



THE UNIVERSITY OF  
NEW SOUTH WALES  
SYDNEY · 2052 · AUSTRALIA

SCHOOL OF SURVEYING & SPATIAL INFORMATION SYSTEMS

## GMAT9202

# Satellite Navigation: Receivers and Systems

**Course Outline – Session 2, 2008**

Version: 4/7/2007

*This document, and other material, is available at the Course Website:  
<http://www.gmat.unsw.edu.au/agd/gmat9202/>*

(User name and password supplied in class)

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## 1. Staff involved in the Course and their Contact Details

### 1.1 Lecturer(s):

A/Prof Andrew Dempster

Office: EE425 (Whenever present, you may just drop in)  
Email: a.dempster@unsw.edu.au Phone: 9385 6890

Dr Yong Li

Office: EE409  
Email: yong.li@unsw.edu.au Phone: 9385 4173

Mr Peter Mumford

Office: EE413C  
Email: p.mumford@unsw.edu.au Phone: 9385 4189

Mr Nonie Politi

Office: EE404  
Email: nonie@unsw.edu.au Phone: 9385 4526

### 1.2 Laboratory Assistants:

Asghar Tabatabaei  
Office: EE413  
Email: asghart@student.unsw.edu.au Phone: 9385 4206

### 1.3 Staff absences during session:

A/Prof Dempster will be off campus from 24-28 September. During that time he can be contacted by email at the above email address. Also, on campus assistance with this course can be obtained from Asghar Tabatabaei during the period A/Prof Dempster is away.

## 2. Educational Aspects of the Course

### 2.1 How this course relates to others in the program

The course is an option in SSIS and EE programs:

8501 MEngSc Electrical Engineering  
8503 MEngSc Telecommunications

The course applies techniques learned in other areas of telecommunications, and applies them to the special case of a satellite navigation receiver, which can be considered as passive telecoms device. A diverse range of techniques related to providing a position are covered. Even if treated as a “black box”, GPS is a technology that is increasingly important in telecoms, providing not only position (used to provide location-based services), but timing information to cellular networks.

8651 MEngSc Surveying and Spatial Information Systems  
8652 MEngSc Spatial Information Systems

Whereas most spatial information specialists require GNSS simply to provide a position, this course enables the student to see how that position is extracted from the signals transmitted from the satellites. Understanding how the signal and receiver combine to produce position measurements allows the student to better comprehend the source of many of the system's

fundamental shortcomings, such as multipath.

## 2.2 Aim of the Course

The aim of the course is to provide an introduction to many of the specialised areas within the GNSS discipline. It does not delve deeply into the operation of a receiver (see GMAT9201), but does look at some receiver functions that have been modified to work under special conditions, such as assisted GPS.

## 2.3 Learning Outcomes

By the end of this session you should be able to

- configure an assisted GPS system,
- make an educated selection of GNSS receiver from those receiving GPS, Glonass, WAAS, Galileo, QZSS signals on the L1, L2, L5, E5 and E6 frequencies.
- write a simple positioning Kalman filter.

## 2.4 Teaching Strategies

The teaching of the course is in lectures that are stand-alone and cover one specific topic. The lectures are ordered such that there is a general introduction to GPS, then discussion of topics that arise from simple GPS and other systems. Matlab laboratories are designed that can be readily manipulated by the student. This gives immediate visual feedback as to how the design changes have affected results.

## 2.5 Suggested Learning Methods

The core material for the course is the set of lecture notes. All that is required for the course is contained within them. The lectures have been derived from several sources, the most important of which is the Kaplan textbook. If the student was to buy one textbook, this one is recommended. As with almost any software-based learning experience, there is no substitute for writing and running code. The more familiar the student is with Matlab, the more likely that person is to understand and be able to use the theoretical ideas presented in lectures.

## 2.6 UNSW Graduate Attributes

This course provides an environment that fosters in our students the following attributes is listed:

the skills involved in scholarly enquiry	Significant
an in-depth engagement with relevant disciplinary knowledge in its interdisciplinary context	Significant
the capacity for analytical and critical thinking and for creative problem solving	Significant
the ability to engage in independent and reflective learning	Significant
the skills to locate, evaluate and use relevant information (Information Literacy)	Some
the capacity for enterprise, initiative and creativity	Minimal
an appreciation of and respect for, diversity	
a capacity to contribute to, and work within, the international community	
the skills required for collaborative and multidisciplinary work	
an appreciation of, and a responsiveness to, change	
a respect for ethical practice and social responsibility	

### 3. Proposed Course Schedule

Wk No.	Wednesday 1-2pm Lecture a Goldstein G01	Wednesday 2-3pm Lecture b Goldstein G01	Wednesday 3-4pm Lecture c Goldstein G01	Wednesday 4-5pm Lab Period EE401A
1 30/7	Course Introduction	Introduction to GPS	Matlab Tutorial 1 Introduction	Matlab tutorial exercises
2 6/8	GPS L1 Signal Specification	<i>GPS Rx Demo</i>	Matlab Tutorial 2 Graphics	Matlab tutorial exercises
3 13/8	GPS L1 Navigation Message	Positioning	Matlab Tutorial 3/4 Programming	Matlab tutorial exercises
4 20/8	Positioning Errors	Quiz 1	Correlators	Assignment work
5 27/8	RAIM	Augmentation Systems	GPS L2C Signal <i>Assignment Tutorial</i>	Assignment work
6 3/9	GPS L5 Signal	Quiz 2	GPS CNAV message (L5/L2C)	Assignment work <i>Assignment 1 due</i>
7 10/9	Weak Signal GPS	<i>Skyplot Demo</i>	Assisted GPS (A-GPS)	Assignment work
8 17/9	FPGA-based Receivers	Quiz 3	Pseudolites <i>Assignment Tutorial</i>	Assignment work
9 24/9	Software Radio	Interference	Galileo Introduction	Assignment work <i>Assignment 2 due</i>
	<i>Mid-session</i>	<i>break</i>		
10 8/10	Galileo Signals	Quiz 4	Galileo Receivers <i>Assignment Tutorial</i>	Assignment work
11 15/10	<i>Assignment 3 Presentations</i>	<i>Assignment 3 Presentations</i>	<i>Assignment 3 Presentations</i>	Assignment work
12 22/10	Glionass/ Beidou/ QZSS	Future of GNSS	Course Review	Assignment work <i>Assignment 3 due</i>

