

CN506C Fundamentals of Global Navigation Satellite Systems II with emphasis on GPS (6.0 CEUs)

Instructor: Dr. Chris G. Bartone, P.E., Professor, Ohio University, School of Electrical Engineering and Computer Science

Prerequisite: Knowledge of science, engineering and/or mathematics will be helpful and the material represented in CN505 Fundamentals of GNSS I with emphasis on GPS.

Intended Audience: Engineers, scientists, and managers interested in the area of GNSS using GPS, Galileo, Glonass, and/or other satellite navigation systems. The course provides a solid basis in the fundamentals of satellite navigation. The course is more advanced than a simple user's course, but not too detailed for the beginner to GNSS. Some knowledge or introduction to GNSS is assumed as this course is intended as a follow-on to CN505 Fundamentals of GNSS I with emphasis on GPS.

Course Overview: This course will present the fundamentals of GNSS with emphasis on GPS in the presence of various error sources and discusses error mitigation techniques. The course will provide details on the nature of various error sources in satellite navigation systems, their impact on performance, and methods for mitigation. The course provides with an illustration of an error mitigated user state calculation, and provides information on receiver autonomous integrity monitoring (RAIM). Details of differential GNSS with illustrations DGPS error performance is presented. The main topics to be covered by this course are:

Morning Session:

- GPS error budget (review)
- Overview of receiver and antenna technologies
 - Receiver block diagram
 - Carrier phase tracking
 - Frequency Lock Loops
 - Phase Lock Loops
 - Loop order considerations
 - Code phase tracking
 - Coherent Delay Lock Loops
 - Non-coherent Delay Lock Loops
- GNSS error rate term considerations
- Satellite orbit errors and introduction of mitigation methods
- Satellite clocks and their errors
- Signal Multipath Error characterization and mitigation techniques
 - Smoothing
 - Complementary Smoothing
 - Single-frequency
 - multi-frequency
 - Code phase multipath
 - Carrier phase multipath

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- Code-Minus-Carrier (CMC) and Code-Carrier-Divergence (CCD) Analysis
- Atmosphere Errors:
 - Troposphere error sources and characterization
 - Advanced troposphere models and error mitigation
 - Ionosphere error sources and characterization
 - Advanced Ionosphere models and mitigation

Afternoon Session:

- GNSS Integrity & Receiver Autonomous Integrity Monitoring (RAIM)
 - GNSS integrity overview and definition for application
 - Requirements on integrity monitoring performance
 - Overview on integrity monitoring techniques
 - Different ways to implement RAIM
- Precise Point Positioning (PPP)
- Differential GNSS and different ways to implement it
 - Correction-based DGNSS
 - Measurement-based DGNSS
 - Differencing techniques;
 - Single difference
 - Double difference
 - Triple difference
 - Data link considerations for DGNSS systems.
 - Example Systems
 - Space-based Augmentation Systems (e.g., WAAS, etc.)
 - Ground-based Augmentation Systems (e.g., NDGPS, LAAS, etc.)
 - Decorrelation (spatial and temporal) of error terms
 - High Accuracy considerations in DGNSS
 - Error mitigation importance
 - Carrier phase ambiguity solution techniques

Course Topic Tailoring: GNSS Solutions can tailor the above course outline to meet your special needs or market. We can provide you more or less emphasis in specific areas, add or subtract topic areas. Feel free to contact us and discuss options for your course outline to maximize your benefit. Be sure to include any requested modifications when you [request a quote](#).

Handout Booklet: A booklet of the slide material presented will be provided. One Handout Booklet will be provided per student. The Handout Booklet will be spiral bound with protective vinyl on the front and back cover (clear on front, navy blue on back). References will be provided on slides, as appropriate, and a reference list of significant material will be provided. Color will be provided on a limited basis where it is needed for clarity. This information will be copyrighted by the author and cannot be reproduced without the written permission of the author or GNSS Solutions if associated with this course. Additionally, an acronym list will be provided.

Location: On-site at the Government and/or contractor facility. A local commercial location can be arranged if requested.

Host Responsibilities:

Facilities: Room, restrooms, seats, chairs, etc.
Refreshment access or provided (coffee, soda, snacks, etc.)
Scheduling of students and fund coordination.
LCD projector with screen and white/chalkboard (or equivalent).
No audio or video taping of the presentation is allowed.
GNSS Solutions can provide the above items with proper coordination.

Day Schedule: The class room shall be available no later than 07:30 on class day, with presentation beginning at 08:30. A 15 min break will be scheduled every hour. One hour for lunch will be scheduled. The course will end at 16:30 every day. A total of 6 hrs of presentation time will occur each day. Different start, stop, break, and duration times can be accommodated.

Scheduling: A lead time of at least 3 weeks shall be used to schedule the course. A 10% deposited is required when ordering the course.

Rescheduling or Cancellation: Once the course has been ordered, the course can be rescheduled or canceled but fees may occur. The amount of these fees can be negotiated at the time of course rescheduling or cancellation. Generally, non-recoverable expenses (e.g., travel costs) may be forfeited in the event the course is rescheduled. If the course is cancelled, a 10% cancellation fee will apply.

Request a Quote: Please have in mind the dates, location, number of attendees, and any exceptions, tailoring or special requests in your [request for quote](#).