiDAR needed to leverage the commercial LiDAR sources and information products in a broad range of applications, including topographic mapping, vegetation characterization, and 3-D modeling of urban infrastructure. Students will learn several software packages (ArcGIS LAS Dataset; FUSION/LDV; PointVue LE; LAStools) for LiDAR data displaying, processing, and analyzing.

Course Objectives:

The course will introduce fundamental concepts of accuracy assessment and appropriate use of LiDAR derived data products. It helps students master basic skills needed to leverage these data sources and information products in the context of application domains, such as topographic mapping, forestry, urban and regional planning, transportation systems design, and emergency response.

Students who excel in this course are able to:

1) Understand the key principles of LiDAR system.
2) Describe the basic principles of georeferencing and processing of LiDAR data.
3) Describe quantitative and qualitative methods and industry standards for quality assurance and accuracy assessment of LiDAR-derived data products.
4) Assess the strengths and weaknesses of various LiDAR platforms and instruments for a broad range of application scenarios.
5) Apply acquired knowledge and critical thinking skills to solve a real-world problem with appropriate LiDAR data processing and analysis methods.
6) Operate LiDAR software packages

Course Organization:

This course is designed as a series of on class lectures followed by hands-on laboratory exercises. The lecture section will last 1-1.5 hours, and laboratory exercises will take the remaining of the allotted time.

Grading Policy:

The final grade in the course will come from the class attendance, laboratory exercises, midterm exam, and the research project. The total average grade for the laboratory exercises constitutes 50% of the final course grade. The class attendance, midterm exam and final project will count 10%, 20%, and 30%, respectively, towards the final course grade.

Course Component	**% of Final Grade**
Attendance	10%
Midterm Exam	20%
Lab Exercises	50%
Final Project	30%

Points	**Final Grade**
94 - 100	A
90 - 93	A-
87 - 89	B+
84 - 86	B
80 - 83	B-
77 - 79	C+
74 - 76	C
70 - 73	C-
67 - 69	D+
64 - 66	D
60 - 63	D-
59 or lower	F

Tentative Lectures, Labs, and Assessment: see Table 1.

Table 1 Scheduled lectures, labs, and assessment

Week	Date	Scheduled Lectures, Labs, and Assessment
1	*Aug. 22*	Overview of the courses, Syllabus Introduction to LiDAR Remote Sensing (Chapter 1) *Lab 01 Introduction to Blackboard (bonus lab)*
2	Aug. 29	LiDAR System Design and Platforms (Chapters 2-5)
3	*Sep.5*	Georeferencing, Calibration, and Preprocessing (Chapters 4 & 6) *Lab 02 LiDAR Data Download and Display (PointVue LE)*
4	Sep.12	Data Format, Accuracy, and Management (Chapters 5, 9 & 10) *Lab 03 Introduction to FUSION/LDV*
5	*Sep.19*	Filtering and DTM Generation (Chapter 11) *Lab 04 Data Filtering and DTM Generation in FUSION/LDV*
6	*Sep.26*	LiDAR Analysis in ArcGIS 10.1 (Training in ESRI) *Lab 05 LiDAR Analysis in ArcGIS 10.1.*
7	*Oct.3*	*Midterm*
8	Oct.10	LiDAR Application: Vegetation Analysis I (Chapter 12) *Lab 06 Tree Information Extraction in FUSION*
9	*Oct.17*	LiDAR Application: Vegetation Analysis II *Lab 07 Tree Information Extraction in FUSION*
10	*Oct.24*	LiDAR Application: Vegetation Analysis III (Chapter 13) Urban Forest Inventory Using Airborne LiDAR and Hyperspectral Imagery
11	*Oct.31*	LiDAR Application: Urban Feature Extraction (Chapters 14-18) *Lab 08 LiDAR Feature Extraction in ArcGIS* *Lab 09 Building Extraction in Point Cloud*
12	Nov.7	LiDAR Application: Bathymetry Lab 10 TBD
13	Nov.14	Doing final project, no lecture
14	Nov.21	SEDAAG Conference (No Class)
15	Nov.28	Doing final project, no lecture
16	Dec. 5	Final Project Presentation
Note: Schedule may be changed		

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GIS 5038C Remote Sensing of the Environment

Credit hours: 3

Course Prerequisites: None

Term: Spring 2013

Online Course (Distance Learning)

Professor: Dr. Charles Roberts
E-mail: croberts@fau.edu

Office Hours:

SE 308 M-F 3-4:30

TA: Aaron Evans
Email: aevans26@fau.edu

Office Hours:
SE 406/GIS Lab Tue 4-8
SE 406/GIS Lab Wed 4-8

Course Description: This is the first course in a three course remote sensing sequence, based on the national model for remote sensing curriculum. It covers the basic principles of remote sensing technology applied to environmental and urban analysis, and includes a survey of remote sensing data sources.

Course Objectives: Students will learn basic theories and common applications for remote sensing of the earth, and they will go through a sequence of hands-on remote sensing procedures and projects with a variety of common remote sensing data sets. Preliminary exposure to digital image analysis procedures will prepare students for the second course, Digital Image Analysis, held in the spring