

Course Directors

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Lectures

Thursdays, 12:00 - 15:00

Lumbers Building, Room 306

Prerequisites

Permission of the Course Directors

Assessment

Project 50%

Class participation 10%

Final examination 40%

Grade System

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

GENERAL COURSE INFORMATION

The primary purpose of this course is to understand advanced concepts of Global Navigation Satellite Systems (GNSSs), with particular focus on the Global Positioning System (GPS).

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.

Feedback on Progress

Feedback on your progress will be provided in two different ways:

- Each class session should give you a fair idea how well you have understood the material. This is the MOST important and timely form of feedback.
- For the project, you will be asked to solve specific computational problems, design and create computer code, use software, write reports, and give presentations. This work will help you assimilate and consolidate 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 made during lectures and via e-mail.

LEARNING OBJECTIVES

Purpose

The primary purpose of this course is to provide students with an in depth understanding of GNSS 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

1. Understanding of point positioning and developing a point position navigation solution.
2. Understanding of input observation and navigation file formats, e.g., RINEX, and the reading of such files.
3. Understanding of GNSS errors and relevant error modelling.
4. Understanding of filtering (and smoothing), specifically sequential least-square filtering and Kalman filtering.
5. Understanding of linear combinations of observables, their noise analysis, and usefulness.
6. Understanding of relative positioning, the Real-Time Kinematic (RTK) float ambiguity solution, and developing an RTK float solution processor.
7. Understanding of the Real-Time Kinematic (RTK) fixed ambiguity solution, the LAMDBA ambiguity fixing method, and developing an RTK fixed solution processor.
8. Understanding of Network RTK and Precise Point Positioning (PPP).
9. Developing a basic understanding of inertial systems and inertial / GNSS integrated navigation.

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.

TENTATIVE CLASS SCHEDULE

DATE	SUBJECT
January	
07	Introduction – course outline and requirements (J. Wang, S. Bisnath)
14	Point positioning (S. Bisnath)
21	Observation and navigation file formats (J. Wang)
28	Errors and error modelling (S. Bisnath)
February	
04	Estimation. Least-squares. Kalman filtering (J. Wang)
11	Linear combinations (S. Bisnath)
18	No lecture – Reading Week
25	Relative positioning. RTK float solution (J. Wang)
March	
03	Ambiguity resolution. RTK fixed solution (S. Bisnath)
10	Network RTK. PPP (S. Bisnath)
17	Inertial navigation systems. Integrated navigation (J. Wang)
24	Course review. Project review (J. Wang, S. Bisnath)
31	Project presentations

ACADEMIC INTEGRITY AT YORK UNIVERSITY

From York University Secretariat¹:

Having **Academic integrity** means that you have adopted appropriate principles or standards that consistently govern how you pursue your school work. A student with academic integrity earns a degree with honest effort, and knows that this degree is a true accomplishment reflecting years of hard work and genuine learning. Furthermore, practicing academic integrity means that you will develop essential lifelong skills that include conducting research responsibly, writing clearly and documenting appropriately.

You must familiarise yourself with [York's Senate Policy on Academic Honesty](#)². This policy defines and clarifies York's commitment to maintaining the highest standards of academic honesty. The policy:

- Recognizes the general responsibility of all faculty members to foster acceptable standards of academic conduct and of students to be mindful of and abide by such standards
- Defines what are considered academic offenses, including plagiarism, cheating, impersonation, and other forms of academic misconduct
- Defines the penalties that can be given to students found to have committed plagiarism or any other form of academic offence
- Outlines the procedures for dealing with students who are accused of committing an academic offence

While it is recognized that there are many pressures on students that may lead to academic misconduct, such as achieving high grades or meeting deadlines, each student has clear responsibility for his or her academic honesty.

You are strongly advised to visit the [Academic Integrity](#) web site for York University³, to read the section "[For Students](#)"⁴, and to complete the [Academic Integrity Tutorial](#)⁵.

There will be zero tolerance for proven academic dishonesty.

¹ <http://www.yorku.ca/acadinte/files/beware-sayswho.pdf>

² <http://www.yorku.ca/secretariat/policies/document.php?document=69>

³ <http://www.yorku.ca/academicintegrity>

⁴ <http://www.yorku.ca/academicintegrity/students/index.htm>

⁵ http://www.yorku.ca/tutorial/academic_integrity

ASSIGNMENT SUBMISSION, LATENESS PENALTIES AND MISSED TESTS

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, 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.