GSEN 6371 – Geopositioning Systems and Autonomous Navigation
Department of Computing Sciences
Fall 2019

A. COURSE INFORMATION

Course number/section: GSEN-6371.001/W01
Class meeting time: M/W 3:30 – 4:45 PM
Class location: Blucher 104
Course Website: Accessed via Blackboard (Bb): https://bb9.tamucc.edu/

B. INSTRUCTOR INFORMATION

Instructor: Dr. Tianxing Chu
Assistant Professor of Geospatial Systems Engineering & GISc
School of Engineering and Computing Sciences
Conrad Blucher Institute for Surveying and Science
Office location: NRC 3406
Office hours: M/W 11:00 AM – 12:30 PM, F 2:00 PM – 4:00 PM
Telephone: 361-825-2685
e-mail: tianxing.chu@tamucc.edu
Appointments: Schedule by email (preferred), phone, or stop by my office.

C. COURSE DESCRIPTION

Catalog Course Description
The course addresses the foundations and computational techniques of Global Navigation Satellite Systems (GNSS) and inertial measurement units (IMUs) for autonomous navigation applications. Specifically, the course will cover concepts and principles of GNSS signal structures and the derivation of observables; error sources and corrections; point, differential, and kinetic positioning techniques; IMU linear and angular dynamics modeling; mechanization of inertial navigation and error propagation; global/local coordinate frames and conversion; and filtering techniques for GNSS/IMU integration. The course also covers current and future capabilities of emerging geopositioning systems as they relate to autonomous navigation and mobile devices.

D. PREREQUISITES AND COREQUISITES

Prerequisites
No prerequisites for this course. However, students are expected to have a basic understanding of the material covered in the courses: PHYS 2425 - University Physics I, MATH 3342 - Applied Probability and Statistics, and MATH 3311 - Linear Algebra. If you have not taken equivalent courses or are not familiar with these Math and Physics basics, you may be required to review some of the them on you own to make up for requisite knowledge. If concerned, please come and discuss with me first.
Corequisites
None.

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)

Optional Textbook(s) or Other References


Supplies
This course requires programming for processing positioning measurement data. Students will have the ability to obtain a licensed version of MATLAB for use and it is available in CI 229 GIS lab. Other software may be used and instructions for access/use will be provided during lectures.

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. Understand evolution, applications and fundamental GNSS concepts (this course primarily introduces GPS as a representative of GNSS family).
2. Understand GPS satellite orbit and calculate positions/velocities.
3. Calculate receiver’s position using GPS pseudorange measurements.
5. Obtain a background in current trends for practical applications of inertial navigation system (INS).
6. Understand the basics of performing INS computations and INS limitations.
7. Identify appropriate strategies for integrating INS with GPS.

Identify emerging technologies for indoor positioning using sensors in smart devices.
G. **INSTRUCTIONAL METHODS AND ACTIVITIES**

Approach: lecture, discussion, presentation and practice exercises. Bi-weekly reading tasks will be assigned. There will be assignments and reports requiring the use of pertinent software or problem solving.

In class problem sets may occasionally be given to gauge student progress and spur discussion. Graded quizzes may occasionally be given in class or assigned as a take home problem set. Guest instructor may be invited occasionally to give us talks on their primary areas of expertise.

H. **MAJOR COURSE REQUIREMENTS AND GRADING**

A student’s final grade will be based on the following point distribution:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Final Project</td>
<td>20%</td>
</tr>
<tr>
<td>Assignment</td>
<td>40%</td>
</tr>
<tr>
<td>Presentation</td>
<td>10%</td>
</tr>
<tr>
<td>Quiz and/or Attendance</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Grade Scale:** A (90-100%) B (80-89%) C (70-79%) D (60-69%) F (<60%).

I. **COURSE CONTENT/SCHEDULE**

SCHEDULE is tentative and subject to change. The official schedule will be on Blackboard with the required weekly readings posted.

