PRIVATE GROUP REMOTE COURSE ONLY

Course 336: GPS/GNSS Fundamentals and Enhancements with Emphasis on DGPS (1.8 CEUs)

DAY 1	DAY 2	DAY 3
Dr. Chris Hegarty		
Fundamentals of GPS operation. Overview of how the system works. U.S. policy and current status. **GPS System Description** • Overview and terminology • Principles of operation • Augmentations • Trilateration • Performance overview • Modernization **GPS Policy and Context** • Condensed navigation system history • GPS policy and governance • Modernization program • Ground segment • Other satellite navigation systems **GPS Applications** • Land • Marine • Aviation • Science • Personal navigation • Accuracy measures • Error sources	**GPS Principles and Technologies** **Clocks and Timing** • Importance for GPS • Timescales • Clock types • Stability measures • Relativistic effects **Geodesy and Satellite Orbits** • Coordinate frames and geodesy • Satellite orbits • GPS constellation • Constellation maintenance **Satellites and Control Segment** • GPS satellite blocks • Control segment components and operation • Monitor stations, MCS, and ground antennas • Upload operations • Ground control modernization	**Differential GPS Overview** • Local-area, regional-area, wide-area architectures • Code vs. carrier-phase based systems • Pseudolites • Performance overview **Differential Error Sources** • Satellite ephemeris errors • Satellite clock errors • Selective availability • Ionospheric, tropospheric delay • Multipath • Receiver internal noise, biases **Observable Modeling** • Code pseudorange and carrier-phase outputs • Code-minus-carrier observables • Carrier-smoothed code operation • Double difference operation • System error budgets
LUNCH IS ON YOUR OWN		
Legacy GPS Signals • Signal structure and characteristics • Modulations: BPSK, DSSS, BOC • Signal generation • Navigation data **Measurements and Positioning** • Pseudorange and carrier phase measurements • Least squares solution • Dilution of precision • Types of positioning solutions **GPS Receiver Basics** • Types of receivers • Functional overview • Antennas	**Error Sources and Models** • Sources of error and correction models • GPS signals in space performance • Ionospheric and tropospheric effects • Multipath • Error budget **Augmentations and Other Constellations** • Augmentations: local-area, satellite-based, and regional • Russia's GLONASS • Europe's Galileo • China's Compass (BeiDou) **Precise Positioning** • Precise positioning concepts • Reference station networks • RINEX data format	**Differential GPS Design Considerations** • Range vs. navigation domain corrections • Data links • Pseudolites • Reducing major error components • Ambiguity resolution **DGPS Case Studies I** • RTCM SC104 message format • USCG maritime DGPS and National DGPS (NDGPS) • Commercial satellite-based systems **DGPS Case Studies II** • Wide Area Augmentation System (WAAS) • Local Area Augmentation System (LAAS) • RINEX format • CORS&IGS network for precise positioning (survey) • Precise time transfer

FOR THOSE WHO NEED GPS/GNSS BASICS AND A FULL DAY OF DIFFERENTIAL GNSS

Instructor

Dr. Chris Hegarty

Description/Objectives

This 3-day public or on-site course offers a comprehensive introduction to GPS/GNSS technology, system concepts, design, operation, implementation and applications, and a full day of differential GPS. Detailed information on the GPS signal, its processing by the receiver, and the techniques by which GPS obtains position, velocity and time will be covered.

Prerequisites

Some familiarity with engineering terms is helpful but not essential.

Who Should Attend?

- Engineers and technical professionals seeking conceptual and detailed explanations of GNSS technology, operation, capabilities, applications, and development trends
- Professionals in navigation, positioning, and related fields who are concerned with the capabilities, operation and principles of GPS, DGPS, and related GNSS systems.
- System analysts and specialists concerned with position data and its use.
- Managers concerned with GPS, GNSS activities, or the positioning field.

Public Course Fee Entitles You to the Following Books

Introduction to GPS: *The Global Positioning System,* 2nd ed., Ahmed El-Rabbany, Artech House, 2006., or book of your choice from our website (*Note: This arrangement does not apply to on-site contracts. Any books for on-site group contracts are negotiated as part of the contract.)*

What Attendees Have Said

"Especially useful were the aspects related to how the user receivers make use of the GNSS signals and all the steps involved in the process, from receiving the raw RF signal to the computation of the user position."

— Marc Garcia Mateos, Course 336, ESA/ESTEC, September 2016

"Dr. Hegarty is extremely knowledgeable and well versed in the material. Well prepared and well designed course and course material! Course material was well organized with accompanying slides — Nice notebook!"

— David Wright, Course 346, June 2015.
(Course 336 is a subset of Courses 346 and 356)

"There are many bright scientists and engineers, but very few are bright and gifted in teaching. Even fewer could explain each part of a very complex equation in simple layman's term. Dr. Hegarty got my full attention."

— Sigong Ho, NovAtel; Course 346, February 2014 (Course 336 is a subset of Courses 346 and 356)