UNMANNED VEHICLE UNIVERSITY
SCHOOL OF UNMANNED TECHNOLOGY
CY2015 – QUARTER 1
26 JAN – 19 APR 2015

CERTIFICATE PLAN

CERTIFICATE IN UNMANNED SYSTEMS PROJECT MANAGEMENT
DELIVERY MODE: 100% DISTANCE LEARNING

UAV301	"UAS FUNDAMENTALS"	4 CREDITS
UAV303	"UAV DESIGN & CONSTRUCTION"	4 CREDITS
SYS401	"PROJECT MGMT OF COMPLEX SYSTEMS"	4 CREDITS
UXV401	"UAS REMOTE SENSING"	4 CREDITS
	TOTAL CREDIT HOURS	**16 CREDITS**

DEGREE PLANS

MASTER OF SCIENCE IN UNMANNED SYSTEMS ENGINEERING
DELIVERY MODE: 100% DISTANCE LEARNING

MAT701	"NUMERICAL ANALYSIS"	4 CREDITS
SYS601	"UAV SYSTEMS ENG & PROJECT MGMT"	4 CREDITS
UAV601	"UAS FUNDAMENTALS"	4 CREDITS
UAV702	"UAS FLIGHT TEST & EVALUATION"	6 CREDITS
UAV801	"UAV AERODYNAMICS & FLIGHT STABILITY"	6 CREDITS
SYS809	"UAV PROPULSION METHODS"	4 CREDITS
UXV701	"UAS REMOTE SENSING"	4 CREDITS
UXV803	"AUTONOMOUS UNMANNED SYSTEMS"	6 CREDITS
	TOTAL CREDIT HOURS	**38 CREDITS**

DOCTOR OF SCIENCE IN UNMANNED SYSTEMS ENGINEERING
DELIVERY MODE: 100% DISTANCE LEARNING

GRADUATE LEVEL WORK	48 CREDITS
DISSERTATION RESEARCH	12 CREDITS
TOTAL CREDIT HOURS	**60 CREDITS**

COURSE OFFERINGS

UAV101 "UAV PILOT TRAINING" 1 CREDIT
INSTRUCTOR: Gene Payson
The UAV pilot training course consists of 3 phases. The first phase is to accomplish an online ground school and pass a general knowledge test. The second phase is to accomplish training on a home PC based simulator that is shipped to the student. The third phase is to attend UAV flight training at one of our UAV Flight Training Centers.
Prerequisites: Student must be 18 years or older
Course Text: To Be Announced (TBA)

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: 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 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. The course is taught online using course management software.

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

Course Text: Williams, G. "*Linear Algebra: With Applications*", 8th Ed., Jones and Bartlett Learning, Burlington MA. ISBN: 978-1-4496-7954-5

RES901 "DISSERTATION RESEARCH" 6 CREDITS

INSTRUCTOR: DR. PASCUAL MARQUES

RES902 "DISSERTATION RESEARCH" 6 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 Texts:

1. Da R and Gastel B. (2012). *How to write and publish a scientific paper.* (7th Ed.). Cambridge University Press. Cambridge.

2. Dunleavy P. (2003). *Authoring a PhD: How to plan, draft, write and finish a Doctoral dissertation or dissertation.* Palgrave Macmillan. Basingstoke.

SYS401 "PROJ MGMT OF COMPLEX SYSTEMS" 4 CREDITS

INSTRUCTOR: MR. ERIC JAMESON

This project-based course exposes students to tools and methodologies useful for the effective management of UAV projects. This course presents the tools and techniques for project definition, work breakdown, estimating, resource planning, critical path development, scheduling, project monitoring and control, and scope management. These tools will be presented within the context of a life cycle and a systems approach. Students will be exposed to advanced project management software. The basics of the Earned Value Management System (EVMS) will be covered. The project management course includes preparation for the Certified Associate in Project Management (CAPM) certification by the Project Management Institute (PMI). PMI certification formally recognizes an individual's competency in project management process and is widely acknowledged as a significant accomplishment by practitioners in the field.

Prerequisites: High school algebra course

Course Text: TBA

SYS601 "UAV SYS ENG & PROJECT MGMT" 4 CREDITS

INSTRUCTOR: DR. OSATO OSEMWENGIE

This course introduces the principles and methods of Modern Systems Engineering. Lectures include needs identification, requirements formulation, concept generation and selection, trade studies, preliminary and detailed design, component and subsystem test and integration as well as functional testing and delivery and operations. The concepts for tradeoffs between cost, performance and schedule are also discussed. The material serves as a baseline for advanced unmanned systems engineering courses.

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

Course Text: Ganesh Vaidyanathan, "Project Management Process, Technology, and Practice", Indiana University, ISBN-10: 0-13-280718-1 ISBN 13: 978-0-13-280718-0

SYS702 "SYSTEM CONCEPTUAL DESIGN" 4 CREDITS

INSTRUCTOR: DR. OSATO OSEMWENGIE

This course explains the details of the conceptual design phase of a system development program. The tools and techniques commonly employed during this phase will be presented. The course moves though the conceptual design process

by starting with a needs analysis and objectives and proceeds to explore alternative concepts and how to select the best alternative that meets the goals of cost, schedule and performance. Topics include CONOPS, development of requirements, functional analysis, risk assessment, system tradeoffs and measures of effectiveness.