## 4. Assessment in the Course

Assessment for the course includes:

• Assignment 1	15%	Due week 6
• Assignment 2	20%	Due week 9
• Assignment 3	25%	Due week 12
• In-class quizzes	10%	Several weeks during session
• Final Quiz	30%	In exam period

### **Laboratories:**

The laboratory exercises included in the assignments will be Matlab-based and will require running the software receiver and producing results, making various modifications to the Matlab code. The report for each laboratory is required to have relevant theoretical background material, from lectures or textbooks, as well as reporting the actions taken and results produced.

## 5. Course Resources

### 5.1 Lecture Material (check the course website):

The Powerpoint lecture slides are available for download as PDF files at the course website:

<http://www.gmat.unsw.edu.au/agd/gmat9202/>

The lecture material will be **supplemented** by:

### 5.2 Text and Reference Books

- Elliott D Kaplan and Christopher Hegarty, "Understanding GPS: Principles and Applications", Artech House, 2<sup>nd</sup> ed., 2006
- James Bao-Yen Tsui, "Fundamentals of Global Positioning System Receivers: A Software Approach", 2<sup>nd</sup> ed., Wiley, 2005
- Borre, K., Akos, D.M., Bertelsen, N., Rinder, P., Jensen, S.H. , "A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach", 2007, ISBN: 978-0-8176-4390-4, Birkhäuser
- B W Parkinson and J J Spilker Jr., "Global Positioning System: Theory and Applications", vols I & II, American Inst Aeronautics & Astronautics, 1996
- Pratap Misra and Per Enge, "Global Positioning System: Signals, Measurements, and Performance", Ganga-Jamuna Press, 2001

### 5.3 Computational Aids

Pocket calculators may be useful during lecturing hours, for tutorials and laboratories in this course. They must be hand-held, internally powered and silent.

Computer software relevant to this course and available in the School's computer lab EE401, includes:

Matlab and several toolboxes

## 6. Administrative Matters

### 6.1 Expected work load

*At UNSW, the normal workload expectations of a student are 25-30 hours per session for each unit of credit, including class contact hours, preparation and time spent on all assessable work.*

To assist students with the organisation of their studies, the expected workloads of the various components of the course are listed below. It is strongly suggested that students use the listed hours to plan their work during session.

Lectures (11 x 2hr)	22hr
Tutorials (12x1hr)	12hr
Assignment, Field exercises & demos	12hr
Revision of Lectures, preparation of practical/tutorial reports, background reading (approximately 4hr x 14wk)	54hr
Total	100hr

### 6.2 Rules

Students should read the University Calendar or Student Guide for details of University Rules and special considerations.

Students are reminded that the University regards academic misconduct as a very serious matter. Unauthorised material must not be taken into a test or examination. Any work submitted for assessment must be entirely the student's own work. The penalty for any suspected academic misconduct ranges from zero mark for the assignment or exam involved, through failure of the subject, to expulsion from the University. If absent from an examination, class test or practical, students must submit written documentation to the University, via the Student Centre in the Chancellery.

All assignments or practical reports are compulsory parts of the course and must be handed in by the due date. **The marks for late submissions will be reduced as follows:** -20% (of the maximum mark) for up to 24 hours after the scheduled submission time, then -10% (of the maximum mark) for each additional 24 hour period late. (For example, a student submitting a report/assignment 4 days late has his/her mark reduced by 4 if the maximum mark of the submission is 10.). Any late submission must be made before solutions are issued to the class.

If a student is unable to submit on time due to illness or other legitimate reason, then a brief written explanation must be given to the lecturer for consideration as soon as is feasible. In some cases the lecturer may grant an extension to the submission date provided he has been contacted before the due date.

Further assessment may be granted in this course at the lecturer's discretion. If further assessment is granted then performance in tutorials may be considered as well as an oral exam including use of a computer.

If students attend less than 80% of their possible classes they may be refused final assessment.

### 6.3 Plagiarism

Plagiarism is the presentation of the thoughts or work of another as one's own.\*

Examples include:

- direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or

- another person's assignment without appropriate acknowledgement
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at:

[www.lc.unsw.edu.au/plagiarism](http://www.lc.unsw.edu.au/plagiarism)

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

\* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle.

† Adapted with kind permission from the University of Melbourne.

## 6.4 Grievances

In the first instance all grievances should be discussed with the lecturer involved. If the problem cannot be resolved, students should contact the School's Grievance Officer in writing.

## 6.5 Rules for practical / field classes

Students are required to read the supplied instructions well before the exercise is commenced.