YORK UNIVERSITY
FACULTY OF SCIENCE AND ENGINEERING
Department of Earth and Space Science and Engineering

ADVANCED SATELLITE POSITIONING
GS/ESS 5410 3.0
Winter 2009

Instructors

Dr. Jian-Guo Wang
E-mail: jgwang@yorku.ca
Phone: 416-736-2100 ext. 20761
Fax: 416-650-8135
Office: Computer Science and Engineering Building, Room 1012T

Dr. Sunil Bisnath
E-mail: sbisnath@yorku.ca
Phone: 416-736-2100 ext. 20556
Fax: 416-736-5817
Office: Petrie Science and Engineering Building, Room 129

Time and Location

Lectures: Wednesday 14.30-17.30 RN836

Prerequisites

Permission of instructors.

Course Description

Organization

Since every individual responds to different stimuli in his / her learning process, the presentation of material will be done in a variety of ways. All methods will require work on your part to be effective. We will take a participative approach to learning, which means that we will learn **with** each other and **from** each other. **Therefore, we are all responsible for being prepared for class:**

- **Participation** is an essential element of learning. It will be **encouraged** and **assessed**.
- Examples will be given, where applicable, to understand the concepts.
- General project-specific questions will be discussed during the lecture.

Project

- The end goal of the project is for each group of students to develop a GPS data processing program to produce post-processed RTK-quality receiver positions from given input observation and navigation files.
- Intermediate goals involve developing the processing modules to achieve the end goal.

Feedback on Progress
Feedback on your progress will be provided in various ways:

- Each lecture should give you a fair idea of how well you have understood the material. This is the most important and timely form of feedback.
- The project, the form of components, will help you apply material presented in lectures.

Announcements
Announcements and information related to the course, such as special lectures, class cancellations, change of due dates, etc. will be disseminated during lecture hours or via e-mail.

Learning Objectives

Purpose
The primary purpose of this course is provide students with an in depth understanding of GPS data processing, including pertinent theory, methodologies and algorithms. The secondary purpose is to advance the student's positioning and navigation software development skills.

Specific Objectives

- Understanding of input RINEX (observation and navigation) files, and the reading of such files.
- Understanding of point positioning and developing a point position navigation solution. Also reviewing of Precise Point Positioning.
- Understanding of filtering (and smoothing), specifically sequential least-square filtering and Kalman filtering.
- Understanding of linear combinations of observables and their usefulness.
- Understanding of the Real-Time Kinematic (RTK) float ambiguity solution, and developing an RTK float solution processor.
- Understanding of the Real-Time Kinematic (RTK) fixed ambiguity solution using the LAMDBA method, and developing an RTK fixed solution processor.
- Developing a basic understanding of Network RTK, and inertial systems.

Suggested References

1. Brown, R.G. and P.Y.C. Hwang (1997). *Introduction to random signals and applied Kalman filtering: with MATLAB exercises and solutions.* Wiley, New York, 484 p.
2. Farrell, J (2008). *Aided Navigation – GPS with high Rate Sensors*, McGraw-Hill, New York, 530 p.
3. Farrell, J and B. Matthew (2007). *The Global Positioning System and inertial navigation*. 2nd edition, McGraw-Hill, New York, 340 p.
4. Gelb, A. (1974). Applied optimal estimation. M.I.T. Press, Cambridge, Mass., 374 p.
5. Hofmann-Wellenhof, B., H. Lichtenegger and J. Collins (2001). *Global Positioning System, theory and practice*, 5th Edition, Springer-Verlag, Wien, 382 p.
6. Leick, A (2004). *GPS satellite surveying*. John Wiley, Hoboken, N.J., 435 p.
7. Strang, G. and K. Borre (1997). *Linear algebra, geodesy, and GPS*. Wellesley-Cambridge Press, Wellesley, Mass., 624 p.
8. Teunissen, P.J.G. and A. Kleusberg (1998). *GPS for geodesy*. Springer, Berlin, 650 p.
9. U.S. DOD (2001). *GPS Interface Control Document (ICD-GPS-200C)*, U.S. Department of Defense, 134 p.
10. Xu, Guochang (2003). *GPS: theory, algorithms and applications.* Springer, Berlin, 315 p.

Evaluation

Project (6 components)	65%
Final Exam	30%
Class participation	5%

Grading, Assignment Submission, Lateness Penalties and Missed Tests

Grading

During the term, marks will be given in percent. Final marks from weighted averages will be converted to letter grades according to University regulations:

Percentage	Grade	Description
≥90%	A+	Exceptional
85-89%	A	Excellent
80-84%	A-	High
75-79%	B+	High Satisfactory
70-74%	B	Satisfactory
60-69%	C	Conditional
< 60%	F	Failure

Assignment Submission

Proper academic performance depends on students doing their work not only well, but on time. Accordingly, assignments for this course must be received on the due date specified for the assignment. Assignments are to be handed in at the beginning of the laboratory period they are due.

Lateness Penalty

Assignments received later than the due date will be penalized **10% per day** that assignment is late. Late assignments must be submitted in person. Exceptions to the lateness penalty for valid reasons such as illness, compassionate ground, etc., may be considered by Instructor(s), but will require supporting documentation (e.g., a doctor's letter).

Missed Tests

Students with a documented reason for missing a course test, such as illness, compassionate grounds, etc., which is confirmed by supporting documentation may request accommodation from Instructor. Further extension or accommodation will require students to submit a formal petition to the Faculty.

Tentative Class Schedule

Week of	Subjects
March 11	Introduction. Data readers – RINEX (observation and navigation messages).
March 18	Data readers (continued). Data formats.
March 25	Point positioning. Error modelling.
April 81	Error modelling. Precise Point Positioning.
April 08	Estimation. Least-squares. Kalman filtering.
April 15	Observable linear combinations. Noise analysis.
April 22	Differential positioning. Relative positioning.
April 29	Real-Time Kinematic (RTK) float solution.
May 06	Ambiguity resolution.
May 13	Real-Time Kinematic (RTK) fixed solution.
May 20	Network RTK. Inertial navigation systems (INS).

Project Tentative Schedule

Week of	Subject
March 11	Project - part #1: Data readers.
March 25	**Part #1 due.** Project - part #2: Point positioning.
April 08	**Part #2 due.** Project - part #3: Filtering.
April 15	**Part #3 due.** Project - part #4: Linear combinations.
April 22	**Part #4 due.** Project - part #5: RTK float solution.
May 06	**Part #5 due.** Project - part #6: RTK fixed solution.
May 20	***Final project report due and presentations.***

Important Course Information for Students

All students are expected to familiarize themselves with the following information, available on the York University Secretariat Policies, Procedures and Regulations webpage: http://www.yorku.ca/secretariat/policies.

- York's Academic Honesty Policy and Procedures / Academic Integrity Website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation