## On-Site at Your Location

# Take Only What You Need. For Example:

**COURSE 111 (0.6 CEUs)**
## Fundamentals of GPS (Monday Only - See Schedule Below)

**COURSE 122 (1.2 CEUs)**
## GPS Fundamentals & Enhancements

**MONDAY ONLY IS COURSE 111**
**MONDAY & TUESDAY IS COURSE 122**

| | MONDAY | TUESDAY |
|---|---|---|
| | Dr. Michael Braasch, Ohio University (April Only) | |
| 8:30 | **Fundamentals of GPS operation. Overview of how the system works. U.S. policy and current status.**<br>**GPS System Description**<br>• Overview and terminology<br>• Principles of operation<br>• Augmentations<br>• Trilateration<br>• Performance overview<br>• Modernization<br>**GPS Policy and Context**<br>• Condensed navigation system history<br>• GPS policy and governance<br>• Modernization program<br>• Ground segment<br>• Other satellite navigation systems<br>**GPS Applications**<br>• Land<br>• Marine<br>• Aviation<br>• Science<br>• Personal navigation<br>• Accuracy measures<br>• Error sources | **GPS Principles and Technologies**<br>**Clocks and Timing**<br>• Importance for GPS<br>• Timescales<br>• Clock types<br>• Stability measures<br>• Relativistic effects<br>**Geodesy and Satellite Orbits**<br>• Coordinate frames and geodesy<br>• Satellite orbits<br>• GPS constellation<br>• Constellation maintenance<br>**Satellites and Control Segment**<br>• GPS satellite blocks<br>• Control segment components and operation<br>• Monitor stations, MCS, and ground antennas<br>• Upload operations<br>• Ground control modernization |
| | LUNCH IS ON YOUR OWN 12:00-1:30 PM | |
| 5:00 | **Legacy GPS Signals**<br>• Signal structure and characteristics<br>• Modulations: BPSK, DSSS, BOC<br>• Signal generation<br>• Navigation data<br>**Measurements and Positioning**<br>• Pseudorange and carrier phase measurements<br>• Least squares solution<br>• Dilution of precision<br>• Types of positioning solutions<br>**GPS Receiver Basics**<br>• Types of receivers<br>• Functional overview<br>• Antennas | **Error Sources and Models**<br>• Sources of error and correction models<br>• GPS signals in space performance<br>• Ionospheric and tropospheric effects<br>• Multipath<br>• Error budget<br>**Augmentations and Other Constellations**<br>• Augmentations: local-area, satellite-based, and regional<br>• Russia's GLONASS<br>• Europe's Galileo<br>• China's Compass (BeiDou)<br>**Precise Positioning**<br>• Precise positioning concepts<br>• Reference station networks<br>• RINEX data format |

**OR**

**COURSE 217 (0.6 CEUs)**
## Introduction to Differential GPS

**WEDNESDAY ONLY IS COURSE 217**

| | WEDNESDAY |
|---|---|
| | Dr. Chris Hegarty, MITRE |
| 8:30 | **Differential GPS Overview**<br>• Local-area, regional-area, wide-area architectures<br>• Code vs. carrier-phase based systems<br>• Pseudolites<br>• Performance overview<br>**Differential Error Sources**<br>• Satellite ephemeris errors<br>• Satellite clock errors<br>• Selective availability<br>• Ionospheric, tropospheric delay<br>• Multipath<br>• Receiver internal noise, biases<br>**Observable Modeling**<br>• Code pseudorange and carrier-phase outputs<br>• Code-minus-carrier observables<br>• Carrier-smoothed code operation<br>• Double difference operation<br>• System error budgets |
| | LUNCH IS ON YOUR OWN 12:00-1:30 PM |
| 5:00 | **Differential GPS Design Considerations**<br>• Range vs. navigation domain corrections<br>• Data links<br>• Pseudolites<br>• Reducing major error components<br>• Ambiguity resolution<br>**DGPS Case Studies I**<br>• RTCM SC104 message format<br>• USCG maritime DGPS and National DGPS (NDGPS)<br>• Commercial satellite-based systems<br>**DGPS Case Studies II**<br>• Wide Area Augmentation System (WAAS)<br>• Local Area Augmentation System (LAAS)<br>• RINEX format<br>• CORS&IGS network for precise positioning (survey)<br>• Precise time transfer |

## OR
## Combine the Two And Take Course 336

**COURSE 336 (1.8 CEUS)**
## GPS Fundamentals, Enhancements and Intro to Differential GPS

**MONDAY ONLY IS COURSE 111; MONDAY & TUESDAY IS COURSE 122; MONDAY, TUESDAY AND WEDNESDAY IS COURSE 336**

| MONDAY | TUESDAY | WEDNESDAY |
|---|---|---|
| Dr. Michael Braasch, Ohio University (April Only) | | Dr. Chris Hegarty, MITRE |
| See Outline Above | See Outline Above | See Outline Above |

**Give us a call for other course configurations.**