



Course 373:

GPS-Based Attitude Determination

Using Carrier Phase Measurements to Achieve High Accuracy Positioning on Dynamic Platforms

On-Site Only

| | Day 1 | Day 2 |
|-------|--|---|
| 8:30 | GPS-Based Attitude Determination Basic principles of operation Historical perspective Relationship between kinematic survey and attitude determination <i>Dr. Penina Axelrad University of Colorado</i> | GPS Attitude Solutions Two step method Deterministic and least squares solutions Linearized direct attitude solution |
| 9:45 | GPS Equipment Configurations Reference frames Attitude representations Attitude determination problem statement | Attitude Solution Accuracy Baseline errors Satellite and baseline geometry, ADOP Alignment calibration |
| 11:00 | GPS Equipment for Attitude Determination Requirements and configuration Specific attitude receiver features Non-dedicated GPS sensor configurations | Attitude Filters & GPS/Gyro Integration Kalman filter solution GPS and gyro error models Expected performance |
| 12:00 | <i>Lunch is on your own</i> | |
| 1:30 | Carrier Phase Measurements & Models What are they? How they are formed in the receiver Measurement models Single and double differences on very short baselines | Space Applications: Case Study I Receiver hardware Three-axis stabilized satellites Spinning satellites Coarse attitude determination Integrated GPS/gyro solutions |
| 2:45 | Error Sources Multipath Oscillator stability Receiver tracking errors | Marine Applications: Case Study II Heading and alignment Multi-receiver configurations GNSS based attitude determination |
| 4:00 | Ambiguity Resolution & Baseline Calibrations Problem definition for attitude determination Use of antenna baseline constraints Search techniques | Aircraft Applications: Case Study III Dynamics, wing flexure, vehicle modes Application to landing systems |
| 5:00 | Motion-based techniques | |

Quotes:

“This course information will be helpful in my algorithm development, simulations, and interpretation of results. Very well done.”

*Roger Hart
Motorola*

“Those sessions that covered solutions/ applications for SNR-measurements and non-dedicated GPS systems will be very useful to me.”

“A breath of fresh air! Enjoyed the class.”

“Excellent teaching style. Best tutorial I sat in.”

“I will be able to evaluate attitude systems now.”

“This course will help me to make a GPS based attitude estimator.”

About This Course

This course addresses the theory and application of high precision GPS carrier phase measurements to attitude determination of ships, aircraft and spacecraft. Case studies are presented for a variety of applications and GPS attitude instruments.

Prerequisites

The ideal preparation for this course is

Course 356: GPS Operations for Engineers.

Course 122: Fundamentals and Applications of GPS and

Course 217: Introduction to Differential GPS

These are all acceptable background, but you will be more comfortable in this course if you have some grounding in carrier phase measurements as well (See [Course 439](#)).

Instructor: Dr. Penina Axelrad



What You Will Learn

- Understanding of GPS carrier phase observations
- Use of carrier phase for GPS based attitude determination
- Error sources in GPS-based attitude determination
- Solution algorithms for GPS and integrated GPS/Gyro attitude solutions
- Ambiguity resolution
- Case studies for land, marine, airborne, and space applications

Materials You Will Keep

A notebook containing copies of all presentation materials used during the course

