On-Site Course Only

COURSE 356B (1.8 CEUs)
GPS / GNSS Operations, DGPS, GPS Signals & Processing

Wednesday Through Friday can be taken as Course 356B (assumes knowledge of Course 122 material)

Dr. Chris Hegarty, MITRE

WEDNESDAY	THURSDAY	FRIDAY
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	**GPS Signal Structure and Message Content** • Signal structures • Signal properties • Navigation message **GPS Receiver Overview** • Functional overview • Synchronization concepts • Acquisition • Code tracking • Carrier tracking • Data demodulation **GPS Antennas** • Antenna types • Antenna performance characteristics • Prefilters • Low-noise amplifiers (LNAs) • Noise figure	**Case Study: Tracing a GPS Signal Through a Receiver** • Received signal • Digitized signal • Correlator outputs • Code-phase estimate • Carrier-phase estimate • Data demodulation **GPS Navigation Algorithms: Point Solutions** • Pseudorange measurement models • Point solution method and example **Basics of Kalman Filtering** • Introduction to Kalman filtering • Filter structure • Simulation results
LUNCH IS ON YOUR OWN		
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	**GPS Signal Processing** • In-phase and quadra-phase signal paths • Analog-to-digital (A/D) conversion • Automatic gain control (AGC) • Correlation channels • Acquisition strategies **Code Tracking, Carrier Tracking & Data Demodulation** • Delay locked loop (DLL) implementations; performance • Frequency locked loops (FLLs) • Phase locked loops (PLLs) • Carrier-aiding of DLLs • Data demodulation **Receiver Impairments and Enhancements** • Impairments - bandlimiting, oscillators, multipath, interference • Enhancements - carrier smoothing, narrow correlator, codeless/semicodeless tracking, vector tracking, external aiding	**Kalman Filtering for GPS Navigation** • Clock models and dynamic models • Integration with INS • Measurement and dynamic mismodeling **Practical Aspects I** • Types of GPS and DGPS receivers • Understanding specification sheets • Data links • Antennas **Practical Aspects II** • Receiver and interface standards • Connectors • Accessories • Test, evaluation, and signal performance

FOR GROUPS WHO ALREADY KNOW GPS/ GNSS BASICS

Instructor

Dr. Chris Hegarty

Description
This 3-day course begins with a discussion of differential GPS, which continues through the rest of the week together with an in-depth look at GPS signal processing, navigation message content, code tracking, receivers and concludes with a discussion on the basics of Kalman filtering. (Note: This course is the same as the last 3 days of Course 356.)

Objectives
- To give a comprehensive introduction to GPS and DGPS technology, system concepts, design, operation, implementation and applications.
- To provide detailed information on the GPS signal, its processing by the receiver, and the techniques by which GPS obtains position, velocity and time.
- To present current information on the status, plans, schedule and capabilities of GPS, as well as of other satellite-based systems with position velocity and time determination applications.
- To fill in technical information gaps for those working in the GPS and GNSS fields.

Prerequisites
Familiarity with the subject matter covered in days 1 and 2 of Course 356.

Who Should Attend?
Excellent for those engineers and technical professionals who know the basics of GPS but need more detail on DGPS, signals, receivers, antennas, navigation algorithms, Kalman filtering and practical aspects of GPS.

Materials You Will Keep
- A color electronic copy of all course notes will be provided on a USB Drive or CD-ROM. Bringing a laptop to this class is highly recommended for taking notes using the Adobe® Acrobat® sticky notes feature; power access will be provided.
- A black and white hard copy of the course notes will also be provided

Course Fee Entitles You to a Book Allowance
Book allowances for on-site group contracts are negotiated as part of the contract.

What Attendees Have Said
"Dr. Hegarty is very knowledgeable and he is a great communicator. He explained conceptual and theoretical topics clearly. He was very accessible in answering questions. He did an excellent job engaging the students in the learning experience."

– Carol Chen, March 2011; San Diego, California

"I thought [Dr. Hegarty] had a great teaching style, was funny and had just the right amount of slides. [Dr. Hegarty] was very good at explaining very technical things in a way that made sense to someone with very little signals / communications background."

– A. Muscat, July 2011; Annapolis, Maryland