UNMANNED VEHICLE UNIVERSITY
SCHOOL OF UNMANNED TECHNOLOGY

CY2016 - COURSE DESCRIPTIONS

MAT701 "NUMERICAL ANALYSIS" 4 CREDITS

INSTRUCTOR: DR. PASCUAL MARQUES

This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in science and engineering. The primary objective of the course is to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of appropriate use. The emphasis of the course will be the thorough study of numerical algorithms to understand (1) the guaranteed accuracy that various methods provides, (2) the efficiency and scalability for large scale systems and (3) issues of stability. Topics include the standard algorithms for numerical computation including root finding for nonlinear equations, interpolation and approximation of functions by simpler computational building blocks (i.e., polynomials and splines), numerical differentiation and divided differences, numerical quadrature and integration.

Prerequisites: College algebra course (100-level or higher)

Course Text(s):

Chapra SC and Canale RP. "*Numerical Methods for Engineers", (6th ed.)*, 2010, McGraw-Hill. London, ISBN-13: 978-0073401065

MAT703 "LINEAR ALGEBRA" 4 CREDITS

INSTRUCTOR: DR. PASCUAL MARQUES

This 12-week 'instructor led' online course is an introduction to the concepts and methods of linear algebra. Among the most important topics are general vector spaces and their subspaces, linear independence, spanning and basis sets, solution space for systems of linear equations, linear transformations, and their matrix representations, and their inner products. The course is designed to develop an appreciation for the process of mathematical abstraction and the creation of a mathematical theory. Practical paper projects are also included.

Prerequisites: College algebra course (100-level or higher)

Course Text(s):

TBD

RES901 “DISSERTATION RESEARCH I” 4 CREDITS
INSTRUCTOR: DR. PASCUAL MARQUES

RES902 “DISSERTATION RESEARCH II” 4 CREDITS
INSTRUCTOR: DR. PASCUAL MARQUES

RES903 “DISSERTATION RESEARCH III” 4 CREDITS
INSTRUCTOR: DR. PASCUAL MARQUES
Students will work with an instructor to identify a topic, perform research and produce a Doctor of Science Dissertation in a specialized area of study. An instructor will guide the student through topic selection, problem identification, literature search, problem solution, dissertation structure and content. At the end of the program students will be required to give a 20 to 40 minute presentation of their research to the examining committee. Dissertations are judged by whether or not an original and unique contribution is made to scholarship.
Prerequisites: completion of 48 hours of graduate-level coursework and pass the graduate degree comprehensive examination.
Course Text(s):
Da R and Gastel B. (2012). *How to write and publish a scientific paper.* (7th ed.). Cambridge University Press. Cambridge.
Dunleavy P. (2003). *Authoring a PhD: How to plan, draft, write and finish a Doctoral dissertation or dissertation.* Palgrave Macmillan. Basingstoke.

SYS401 “INTRO TO SYSTEMS ENGINEERING” 4 CREDITS
INSTRUCTOR: MR. JOHN MINOR
Course Description: This 12-week online distance learning course introduces fundamental principles of the systems engineering process and techniques. This course covers the same material as SYS 601, but at a lower level (vocational-technical) of understanding. It covers the role of system engineering in the system life cycle from pre-concept exploration through concept development, design, production, utilization, operations support, and retirement. It addresses technical and project processes with which the system engineer is involved, enabling and support process activities, and specialty engineering activities. Tailoring of the system engineering function to suit the scope and needs of the project will be discussed. Finally, the course reviews management processes and techniques with which system engineer will be involved as part of the program management activity.

Course Text(s):
Benjamin S. Blanchard, Systems Engineering Management (4th Edition), Wiley, New Jersey 2008

SYS601 "INTRO TO SYSTEMS ENGINEERING" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

Course Description: This 12-week online distance learning course introduces fundamental principles of the systems engineering process and techniques. This course covers the same material as SYS 301, but at a higher (graduate) level of understanding. It covers the role of system engineering in the system life cycle from pre-concept exploration through concept development, design, production, utilization, operations support, and retirement. It addresses technical and project processes with which the system engineer is involved, enabling and support process activities, and specialty engineering activities. Tailoring of the system engineering function to suit the scope and needs of the project will be discussed. Finally, the course reviews management processes and techniques with which system engineer will be involved as part of the program management activity.

