EET-1195: UNMANNED AERIAL VEHICLES

Cuyahoga Community College

Viewing:EET-1195 : Unmanned Aerial Vehicles

Board of Trustees:
2018-05-24

Academic Term:
Fall 2018

Subject Code
EET - Electrical/Electronic Engineer

Course Number:
1195

Title:
Unmanned Aerial Vehicles

Catalog Description:
Addresses the emerging market for unmanned aerial vehicle (drones), their ethical use, safety issues, legal issues, electrical and mechanical components, on-board control systems, software and remote control.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
2

Requisites

Prerequisite and Corequisite
EET-1100 Introduction to Robotics or EET-1150 Basic Robotics with Math or departmental approval.

I. ACADEMIC CREDIT

Academic Credit According to the Ohio Department of Higher Education, one (1) semester hour of college credit will be awarded for each lecture hour. Students will be expected to work on out-of-class assignments on a regular basis which, over the length of the course, would normally average two hours of out-of-class study for each hour of formal class activity. For laboratory hours, one (1) credit shall be awarded for a minimum of three laboratory hours in a standard week for which little or no out-of-class study is required since three hours will be in the lab (i.e. Laboratory 03 hours). Whereas, one (1) credit shall be awarded for a minimum of two laboratory hours in a standard week, if supplemented by out-of-class assignments which would normally average one hour of out-of-class study preparing for or following up the laboratory experience (i.e. Laboratory 02 hours). Credit is also awarded for other hours such as directed practice, practicum, cooperative work experience, and field experience. The number of hours required to receive credit is listed under Other Hours on the syllabus. The number of credit hours for lecture, lab and other hours are listed at the beginning of the syllabus. Make sure you can prioritize your time accordingly. Proper planning, prioritization and dedication will enhance your success in this course.

The standard expectation for an online course is that you will spend 3 hours per week for each credit hour.

II. ACCESSIBILITY STATEMENT

If you need any special course adaptations or accommodations because of a documented disability, please notify your instructor within a reasonable length of time, preferably the first week of the term with formal notice of that need (i.e. an official letter from the Student Accessibility Services (SAS) office). Accommodations will not be made retroactively.

For specific information pertaining to ADA accommodation, please contact your campus SAS office or visit online at http://www.tri-c.edu/accessprograms. Blackboard accessibility information is available at http://access.blackboard.com.

Eastern (216) 987-2052 - Voice
Metropolitan (216) 987-4344 – Voice. (216) 987-4048 – TTY.
III. ATTENDANCE TRACKING

Regular class attendance is expected. Tri-C is required by law to verify the enrollment of students who participate in federal Title IV student aid programs and/or who receive educational benefits through other funding sources. Eligibility for federal student financial aid is based in part on enrollment status.

Students who do not attend classes for the entire term are required to withdraw from the course(s). Additionally, students who withdraw from a course or stop attending class without officially withdrawing may be required to return all or a portion of their financial aid based on the date of last attendance. Students who do not attend the full session are responsible for withdrawing from the course(s)

Tri-C is responsible for identifying students who have not attended a course before financial aid funds can be applied to students’ accounts.

Therefore, attendance is recorded in the following ways:

• For in-person and blended-learning courses, students are required to attend the course by the 15th day of the semester (or equivalent for terms shorter than five weeks) to be considered attending. Students who have not met all attendance requirements for in-person and blended courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

• For online courses, students are required to login at least two times per week and submit one assignment per week for the first two weeks of the semester, or equivalent to the 15th day of the term. Students who have not met all attendance requirements for online courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

At the conclusion the first two weeks of a semester or equivalent, instructors report any registered students who have “Never Attended” a course. Those students will be administratively withdrawn from that course. However, after the time period in the previous paragraphs, if a student stops attending a class or wants or needs to withdraw, for any reason, it is the student’s responsibility to take action to withdraw from the course. Students must complete and submit the appropriate Tri-C form by the established withdrawal deadline.

Tri-C is required to ensure that students receive financial aid only for courses that they attend and complete. Students reported for not attending at least one of their registered courses will have all financial aid funds held until confirmation of attendance in registered courses has been verified. Students who fail to complete at least one course may be required to repay all or a portion of their federal financial aid funds and may be ineligible to receive future federal financial aid awards. Students who withdraw from classes prior to completing more than 60 percent of their enrolled class time may be subject to the required federal refund policy.

If illness or emergency should necessitate a brief absence from class, students should confer with instructors upon their return. Students having problems with coursework due to a prolonged absence should confer with the instructor or a counselor.

