COURSE SUMMARY
Unmanned Aerial Vehicles (UAVs), or Unmanned Aircraft Systems (UAS) as is the preferred term by the US DOD, have seen unprecedented levels of growth in military and civilian application domains. Fixed-wing aircraft, heavier or lighter than air, rotary-wing (rotorcraft, helicopters), vertical take-off and landing (VTOL) unmanned vehicles are being increasingly used in military and civilian domains for surveillance, reconnaissance, mapping, cartography, border patrol, inspection, homeland security, search and rescue, fire detection, agricultural imaging, traffic monitoring, to name just a few application domains. This course offers a very comprehensive study of UAS that includes:

- History of unmanned aviation, including evolution of designs and models for application-specific domains;
- Modeling, control and navigation fundamentals for both teleoperation, semi-autonomous and fully autonomous flights;
- See-and-avoid-systems for different classes of UAS as required by the FAA;
- Integration of UAS into the National Airspace System (NAS), a topic of major challenge because most available information reflects manned aviation;
- Applications and case studies.

COURSE TOPICS
Course topics include:

1. Unmanned Aviation – the current world map
2. A Historical Perspective on UAS – from fiction to reality
3. Modeling Fundamentals
   a. Fixed-wing
   b. Rotary-wing
4. Control Fundamentals
5. Navigation Issues – sensor based navigation
6. Fundamentals of Obstacle Avoidance
7. See-and-avoid Systems
8. Integration of UAS into the NAS
   a. Current manned aviation regulation, airworthiness, certification, special aircraft categories, pilot certification, federal aviation requirements, operation rules, airspace classes and regulation development models.
   b. Overview of the history and current status of UAS airworthiness and operational regulation worldwide.
c. UAS safety assessment and functional requirements. This will be achieved in terms of defining an “Equivalent Level of Safety”, or ELOS, with that of manned aviation, specifying what the ELOS requirement entails for UAS regulations. To accomplish this, the safety performance of manned aviation is first evaluated, followed by a novel model to derive reliability requirements for achieving target levels of safety (TLS) for ground impact and mid-air collision accidents.

d. Elements of a viable roadmap leading to UAS integration into the NAS, emphasizing differences between manned and unmanned aviation, followed by recommendations on key issues like the development of a risk reference system for UAS, classification for regulatory purposes and certification of systems and operators.

e. Technology-related issues that will need to be adequately resolved before UAS can enjoy unrestricted access to the NAS. When applicable, existing regulations for manned aviation are adapted; however, the need for new rules, procedures and regulations is also essential.

9. Applications
10. The road ahead.

COURSE OBJECTIVES – EXPECTED OUTCOMES

- Understanding of the current state-of-the-art in UAS;
- Understanding of ‘what it takes’ to build and ‘fly’ any type of UAS;
- Clear understanding of modeling, control and navigation issues;
- Knowledge related to ‘why see-and-avoid systems’ are integral part of any UAS;
- Knowledge of existing and current manned aviation regulation related to airworthiness certification, pilot certification, operational rules and airspace classes;
- Understanding of UAS regulatory efforts at the international level, with emphasis in the European Union (EU), Canada, Japan and Australia;
- Providing a detailed safety assessment and functional requirements for UAS that may be used to develop a roadmap for integrating UAS into civilian airspace;
- Demonstrating through case studies completed for a wide range of UAS families, where and how UAS can fly worldwide, once safety levels are satisfied.

The course is suitable for scientists, engineers, researchers and practitioners from academia and industry who wish to acquire a comprehensive knowledge on the current status of UAS related R&D and applications.

COURSE MATERIAL

Textbooks
3. Paper / document reprints and lecture notes will be distributed.

References (May be provided by the Instructor)

GRADING POLICY

In Class Mid-Term Exam: 20%
Take Home Final Exam: 20%
Homework Projects (software simulation based): 20%
Design project (group project): 40%

The FAA approved X-Plane Simulator will be used: http://www.x-plane.com. To order Version 9, go to http://www.x-plane.com/order.html.