NEXT COURSE IN EARLY NOVEMBER 2015
WASHINGTON, DC AREA
Watch Our Website for Details!

NEW COURSE

COURSE 546 (2.4 CEUs)

Inertial Systems, Kalman Filtering and GPS/INS Integration

	DAY 1	DAY 2	DAY 3	DAY 4
	Dr. Alan Pue, Johns Hopkins University, Applied Physics Lab.		Mr. Michael Vaujin, Aerospace, Navigation & Defense Consultant	
8:30	**Introduction to INS/GPS Integration** • Inertial navigation • Integration architectures • Example applications **Vectors and Coordinate Systems** • Vector definitions • Coordinate transformations • Vector kinematics **Navigation Coordinate Systems** • Earth model • Navigation coordinates • Earth relative kinematics	**Strapdown Computations** • Quaternions • Orientation vector • Coning and sculling compensation **Navigation System Errors** • Tilt angle definitions • Navigation error dynamics • Simplified error characteristics **System Initialization** • INS static alignment • Transfer alignment • Simplified error analysis	**Random Process Review** • Random variables, probability densities • Gaussian & multivariate expectation • Covariance matrix, random process • Autocorrelation, power spectral density • Stationary & non-stationary linear response • Shaping filters **State Space Modeling** • Models derived from differential equations • PSDs and block diagrams • Discrete time solution • Mean & covariance response • Markov & integrated Markov Examples **The Kalman Filter** • Derivation and examples	**Smoothing & Prediction** • Prediction recursive equations • Smoothing, fixed point • Fixed lag, fixed interval • Computer demos of all **Square Root Filtering** • Motivation, UD factorization, • Square root covariance filtering, • Square root covariance smoothing • Computer demo **Square Root Information Filters** • Motivation and theoretical development • Another aided navigator demo
	LUNCH IS ON YOUR OWN 12:00-1:30 PM			
5:00	**Inertial Navigation Mechanization** • Gravity model • Navigation equations • Implementation options **Inertial Sensor Technologies** • Accelerometer technologies • Ring laser gyros • Fiber optic gyros **MEMS Technologies and INS Testing** • Instrument technologies • INS technology survey and trends • INS testing	**Inertial Aiding** • Aiding techniques • Kalman filters • Aiding examples **GPS Receivers** • Interfaces and timing • Measurement processing • Measurement errors **INS Aiding of Receiver Signal Tracking** • Code and carrier tracking • Track loop design trades • Interference suppression	**Kalman Filter Methods of Implementation** • Tuning examples • Sequential vs. batch measurement processing • Measurement decorrelation • Matrix partitioning **Building Extended Kalman Filters** • Radar tracking of vertical body motion with non-linear dynamics • Sled tracking of horizontal motion with non-linear measurements • Computer demos for both **Aided Navigator Example, Loosely Coupled** • Local level psi-angle implementation • 15 state, PVT GPS aided • Practical implementation Considerations • Computer demo	**Adaptive Filtering** • Residual analysis, on-line, off-line • Iterative residual analysis methods • Multiple model adaptive estimation • Computer demo **Unscented Kalman Filters** • Unscented transforms & sigma points • Augmented & non-augmented filters • Application to navigation • Performance vs. EKF • Computer demo **Advanced Suboptimal Analysis** • Effects of mis-modeling • Optimal covariance analysis • Two-pass error budget design analysis • Computer demo

Course Objectives

This 4-day course on aided navigation will thoroughly immerse the student in the fundamental concepts and practical implementations of the various types of Kalman filters that optimally fuse GPS receiver measurements with a strapdown inertial navigation solution.

The course includes the fundamentals of inertial navigation, inertial instrument technologies, technology surveys and trends, integration architectures, practical Kalman filter design techniques, case studies, and illustrative demonstrations using MATLAB®.

Who Should Attend?

- GPS/GNSS professionals who are engineers, scientists, systems analysts, program specialists and others concerned with the integration of inertial sensors and systems.
- Those needing a working knowledge of Kalman filtering, or those who work in the fields of either navigation or target tracking.

Prerequisites

- Familiarity with principles of engineering analysis, including matrix algebra and linear systems.
- A basic understanding of probability, random variables, and stochastic processes.
- An understanding of GPS operational principles in Course 356, or equivalent experience.

Equipment Recommendation

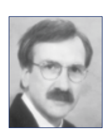
- A laptop (PC or Mac) with full version of MATLAB® 5.0 (or later) installed. This will allow you to work the problems in class and do the practice "homework" problems each evening. All of the problems will also be worked in class by the instructor, so this equipment is *not required*, but is ***recommended***.
- The course notes are searchable and you can take electronic notes with the Adobe® Acrobat®9 Reader we provide to you.

Materials You Will Keep

- A CD-ROM or USB drive with a color copy of all course notes. 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, printed 3 slides to a page.
- *Introduction to Random Signals and Applied Kalman Filtering, 3rd edition,* by R. Grover Brown and Patrick Hwang, John Wiley & Sons, Inc., 1996. (*Note: This arrangement does not apply to on-site contracts. Any books for on-site group contracts are negotiated on a case by case basis.)*

Instructors


Mr. Michael Vaujin


Dr. Alan Pue