ON-SITE COURSE

Courses 356: GPS / GNSS and DGPS Operations for Engineers & Technical Professionals: Principles, Technology, Applications and DGPS Concepts (3.0 CEUs)  
(Similar to Course 346, but with three additional hours of Differential GPS and two additional hours of Kalman filtering.)

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<td>Dr. Chris Hegarty, MITRE</td>
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### 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
- Telemetry
- Performance overview
- Modernization

### GPS Policy and Context

- Condensed navigation system highlights
- GPS policy and governance
- Modernization program
- Ground segment
- Other satellite navigation systems

### GPS Applications

- Land
- Marine
- Aviation
- Science
- Personal navigation
- Accuracy measures
- Error sources

### 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
- ICAO 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/GNSS network for precise positioning (survey)
- Precise time transfer

### GPS Receiver Impairments and Enhancements

- Impairments - bandlimiting, oscillators, multipath, interference
- Enhancements - carrier-smoothing, narrow correlator, code/semi-codeless tracking, vector tracking, external aiding

### GPS Signal Processing

- In-phase and quadrature-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 (PLLs)
- Carrier-aiding of DLLs
- Data demodulation

### Kalman Filtering for GPS Navigation

- Clock models and dynamic modeling
- 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

### Lunch is On Your Own

- 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.

### 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.
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### Course Fee Entitles Your Group to a Book Allowance

Any book allowances for on-site group contracts are negotiated as part of the contract.

### What Attendees Have Said

"[My objective was to] gain a better understanding of GPS operating principles with a focus on error sources and differential GPS. I thought [Dr. Hegarty’s] teaching style was excellent. He specifically tailored his approach to the small classroom environment with significant student interaction: True teaching versus lecturing. [I would recommend this course to] system engineers requiring more than a black box knowledge of GPS."  
- Jim Sabin (Organization withheld upon request), March 2011, San Diego, California

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### Course Objectives

- To give you a comprehensive introduction to GPS and DGPS technology, system concepts, design, operation, implementation and applications, including critical information on DGPS and Kalman filtering concepts.
- 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.
- This course has two highly respected instructors who bring their unique experiences and professional expertise to the class.

### Who Should Attend?

Excellent for engineering staff who need to be rapidly brought up to speed on GPS, and for those already working in GPS who need exposure to the system as a whole in order to work more effectively.

### Prerequisites

Familiarity with engineering terms and analysis techniques. General familiarity with matrix operations is desirable for Thursday and Friday, and familiarity with signal processing techniques is desirable for Wednesday through Friday. (The materials for days 3, 4 and 5 of Course 356 are more intensive than what is taught in Course 346.)

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To REGISTER or for MORE INFORMATION, Contact Carolyn McDonald at (703) 256-8900 or cmcdonald@navtechgps.com.