IV. LEARNING OUTCOMES ASSESSMENT

Occasionally, in addition to submitting assignments to their instructors for evaluation and a grade, students will also be asked to submit completed assignments, called ‘artifacts,’ for assessment of course and program outcomes and the College's Essential Learning Outcomes (ELOs). The artifacts will be submitted in Blackboard or a similar technology. The level of mastery of the outcome demonstrated by the artifact DOES NOT affect the student’s grade or academic record in any way. However, some instructors require that students submit their artifact before receiving their final grade. Some artifacts will be randomly selected for assessment, which will help determine improvements and support needed to further student success. If you have any questions, please feel free to speak with your instructor or contact the Learning Outcomes Assessment office.

V. CONCEALED CARRY STATEMENT

College policy prohibits the possession of weapons on college property by students, faculty and staff, unless specifically approved in advance as a job-related requirement (i.e., Tri-C campus police officers) or, in accordance with Ohio law, secured in a parked vehicle in a designated parking area only by an individual in possession of a valid conceal carry permit.

As a Tri-C student, your behavior on campus must comply with the student code of conduct which is available on page 29 within the Tri-C student handbook, available at http://www.tri-c.edu/student-resources/documents/studenthandbook.pdf You must also comply with the College's Zero Tolerance for Violence on College Property available at http://www.tri-c.edu/policies-and-procedures/documents/3354-1-20-10-zero-tolerance-for-violence-policy.pdf

Outcomes
Course Outcome(s):
Describe the ethical issues surrounding the use of Unmanned Aerial Vehicles (UAV) and the new uses that affordable UAVs may offer.

Essential Learning Outcome Mapping:
Civic Responsibility: Analyze the results of actions and inactions with the likely effects on the larger local and/or global communities.
Information Literacy: Acquire, evaluate, and use information from credible sources in order to meet information needs for a specific research purpose.
Objective(s):
1. Explain possible uses for UAVs in warfare.
2. Explain possible uses for UAVs in police work.
3. Explain the possible uses and ramifications for the use of UAVs in criminal activities.
4. List some industries or services that may be adversely affected (go out of business) because of the expanded use of UAVs.
5. Explain some dangers that public use of UAVs may pose and how quality of life may be enhanced.
6. Explain what “emerging market(s)” means and how UAVs may be viewed as an emerging market.
7. Explain and justify the use of UAVs in spying, including paparazzi.

Course Outcome(s):
Write a formal lab report (using the EET Student Handbook for instructions).

Essential Learning Outcome Mapping:
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):
1. Demonstrate word processing skills by importing pictures, graphs, and schematic diagrams to written lab reports.
2. Verify by using the word processor’s statistical rating tool that the report is equal to or above 12th grade (high school) level.

Course Outcome(s):
Demonstrate through programming the operation of a servo control unit that can be used in surveillance.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Determine the range of the camera-fed transceiver that will link a UAV with the control center.
2. Explain the operation of a servo control motor with regard to the x- and y-axis.
3. Test a wireless surveillance camera.
4. Mount a wireless surveillance camera to a gimbal and then mount the gimbal to a servo control unit.
5. Test the gimbal mounted camera and servo assembly and, if operational, mount on a UAV.
6. Test the surveillance camera and servo controller by test flying the UAV and monitor the results at the control center.

Course Outcome(s):
Present an oral report on a lab experiment of your choice.

Essential Learning Outcome Mapping:
Oral Communication: Demonstrate effective verbal and nonverbal communication for an intended audience that is clear, organized, and delivered effectively following the standard conventions of that language.

Objective(s):
1. Verify by using the word processor’s statistical rating tool that the report is equal to or above 12th grade (high school) level.
2. Demonstrate presentation software skills by importing pictures, graphs, schematic diagrams into materials to be used in an oral presentation.

Course Outcome(s):
Calculate and explain the forces related to propellers and the wind loading aspects of a UAV.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Explain drag and how it can affect a UAV.
2. Determine the energy in wind relative to a stationary point and explain the mathematical relationship between wind speed and energy.
3. Explain how an airfoil provides lift.
4. Explain how a propeller generates thrust (or lift) and how propeller pitch affects performance.
Course Outcome(s):  
Calculate torque, power, efficiency, etc, for a direct current motor(s) used in UAVs.

Essential Learning Outcome Mapping:  
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):  
1. Explain the difference between permanent magnet (PM) direct current (DC) motors and DC motors that only use electromagnetic properties.
2. Explain how the number of poles affects the speed and torque of a DC motor.
3. Measure and graph the power, speed, and torque characteristics of a PM DC motor.
4. Explain the advantages and disadvantages of brushed versus brushless DC motors.
5. Explain the political and economical issues associated with rare earth minerals is used in PM motors.

Course Outcome(s):  
Design, troubleshoot, and explain the general motor control electronics used in UAVs.