Course Text(s):
Benjamin S. Blanchard, Systems Engineering Management (4th Edition), Wiley, New Jersey 2008

UAV301 "UAS FUNDAMENTALS" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

These courses provide a comprehensive technical overview of unmanned aircraft systems. The following topics are covered in this course: UAV Components, UAV Communications & Data Links, UAV Sensors & Characteristics, UAV Ground Control Systems, Civil UAV Types, Roles and Operations, Civil Airspace Integration, Sense and Avoid Systems, UAV Mishaps, Causes of Failure, Improving Reliability, Human Machine Interface, UAV Alternative Propulsion (Fuel Cells and Solar), UAV Navigation, UAV Autonomous Operations, UAV Swarming, Future UAV Roles & Technologies.

Course Text(s):
Paul Fahlstrom and Thomas Gleason: Introduction to UAV Systems, 4th Edition, September 17, 2012 , Wiley.

UAV303 "UAV DESIGN & CONSTRUCTION" 4 CREDITS

INSTRUCTOR: MR. ERIC JAMESON

This course is designed to give participants hands-on experience in small Unmanned Aerial Vehicle (sUAV) design and construction to include systems integration and testing procedures. The balance of classroom instruction coupled with practical applications provides an understanding of the many interdependent subsystems in a sUAV.

Course Text(s)/Lab Equipment:

Drone University Paperback – October 18, 2014 by John M. Glover (Author)

Two-part Lab (each part costing $900.00)

Lab - Part I equipment package includes build kit, battery, charger, controller

Lab - Part II equipment package includes gimbal, camera, FPV equipment

UAV402 “UAS FLIGHT TEST & EVALUATION” 4 CREDITS

INSTRUCTOR: MR. FRED BIVETTO

This course covers the spectrum of unmanned aircraft systems (UAS) test and evaluation theory and techniques. Test and evaluation is just as much an essential part of the UAS design and development process as it is for a manned aircraft. However, the complexity and various levels of autonomy in the modern UAS present unique challenges to the system developer and tester that are seldom encountered in manned aircraft development, test and evaluation programs. This course provides students with a thorough understanding of the entire test and evaluation process as it applies throughout the developmental life cycle of the UAS, culminating with the capstone event—a comprehensive scenario-based flight test project. Course topics cover the major elements of test and evaluation process, including the use of modeling and simulation, system integration laboratories, hardware-in-the-loop (HITL) testing and simulation, installed system test facilities, and open air test ranges. The methods and challenges associated with flight testing remotely piloted and autonomous UASs are examined. Testing in all flight regimes of the UAS mission are covered to include launch and recovery, in-flight vehicle performance, stability, and control, sensor payload performance, communication and data link performance, ground station controls and displays, and human factors. Important test considerations such as design for reliability, robustness, and redundancy are examined. The critical importance of test safety is emphasized to include risk management, identification of risks, and risk mitigation.

Course Text(s): OPEN SOURCE (will be provided with course)

Stoliker, F. “Intro to Flight Test Engineering”, 2005, NATO.

Pontzer, A. “Unique Aspects of Flight Testing UAS”, 2010, NATO.
U.S. Naval Test Pilot School. “Fixed Wing Performance”
U.S. Naval Test Pilot School. “Fixed Wing Stability & Control”
U.S. Naval Test Pilot School. “Systems Testing”

UAV601 “UAS FUNDAMENTALS” 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

This course provides a comprehensive technical overview of unmanned aircraft systems. The following topics are covered in this course: UAV Components, UAV Communications & Data Links, UAV Sensors & Characteristics, UAV Ground Control Systems, Civil UAV Types, Roles and Operations, Civil Airspace Integration, Sense and Avoid Systems, UAV Mishaps, Causes of Failure, Improving Reliability, Human Machine Interface, UAV Alternative Propulsion (Fuel Cells and Solar), UAV Navigation, UAV Autonomous Operations, UAV Swarming, Future UAV Roles & Technologies.

Course Text(s):

Paul Fahlstrom and Thomas Gleason: Introduction to UAV Systems, 4th Edition, September 17, 2012 , Wiley.

UAV604 “UAV LAWS & REGULATIONS” 4 CREDITS

INSTRUCTOR: MS. CHRISTINA ENGH and MS. KELLY NEUBECKER, JD

This course will equip the student with a standardized and well-established collection of aviation/UAS law/regulation concepts, background and applications. After completing the course the student will be able to: understand the background and history of aviation safety, law and regulations; understand Pilot-In-Command (PIC) responsibility; review of the FAA (US) Federal Aviation Regulations / Aeronautical Information Manual (FAR/AIM); understand the UAS legal requirements and concerns for private operations; understand the UAS legal requirements and concerns for commercial operations; understand the UAS legal requirements and concerns for government operations; review of the current FAA (US) Certificate of Authorization (COA) process; review of the current FAA (US) 333 Exemption process and examination of various international UAS law and regulation trends.

