Analytical and Digital Photogrammetric Engineering GSEN 5385
School of Engineering and Computing Sciences
Spring 2016

A. COURSE INFORMATION
Course number/section: GSEN-5385-001
Class meeting time: W 02:00-05:00
Class location: CBI 104
Course Website: Accessed via Blackboard (Bb): https://bb9.tamucc.edu/

B. INSTRUCTOR INFORMATION
Instructor: Dr. Michael J. Starek
Assistant Professor of Geospatial Engineering & GISc
School of Engineering and Computing Sciences
Director of MANTIS Geospatial Lab
Conrad Blucher Institute for Surveying and Science
Office location: CBI 113
Office hours: M. 2 to 4, T 2 to 4, W: 1 to 2 PM
Telephone: 361.825.3978
e-mail: michael.starek@tamucc.edu
Appointments: Office hours and scheduled by email or phone. And always feel free to stop by as the door is always open.

C. COURSE DESCRIPTION
Catalog description. A study of the mathematical and geometric models of modern photogrammetry. Covers principles of stereoscopic vision, collinearity, coplanarity, epipolar geometry, ground control densification and extension by analytical aerotriangulation. Explores automation in photogrammetric procedures - digital aerotriangulation, automated data capture, direct geo-referencing via integrated inertial/GNSS-aided navigation.

My description. This course is intended to be exploratory and adaptive as we progress from the foundational material of airborne photogrammetry to the forefront of 3D surveying and imaging techniques. The first half of the course will focus on the mathematical and conceptual foundations of airborne digital imaging systems for 2D and 3D measurement of the natural and built environment. From there, we will move into emergent 3D surveying and imaging techniques including UAV-based structure-from-motion photogrammetry, LiDAR systems and data processing, and technology on the rise such as SLAM mapping and structured light depth cameras of the Kinect fame.

D. PREREQUISITES AND COREQUISITES
Permission of the Program Coordinator. Some knowledge of calculus, linear (matrix) algebra, and statistics will be required for certain topics. Math can be refreshed along the
way, but if you have not taken coursework in these areas, please discuss with me first.

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES


Journal papers and additional readings will be provided to complement the material.

Software

There is no specific software for this course. We may, on occasion, use open-source software and there are a set of distributable computer programs that come with the textbook for teaching certain concepts. ArcGIS may be used for a few assignments, particularly for the LiDAR component, which is available to you as a student version. Basic programming knowledge in a language of your choice may be helpful on a few assignments.

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

By the end of this course, students should be able to:

1. Define and characterize basic principles of digital photogrammetric systems
2. Demonstrate the principles of interior and exterior orientation including the different methods utilized to spatially reference airborne imagery.
3. Recognize limitations and potential sources of error and distortion that impact the photogrammetric process and be able to apply methods to correct this distortion.
4. Perform single and stereo-pair image analysis for spatial measurement in 2D and 3D.
5. Apply structure-from-motion photogrammetry and explain its differences to traditional photogrammetry for 3D measurement.
6. Integrate, process, and apply LiDAR data for topographic mapping.
7. Describe a range of 3D imaging modalities and recognize trade-offs in performance and capabilities for surveying and geospatial applicability.

G. INSTRUCTIONAL METHODS AND ACTIVITIES
The course will be taught in a lecture, discussion, and case-study format. Weekly reading will be assigned. There will be up to ten assignments requiring the management and analysis of geospatial data. ArcGIS will serve as the main software utilized in these assignments; however, specific assignments may utilize other software tools for data processing and analysis (e.g. open-source). A midterm with short answer and essay formats will be given. A comprehensive final project will be assigned (see grading below).

**Online Students**

My lectures will be recorded live (audio only) along with my screen shots (e.g. power points) using Webex. Students taking the course online must have continuous web access and are expected to keep pace with the course as if they were an in-class student. You must adhere to all assignment deadlines, exam deadlines, etc.

### H. MAJOR COURSE REQUIREMENTS AND GRADING

Your final grade will be based on the following point distribution:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
</tr>
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<tbody>
<tr>
<td>Midterm Exam</td>
<td>27.5%</td>
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<tr>
<td>Final Project</td>
<td>27.5%</td>
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<tr>
<td>Assignments combined</td>
<td>45%</td>
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</tbody>
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### I. COURSE CONTENT/SCHEDULE

**TOPICAL OUTLINE** (adaptive and subject to change)

- Fundamentals of digital imaging systems, electromagnetic radiation, optical principles
- Airborne vertical photography,
- Image coordinate measurement and reduction
- Mathematical and geometric principles
- Theory and procedures of photogrammetric orientation/geo-referencing
- Digital image matching, orthophoto generation, digital surface model generation
- Structure from motion photogrammetry
- LiDAR mapping systems and data processing
- Emergent techniques for 3D imaging