Prerequisites: None

Course Text:

Kenneth E. Kendall and Julie E. Kendall, "*Systems Analysis and Design",* 9th Edition, *2014, Prentice Hall, ISBN-10: 0133023443 • ISBN-13: 9780133023442*

UAV301 "UAS FUNDAMENTALS" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR & MR. FRED BIVETTO

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. This course covers the same material as UAV-601, but the level of student understanding, the homework, and the exams are significantly less demanding that in UAV-601.

Prerequisites: High School Algebra Course

Course Texts:

1. Douglas M. Marshall (Editor), Richard K. Barnhart (Editor), Stephen B. Hottman (Editor), Eric Shappee (Editor), Michael Thomas Most (Editor): "*Introduction to Unmanned Aircraft Systems*" 1st Edition, October 25, 2011, CRC Press, ISBN-13: 978-1439835203; ISBN-10: 1439835209
2. Paul Fahlstrom and Thomas Gleason: Introduction to UAV Systems, 4th Edition, September 17, 2012 , Wiley,

UAV601 "UAS FUNDAMENTALS" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR & MR. FRED BIVETTO

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.

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

Course Texts:

1. Douglas M. Marshall (Editor), Richard K. Barnhart (Editor), Stephen B. Hottman (Editor), Eric Shappee (Editor), Michael Thomas Most (Editor): "*Introduction to Unmanned Aircraft Systems*" 1st Edition, October 25, 2011, CRC Press, ISBN-13: 978-1439835203; ISBN-10: 1439835209
2. 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 will provide the students with the knowledge to build and fly their own UAV. Topics covered include Definitions and Types, Small UAV Sensors, Small UAV Design, Small UAV Propulsion, Small UAV Energy Systems, Small UAV Regulation, Small UAV Operations, Starting a UAV Business. Course material will help students make the best decision possible in purchasing small UAVs. The content will also help graduates be effective as a pilot, sensor operator, maintenance technician, mission commanders, observers, supervisor, purchasing agent, decision makers, and more. The participants will gain a thorough working knowledge of small UAVs and sensors including operational capabilities of the most common systems available today, and the technology behind them.

Prerequisites: None

Course Text: TBA

UAV604 "UAV LAWS & REGULATIONS" 4 CREDITS

INSTRUCTOR: MR. STEVE HOGAN

This course will survey the rapidly evolving field of the law governing the use of Unmanned Aircraft Systems ("UAS") in the national airspace ("NAS"). The course will proceed based on six "modules" addressing various aspects of the new field of UAS Law. These modules are: (1) Emerging FAA Regulatory Framework; (2) Government Use of UAS and the Fourth Amendment; (3) State Regulation of Government and Commercial UAS; (4) Tort Liability for UAS Operations; (5) Emerging Frameworks for UAS and Privacy; and (6) Overview of Intellectual

Property Issues for the UAS Industry. Upon successful completion of the course, the student will have a working knowledge of the legal issues relevant to the UAS industry.
Prerequisites: None
Course Text: TBA

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 Texts are FREE and 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 Texts:

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

UAV809 "UAV PROPULSION SYSTEMS" 4 CREDITS

INSTRUCTOR: DR. EMAID RETHA

This course lectures related to fundamental principles of Unmanned Aerial Vehicle (UAV) propulsion design. It is intended as a first course that provides in-depth understanding of state-of-the-art propulsion issues for UAVs, including propulsion options, cycle analysis, and principles of operation, systems, components, and performance and efficiency calculations. Also the Theories of aero-engines and their related background in aerodynamics, thermodynamics and stress analysis are presented. System as well as component engineering aspects of engine aero-thermo-mechanical design is examined. Unmanned Aircraft Systems alternative power will be discussed.

Prerequisites: Intermediate college calculus course (200-level or higher)

Course Texts:

1. Mattingly, J. "*Elements of Propulsion Gas Turbines and Rockets*", 2006, AIAA.
2. Heywood, J. "*Internal Combustion Engines Fundamentals*", 1988, McGraw-Hill.

UXV401 "UAS REMOTE SENSING" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

See the description for UXV-701. This course covers the same material as UXV-701, but the level of detail the student is expected to understand, the homework and the exams are significantly less demanding than for UXV-701.

Prerequisites: High School Algebra Course

Course Text:

Author's Notes combined with the following textbook:

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

UXV701 "UAS REMOTE SENSING" 4 CREDITS

INSTRUCTOR: MR. JOHN MINOR

These courses covers visible, infrared and radar sensors used by unmanned aircraft systems. 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:

Author's Notes combined with the following textbook:

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

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 algebra course (100-level or higher)

Course Texts:

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: ELENA SPIRDON

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: 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: *Unmanned Vehicle University reserves the right to cancel any course with fewer than three registered students.*