<table>
<thead>
<tr>
<th>DATE (BY DAY OR WEEK)</th>
<th>TOPIC</th>
<th>CHAPTER(S)</th>
<th>ASSIGNMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course overview and fundamentals of GNSS</td>
<td>Ch 1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GPS Segments and classifications of positioning solutions</td>
<td>Ch 2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Coordinate and time systems</td>
<td>Ch 4 and Ch 5</td>
<td>Assignment 1</td>
</tr>
<tr>
<td>4</td>
<td>Satellite orbital motions</td>
<td>Ch 6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>GPS signals and observables</td>
<td>Ch 6</td>
<td>Assignment 2</td>
</tr>
<tr>
<td>6</td>
<td>Error sources in GPS and compensation</td>
<td>Ch 7</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mathematical model of point positioning</td>
<td>Ch 8</td>
<td></td>
</tr>
</tbody>
</table>
Differential GPS workflows and RTK Surveying

See Bb Schedule

Review

Ch 8

Assignment 3

Midterm exam

Ch 9

Fundamentals of IMU

Ch 10

Assignment 4

IMU navigation computation and error modeling

Ch 11

Inertial navigation systems

Ch 12

Assignment 5

INS/GPS integration

Ch 13

Emerging technologies for indoor positioning

See Bb Schedule

Presentation

Exam Week

See Bb Schedule

Final Project

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

Attendance is **required** since the student will be responsible for all materials that are covered in class. It is counted for your participation grade. If you miss a class due to unavoidable circumstances, you should copy class notes from another student in the class and review recorded lecture. Attendance is mandatory for exams, final project, and presentations. Repeated tardiness will not be tolerated. 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. Online student attendance will be gauged based on regular Blackboard access.

Late Work and Make-up Exams

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 3 days late - Minus 3 pts or 3% of max score per day past due
- 4 to 6 days - Minus 4 pts or 4% of max score per day past due
- 1 week late – Minus 30 pts or 30 % of max score plus minus 5 pts each day after
- After assignment is graded and returned = 0 (typically 1 week!)

Example: Max score on an assignment is 100 and you are 5 days late, then max grade you can get is 80.
If you are not able to meet a particular deadline, you must notify me well before the due date to request an extension. Reduced penalty extensions will be granted on a case-by-case basis and will be refused for repeat offenders. Once an assignment is graded and returned to class you receive a 0.

**Extra Credit**
May be given on occasion and will be announced in class or added as bonus point question/s on an exam or assignment.

**Cell Phone Use**
Cell phones must be on silent mode or turned off and are not allowed to be utilized during class.

**Laptop Use**
Laptops can only be used for looking at lecture notes/materials; cannot be used to search web or work on other things not class or lecture related.

**Food in Class**
Not permitted.

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

**Participation**
Participation is expected. Refer to participation grading criteria under Section H above.

**Exam Policy for Distance Students**
Exams will be given in-class. Therefore, distance students must take the same exam on that same day. Online students will be notified of the procedure at least one week in advance. Implementation will either be through Blackboard or exam proctoring service. 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.

**Others**
All work submitted for grading must be the student's own work. Plagiarism will result in a score of 0 (zero) for the work or dismissal from the course and the Dean of Students office will be notified. No copying from another student's work or past work of any type is allowed. It is the student's duty to allow no one to copy his or her work. Anyone found cheating and/or copying, in the exams or assignments, in the instructor's opinion, may receive an automatic F for the course.

If you are having a problem finishing an assignment or other concerns, please talk to me.
K. COLLEGE AND UNIVERSITY POLICIES

- **Academic Integrity (University)**
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **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.

- **Statement of Civility**
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **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 your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.** Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Please consult the Academic Calendar ([http://www.tamucc.edu/academics/calendar/](http://www.tamucc.edu/academics/calendar/)) for the last day 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, and the College of Science and Engineering Grade Appeals webpage at 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.

  [http://disabilityservices.tamucc.edu/](http://disabilityservices.tamucc.edu/)

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

L. **OTHER INFORMATION**

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set
up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

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.