**SCHEDULE** is adaptive and subject to change. Weekly readings will be posted to Bb.

<table>
<thead>
<tr>
<th>DATE (BY DAY OR WEEK)</th>
<th>TOPIC</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Course introduction</td>
</tr>
<tr>
<td>2</td>
<td>Principles of Photography and Digital Imaging</td>
</tr>
<tr>
<td>3</td>
<td>Airborne Digital Cameras and Calibration Assignment 1 Due</td>
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<tr>
<td>Assignment</td>
<td>Description</td>
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<tr>
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<tr>
<td>2</td>
<td>Image Measurements and Refinements Assignment 2 Due</td>
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<tr>
<td>3</td>
<td>Vertical and Tilted Photographs Assignment 3 Due</td>
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<tr>
<td>4</td>
<td>Analytical Photogrammetry and Collinearity Assignment 4 Due</td>
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<td>5</td>
<td>Topographic Mapping and Spatial Data Collection Assignment 5 Due</td>
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<td>6</td>
<td>Control for Aerial Photogrammetry and Aerotriangulation Assignment 6 Due</td>
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<tr>
<td>7</td>
<td>MIDTERM</td>
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<tr>
<td>8</td>
<td>Aerotriangulation and Bundle Adjustment</td>
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<td>9</td>
<td>Mosaicing and Digital Image Matching Assignment 7 Due</td>
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<td>10</td>
<td>Structure from Motion and Structured Light Imaging Assignment 8 Due</td>
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<td>11</td>
<td>Simultaneous Localization and Mapping (SLAM)</td>
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<td>12</td>
<td>Topographic LiDAR Mapping Systems</td>
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<td>13</td>
<td>LiDAR Filtering and Surface Modeling Assignment 9 Due</td>
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<td>14</td>
<td>Bathymetric and Full-waveform LiDAR Assignment 10 Due</td>
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<td>15</td>
<td>Final Project</td>
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Note: Changes in this course schedule may be necessary and will be announced to the class by the Instructor. The assignments and exams shown are directly related to the Student Learning Outcomes described in Section F.

J. **COURSE POLICIES**

Attendance/Tardiness
Regular attendance is expected. In-person students are expected to attend face-to-face lectures and distance students are normally not permitted to attend in-person lectures without prior approval first. Recorded lectures may be restricted to distance students at discretion of the instructor (e.g. in-person attendance is poor due to students watching online as opposed to attending class).

Assignments and Late Work Policy
You are expected to work individually on all assignments/exams unless otherwise stated. Assignment due dates will be specified for each assignment.

Effective as of 12:00 AM ET on the day following the assignment due date:
1 to 2 days late - Minus 3% per day past due
If you are not able to meet a particular deadline, you must notify me before the due date to request an extension. Reduced penalty extensions will be granted on a case-by-case basis and will likely be refused for repeat offenders.

**Cell Phone Use**
Absolutely no cell phone use during class, except for emergency situations.

**Missed Exam**
You are expected to take the exam when scheduled. Make-up exams will only be permitted under department approved circumstances.

**Exam Policy for Distance Students**
Exams may be given as take home or in-class (to be determined). The course may require the use of exam-proctoring involving third party charges. Exam-proctoring charges may range from $1 - $50.00 per exam. Students may be required to schedule exams at least 24 hours in advance or incur late scheduling charges. All costs for exams are the responsibility of the student. Students may also be responsible for providing webcams to be used in test proctoring. Online students will be notified of the procedure.

In-person students must take the exam in-class and distance students cannot take the exam in-person during class without instructor approval.

**My Decree**
If you are having a problem finishing an assignment or other concerns, please talk to me. My goal is to help you succeed in the course and if you put in the effort, you will.

**K. COLLEGE AND UNIVERSITY POLICIES**

- **Academic Integrity (University)**
  It is expected that university students will demonstrate a high level of maturity, self-direction, and ability to manage their own affairs. Students are viewed as individuals who possess the qualities of worth, dignity, and the capacity for self-direction in personal behavior.
  See Full University Policy at http://catalog.tamucc.edu/content.php?catoid=10&navoid=313#Academic_Integrity

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the
ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

• **Deadline for Dropping a Course with a Grade of W (University)**
  I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. Please consult with me before you decide to drop to be sure it is the best thing to do. The grade of W will be assigned to any student officially dropping a course by Friday, April 8, 2016. No student is eligible to receive a W without completing the official drop process by this deadline. Visit the Office of the University Registrar for the Course Drop Form that must submitted. After April 18, 2016 a student will not be allowed to drop a course.

• **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage at [http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

• **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.
GENERAL DISCLAIMER
I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.