CN505C Fundamentals of Global Navigation Satellite System (GNSS) I with emphasis on the 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.

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.

Course Overview: This course emphasizes the fundamentals of GNSS with emphasis on GPS. The course begins with a solid overview of GNSS and GPS. Various coordinate frames and datums used in GNSS will be presented. GNSS signal structure formats of current and future GNSS signals will be discussed, as well as, an overview of Galileo, Glonass, and Compass. The core functions that need to be performed in obtaining a user solution using GPS will be explained. The course concludes with an illustration of a user state calculation, performance metrics (i.e., DOPs) and an error budget for GPS. The major topics include:

Morning Session:

- Positioning vs Navigation
- Types of Navigation Systems
- A timeline on navigation and GNSS
- Requirements for GNSS signals in space
- GNSS Frequency Bands: Legacy, modernized, future, ITU/ICAO regulations
- GPS Policy Overview & US Federal Radionavigation Plan
- GPS Segments – overview:
    - Space Segment; GPS Blocks, numbers, capabilities, timeline
    - Control Segment: Legacy and Modernization efforts
    - User Segment: Various applications introduced
- Coordinate frames and datum's used in the application of GNSS.
    - Terrestrial and Inertial Reference Frames
    - Earth Centered Inertial (ECI)
    - Earth Centered Earth Fixed (ECEF)
    - Latitude, Longitude, Height (LLH), Mean Sea Level (MSL)
    - Height: Geodetic, MSL, WGS-84, Undulation
    - Other datum's used in the World
    - Local Level Tangent (LLT)
    - Coordinate Conversions
- GPS signal structure formats for current and future signals.
    - Basics of Direct-Sequence Spread Spectrum (DSSS) systems
    - Basics of a DSSS communications link
    - Auto and Cross correlation of spreading codes

        - M-sequences
        - Gold codes
        - Random codes
    - GNSS Signal formats and encoding
    - BPSK, BOC, and MBOC modulations
    - Legacy GPS code formats: C/A, P(Y)
    - Modernized GPS:
        - L2C, L5, L1C
- Galileo GNSS Introduction
- Galileo Signals and Services:
    - Open Services (OS)
    - Commercial Services (CS)
    - Safety of Life (SOL)
    - Public Regulated Services (PRS)
    - Search and Rescue (SAR)
- Glonass
    - The signal format, spectrum, and modernization efforts
- Compass

Afternoon Session:

- GPS Link Budget
- Overview of various GNSS receiver and antenna technologies
- GPS Navigation Message Data Format Descriptions
    - NAV & CNAV message formats
- Calculation of the GPS space vehicle (SV) position using the broadcast Kepler ephemeris parameters (ephemeris and almanac)
- GPS Almanac formats and accuracy considerations
    - Yuma and SEM, format illustrations.
- GPS Satellite clock corrections and error plots.
- GPS Time Considerations
    - UTC
    - Local time
    - Conversion from GPS to local time and back.
- Atmosphere Errors:
    - Troposphere error sources and characterization
        - Simple exponential model; Error prediction plots vs altitude and elevation angle.
    - Ionosphere error sources and characterization
        - Ionosphere measurement methods and mitigation
        - GPS Broadcast model (i.e, Klobuchar Model)
            - Broadcast model error predictions plots based on real data for various user latitude, longitude, time-of-day (local), and elevation angle.
- Calculation of user state (i.e., position and time)
- Calculation of user velocity and noise considerations
- Associated performance parameters (i.e., dilution of precision terms)
- GPS error budget (overview)

- On-line positioning services
- Continuous Operating Reference Stations (CORS)
- GNSS receiver file formats and the RINEX format
    - Manufacture unique formats and how to handle them.

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 professionally spiral bound with clear 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. All color and/or password protected slide copies may be requested at additional cost.

Reference List: A reference list will be provided as part of the note package to allow the interested attendee to obtain additional information. Additionally, an acronym list will provided.

Location: On-site at the Government and/or contractor facility. A local commercial location can be arranged by GNSS Solutions 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 include the dates, location, number of attendees, and any exceptions, tailoring or special requests in your request for quote.