

**CN471 Integrated Navigation Systems for Low-Cost Applications**  
**ION GNSS 2007, September 25, 2007, 1:30 pm - 5:00 pm, CEU: 3.0**

**Instructor:** Dr. Demoz Gebre-Egziabher, P.E., Assistant Professor, University of Minnesota, Twin Cities Campus.

**Prerequisite:** Some basic knowledge of GNSS, mathematics and computer science will be useful.

**Intended Audience:** Engineers, scientists, and managers interested in multi-sensor systems used in low-cost navigation or attitude determination systems. These systems are intended for applications such as Micro Aerial Vehicles (MAVs) or Uninhabited Ground Vehicles (UGVs).

**Notes Provided:** Slides presented will be professionally spiral bound, with clear plastic cover, including color to add clarity where needed.

**Reference List:** A reference list will be provided as part of the note package for completeness and to allow the interested attendee to obtain additional information.

**Course Overview:** This course emphasizes the fundamentals of multi-sensor system design and performance analysis. This includes a brief overview of the types sensors normally found in these low-cost systems. Methods for developing simple error models for these sensors will also be presented. Finally, the design of algorithms such as Kalman Filters or Extended Kalman Filters for mechanizing an integrated navigator or attitude determination system will be presented.

**Course Content:** The main topics to be covered by this course are:

- Overview of multi-sensor systems
- Applications of low cost multi-sensor systems
- Sensors:
  - GPS for position and velocity
  - GPS as an attitude sensors
  - Inertial sensors
  - Magnetometers
  - Air data sensors
- Modeling and calibrating low cost sensors
- Overview of the Kalman Filter
- Design of integrated navigation systems.
  - GPS/INS Systems
  - Heading and velocity dead reckoning systems
- Design of integrated attitude determination systems
  - Single GPS antenna/INS attitude determination
  - Multi-antenna GPS attitude determination
  - Air data, Magnetometer and rate gyro attitude determination systems
  - Magnetometer, GPS and accelerometer attitude determination systems.

**Course Outcomes:** At the completion of this course, the attendee should have the ability to understand the issues associated with the design of integrated multi-sensor systems for navigation and attitude determination.