2.1 GPS and Galileo receivers

Module: 2.1
Period: Winter Quarter

Responsiable: Adjunct professor
Teachers: Adjunct professor

Credits: 5
Total hours: ~50

Course Objectives
The main objective of the course is to describe in details the architecture and the functionality of a GNSS receiver. The basic functions of a GNSS receiver are: to capture and separate the signals in space (SIS) transmitted by the satellites in view; to measure the Time of Arrival (ToA) and Doppler shift of each received signal; to demodulate the navigation message; to estimate the PVT (Position, Velocity and Time).

The main functional blocks necessary to perform the above mentioned tasks are:
- The receiver antenna
- The Radio Frequency front-end
- The Analog-to-Digital Converter (ADC)
- The acquisition block
- The Carrier tracking system
- The Code tracking system
- The navigation message demodulator
- The block for PVT computation

All these topics will be covered in this course. However, special attention will be given to some of them, not already covered in the other courses of this Master.

Course Syllabus

- The acquisition blocks (architecture and functionality)
  - Analysis of different types of ACF (Autocorrelation Function) and CCF(Cross Correlation Function) that may be embedded into a generic digital system, with particular attention to the following methods:
    - Linear correlation
    - Circular correlation
  - Basic concepts about detection and estimation of particular interest in acquisition schemes.
  - Non-coherent acquisition scheme at IF:
    - Integration time
    - Search space
    - Bin size
    - Carrier wipe-off
    - Serial correlator
- Parallel correlator

- The Code tracking system: coherent and non-coherent DLLs
  - Detailed analysis of the DLL scheme:
    - Code wipe-off
    - Frequency wipe-off
    - S-curve
    - Early-Late
    - Incommensurability

- Pseudo-range evaluation
  - Analysis of the receiver block that demodulates the navigation message and evaluates the pseudo-range.

- The effect of ADC in the SIS, in the code correlation, and in the noise
  - Quantization effects introduced by the ADC on correlation blocks that constitute the core elements of both the acquisition system and the DLL (Delay Lock Loop). In particular, the following cases will be examined:
    - Sampler at IF with infinite precision quantization
    - Sampler at IF with 1-bit quantization