Course Text(s):

Rupprecht, Jonathan B., “Drones: Their Many Civilian Uses & U.S. Laws Surrounding Them”, Version 2.02, 2015
FAR/AIM 2016
NPRM FAR PART 107 “sUAS Operator Certification” (provided)

UAV702 “UAS FLIGHT TEST & EVALUATION” 6 CREDITS

INSTRUCTOR: MR. FRED BIVETTO

This course covers the spectrum of unmanned aircraft systems (UAS) test and evaluation theory and techniques. Test and evaluation is just as much an essential part of the UAS design and development process as it is for a manned aircraft. However, the complexity and various levels of autonomy in the modern UAS present unique challenges to the system developer and tester that are seldom encountered in manned aircraft development, test and evaluation programs. This course provides students with a thorough understanding of the entire test and evaluation process as it applies throughout the developmental life cycle of the UAS, culminating with the capstone event—a comprehensive scenario-based flight test project. Course topics cover the major elements of test and evaluation process, including the use of modeling and simulation, system integration laboratories, hardware-in-the-loop (HITL) testing and simulation, installed system test facilities, and open air test ranges. The methods and challenges associated with flight testing remotely piloted and autonomous UASs are examined. Testing in all flight regimes of the UAS mission are covered to include launch and recovery, in-flight vehicle performance, stability, and control, sensor payload performance, communication and data link performance, ground station controls and displays, and human factors. Important test considerations such as design for reliability, robustness, and redundancy are examined. The critical importance of test safety is emphasized to include risk management, identification of risks, and risk mitigation.

Prerequisites: College algebra course (100-level or higher)

Course Text(s): OPEN SOURCE (will be provided with course):

Stoliker, F. “Intro to Flight Test Engineering”, 2005, NATO.

Pontzer, A. “Unique Aspects of Flight Testing UAS”, 2010, NATO.

U.S. Naval Test Pilot School. “Fixed Wing Performance”

U.S. Naval Test Pilot School. “Fixed Wing Stability & Control”

U.S. Naval Test Pilot School. “Systems Testing”

UAV801 “UAV AERODYNAMICS & FLIGHT STAB” 6 CREDITS

INSTRUCTOR: DR. PASCUAL MARQUES

This course addresses fundamental principles of aerodynamics and flight stability for applications in unmanned aircraft vehicle (UAV) design. It requires a basic knowledge of mathematics and numerical modeling and is intended as a first

course that provides a sound foundation for more advanced courses in aerodynamics modeling and computational fluid dynamics (CFD). Topics include: Fundamental aerodynamics theory, thin-airfoil theory, lifting-line theory, finite wing theory, vortex-panel method, airfoils suitable for UAVs, airfoil geometry, surface velocity, pressure distribution, boundary layer thickness distribution, airfoil operation in off-design conditions, Influence of Reynolds number, high-lift configurations in UAVs, boundary layer stability, flow control, rotor blade aerodynamics, methodology of CFD, and UAV flight stability.
Prerequisites: College algebra course (100-level or higher)

Course Text(s):

Anderson J. D. (2011). "Fundamentals of Aerodynamics", (5th ed.), McGraw-Hill, London. ISBN-13: 978-0073398105

UXV401 "UAS REMOTE SENSING" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

This course covers visible, infrared and radar sensors used for remote sensing by unmanned aircraft systems. This course covers the same material as UXV701 but at a lower (vocational/technical) level of understanding. Lectures include the theoretical background necessary to understand remote sensing applications in the optical and radio frequency portions of the electromagnetic spectrum, to include the effects of dynamic atmospheric conditions, target scene content and clutter. Sensor design and theory of operation is presented in the context of accomplishing specific missions for representative civil and commercial applications. Numerous example images and videos are used to illustrate system operation and performance and to facilitate student learning. Additionally, multi- and hyper- spectral imaging and light detection and ranging (LIDAR) sensors are illustrated and capabilities examined. Representative unmanned system sensor applications covered include target detection/acquisition/tracking, ranging, surveillance, reconnaissance, ground mapping, navigation, environmental monitoring, wildfire suppression, disaster and emergency management, agricultural monitoring, law enforcement, homeland security (airport, border, and port) and communications.
Prerequisites: College algebra course (100-level or higher)

Course Text(s):

Gundalach, J. "Designing Unmanned Aircraft Systems: A Comprehensive Approach", 2nd Edition, August 31, 2014, AIAA Press, ISBN-13: 978-1624102615, ISBN-10: 1624102611

UXV609 "INTRODUCTION TO ROBOTICS" 4 CREDITS

INSTRUCTOR: DR. ALA KHAMIS

Course Description: This course introduces the basics of robot design, planning and control. Topics include linear control theory, coordinate transformations, kinematics, dynamics, nonlinear control, trajectory planning, force control, sensors and actuators, filtering, optimal control and adaptive control. During the course the students will: learn the math and computational methods necessary to model and solve kinematic problems involving robot manipulators and mobile robots, familiarize with the most common robot sensors and understand fundamental sensor processing algorithms and their engineering trade-offs, explore the computational challenges inherent in fundamental mobile robotic tasks (e.g. localization, mapping, motion planning), explore simple robot control systems integrating perception, planning, and action.