Essential Learning Outcome Mapping:  
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):  
1. Explain and demonstrate the operation of metal oxide semiconductor Field Effect Transistors (MOSFET), calculate power dissipation relative to the transistor’s characteristics, and the gate - source control characteristics.
2. Explain pulse width modulation (PWM) and calculate and measure the DC average voltage, the root-mean-square voltage, and power as they relate to the active percentage time of a PWM voltage.
3. Explain and measure the efficiency of control electronics used in UAVs.

Course Outcome(s):  
Connect and verify the operation of electronic sensors in a UAV.

Essential Learning Outcome Mapping:  
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):  
1. List the sensors a UAV may need in autonomous applications.
2. Explain the data frames provided by a global positioning system (GPS) integrated circuit sensor and demonstrate the decoding and display the sequence on a microcontroller or single board computer.
3. Demonstrate the acceleration versus output voltage or digital stream of an accelerometer integrated circuit.
4. Demonstrate the output voltage or digital stream of a compass integrated circuit.
5. Demonstrate the output voltage or digital stream of a barometric pressure integrated circuit.
6. Demonstrate the output voltage or digital stream of a temperature sensing integrated circuit.

Course Outcome(s):  
Describe the programming aspects on a stable control system used in a UAV.

Essential Learning Outcome Mapping:  
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):  
1. Explain the difference between positive and negative feedback systems and provide an example of each.
2. Explain each component of a proportional - integral - differential (PID) control system.
3. Explain what can happen if a negative feedback control system encounters an environment outside of its designed control range.

Course Outcome(s):  
Describe the dangers to the public that expanded use of UAVs present.
Essential Learning Outcome Mapping:
Civic Responsibility: Analyze the results of actions and inactions with the likely effects on the larger local and/or global communities.
Information Literacy: Acquire, evaluate, and use information from credible sources in order to meet information needs for a specific research purpose.

Objective(s):
1. List the possible effects of UAVs on commercial and private aircraft.
2. Explain how unintentional radio frequency (RF) radiation can adversely affect government, business enterprise, or private citizens with regard to electronic equipment.
3. Explain how jamming a UAV may constitute a hazard for the public.

Course Outcome(s):
Calculate and explain rechargeable battery chemistries.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Explain the difference between energy density and power density.
2. With regard to a battery’s energy rating in milliampere hours, explain how the actual energy availability is affected by the discharge current rate.
3. Explain the difference between nickel metal hydride (NiMH) and lithium-ion (Li-ion) battery technologies that include energy density, power density, voltage characteristics under load, memory effect, disposal issues, and inherent danger if a fully charged battery is short circuited.

Course Outcome(s):
Demonstrate navigational methods using latitude and longitude.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):
1. Given latitude and longitude, find a point on a map.
2. Using Google Earth or a similar program, given an address or location, provide the latitude and longitude.
3. Design a flight path around an airport by specifying compass direction in degrees, minutes, and seconds (or decimal minutes) and latitude and longitude of turn points.
4. Program an autonomous UAV or fly by remote control a flight path around some object.

Methods of Evaluation:
A. Tests
B. Quizzes
C. Homework
D. Lab Assignments
E. Programming Assignments

Course Content Outline:
1. Concepts
   a. General uses for UAVs, pro’s and con’s
      i. UAVs in warfare and police work
      ii. UAVs relative to criminal activities
      iii. Ownership of airspace
   b. Aerodynamics
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1. Components
i. Wind loading
   ii. Propeller Thrust
   iii. Drag
   iv. Energy of wind

c. Electric Motors and control systems
   i. Permanent versus electromagnetic
   ii. Brushless versus brushed motors
   iii. Obtaining rare earth minerals
   iv. Using electronic switches to control motor speed
   v. Concept of Pulse Width Modulation for motor control
   vi. Negative feedback in control systems
   vii. Failure of negative feedback control systems

d. Navigational methods
   i. Longitude
   ii. Latitude
   iii. Global Positioning System (GPS)
   iv. Autonomous flight

e. Batteries
   i. Energy density
   ii. Power density
   iii. Nickel-metal hydride (NiMH) batteries
   iv. Lithium ion (Li-ion) batteries
   v. Flight range

f. Sensors
   i. GPS sensors
   ii. Accelerometers
   iii. Temperature
   iv. Atmospheric pressure
   v. Compass
   vi. Collision avoidance
   vii. Cameras and radio links

2. Skills
   a. Using electronic test equipment
   b. Using mechanical test equipment
   c. Relating lab results with theoretical calculations
   d. Manual control of UAVs

3. Ethical considerations
   a. Invasion of privacy
   b. Stealing information through unauthorized viewing
   c. Terrorism

4. Safety considerations
   a. Danger to aircraft
   b. Danger to people
   c. Danger of mishandling Li-ion Batteries (explosions)

Resources


**Resources Other**

**Electronic Devices and Circuit Theory (11th Edition),**


Pearson

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