Prerequisites: College Algebra, Linear Algebra (vectors and matrices). Programming skill in C/C++ highly desired but not required.

Course Text(s):

To Be Announced

UXV701 "UAS REMOTE SENSING" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

This course covers visible, infrared and radar sensors used in remote sensing by unmanned aircraft systems. This course covers the same material as UXV401 but at a higher (graduate) level of understanding. Lectures include the theoretical background necessary to understand remote sensing applications in the optical and radio frequency portions of the electromagnetic spectrum, to include the effects of dynamic atmospheric conditions, target scene content and clutter. Sensor design and theory of operation is presented in the context of accomplishing specific missions for representative civil and commercial applications. Numerous example images and videos are used to illustrate system operation and performance and to facilitate student learning. Additionally, multi- and hyper- spectral imaging and light detection and ranging (LIDAR) sensors are illustrated and capabilities examined. Representative unmanned system sensor applications covered include target detection/acquisition/tracking, ranging, surveillance, reconnaissance, ground mapping, navigation, environmental monitoring, wildfire suppression, disaster and emergency management, agricultural monitoring, law enforcement, homeland security (airport, border, and port) and communications.

Prerequisites: College algebra course (100-level or higher)

Course Text(s):

Gundalach, J. "*Designing Unmanned Aircraft Systems: A Comprehensive Approach*", 2nd Edition, August 31, 2014, AIAA Press, ISBN-13: 978-1624102615, ISBN-10: 1624102611

UXV803 "AUTONOMOUS UNMANNED SYSTEMS" 6 CREDITS

INSTRUCTOR: MR. JOHN SAUTER

This course provides a comprehensive background in autonomous control of unmanned systems. It describes the different levels of control in autonomous systems and, drawing from multiple examples, defines a generic control architecture. The basic elements of control theory and feedback control are covered including PID, fuzzy logic, and artificial neural networks and are applied to the design of simple robotic controller. Each of the key elements in autonomous systems is reviewed. Starting with sensing, we work through higher levels of information processing such as feature extraction, detection, recognition, and identification. The special problem of geo-location and mapping is discussed. We describe how this information can be represented in a world model including uncertainty and probabilistic descriptions of state. Mechanisms for reasoning, planning, and optimization in decision-making are described. Basic coordination schemes are discussed such as group decision-making, task allocation, scheduling, and formation control. Human interfaces and adjustable levels of autonomy, and issues related to establishing trust in autonomous systems are discussed. The course concludes with an overview of swarming systems and biological mechanisms for collaborative control of multiple systems. Design patterns for swarm control are discussed and a sample system developed. Case studies of swarm control are studied and their effectiveness evaluated.

Prerequisites: College calculus course

Course Text(s):

Siegwart, R. "Intro to Autonomous Mobile Robots", 2011, Intelligent Robotics.
Mataric, M. "The Robotics Primer", 2007, Intelligent Robotics.

UXV805 "HUMAN ROBOT INTERACTION" 4 CREDITS

INSTRUCTOR: MS. ELENA SPIRIDON

Numerous unmanned aircraft system accidents have been attributed to the design of the ground control station interface between the human and the machine. This course focuses on the emerging field of human-robot interaction (HRI), which is comprised of a multitude of disciplines including: robotics, artificial intelligence, human factors, human computer interaction and cognitive psychology. Topics include: Good practices when designing HRI systems, interaction and architectures, programming languages, metrics, social robotics, emotions, frameworks and relations between perception, actuation and HRI. The main goal is to improve the interaction between a human and machine.

Prerequisites: College algebra course (100-level or higher)

Course Text(s):

Boy GA. (2011). (Ed.). "*The Handbook of Human-Machine Interaction: A Human-Centered Design Approach*". Ashgate. Burlington, VT.
ISBN: 978-1-4094-1171-0 (ebook)

Disclaimer: *Actual courses offerings may be modified based upon minimum registration requirements and course text information is subject to change.*