

ES100 Engineering Design Project

Micro Air Vehicle

Background:

Small unmanned aerial vehicles like Raven RQ-11 have been used by the military for years. The four-pound vehicle developed by Aerovironment (AV) has a wing span of 55 inches. It can fly an autonomous surveillance mission for more than an hour within a range of six miles.



On the civilian side, a French company Parrot launched a new iProduct controlled one-pound quad-rotor smart helicopter called AR. Drone with amazing capabilities. It makes Wii thing of the past by replacing the computer graphics display with a real flying machine.



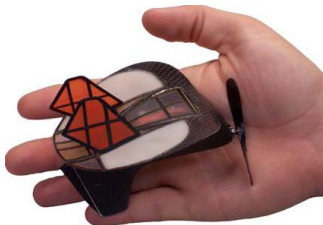
Micro Air Vehicle (MAV) is a product with many applications and a lot of market potentials. With the advancement of microelectronics, the new breed of flying machine is getting even smaller. Lately AV demonstrated the capabilities of a 6" wingspan 19-g nano humming bird – an NAV.



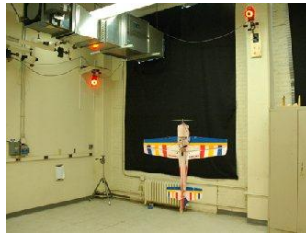
Research on MAV also exist in the academic labs. University of Maryland Autonomous Vehicle Lab is famous for it's bio-inspired flying machine such as the mechanical samara.



University of florida has won several prizes in the annual international MAV competition with its composite wing butterfly.



The MIT Aerospace Controls Lab has demonstrated the autonomous VTOL flying capabilities that make the would-be 3D R/C plane flyers envy.



You need to know the answers of the following questions. They are worth 2% of your course grade.

What is an UAV?

How do we classify UAVs in terms of flight mechanism?

How do we classify UAVs in terms of propulsion system?

What are yaw, pitch, and roll of an aircraft?

What is stability and control of an aircraft?

How do we control the flight of a fixed-wing aircraft?

How do we control the flight of a rotary-wing aircraft?

How do we design an aircraft with inherent stability?

AR.Drone – sensors and processors

GWS SlowStick - dihedral, CG location

Group:

Form a project team with 6 people. Elect a team leader who serves as the coordinator between members and the instructor(s). The project will be evaluated as a group. Start a [Google Code](#) project group with the title ES100 Project – MAV. Identify your contribution in the downloadable files. Teamwork is worth 10% of your course grade.

Learn:

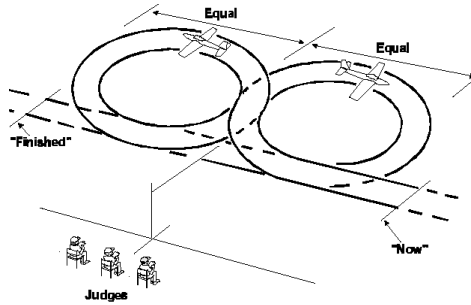
Watch the demonstration and practice the flying skills with the AR.Drone. Purchase a Hobby Zone Vapor per group and use it as a trainer. Each of you needs to pass a flight test which is worth 2% of your course grade.

Design:

Utilize the knowledge learned in each phase of the course including conceptual design using engineering sketches, detailed design using Pro/ Engineer, and cost analysis and material list preparation using Excel to design a micro air vehicle with the following requirements:

1. Structure and payload requirements
 - (a) There is no size restriction.
 - (b) A quick mount should be provided for a 20-g micro DVR.
 - (c) The maximum weight of the vehicle including payload should be 450 g.
2. Mode of flight requirements
 - (a) Fixed wing, rotary wing, flapping wing, hovercraft, lighter-than-air, or any innovation is allowed. Although your option is open, it is recommended that you adopt a 3-channel GWS Slow Stick kit as your basic platform unless there is an experience flyer in you group.
 - (b) Ground takeoff and landing is required (no toss).
3. Power and propulsion requirements
 - (a) The use of internal combustion engines or open flame hot-air is prohibited.
 - (b) The vehicle must be able to fly for at least 5 minutes without replenishing or recharging its energy source.
4. Control requirements

The vehicle must be controlled by a 2.4G Hz radio transmitter in a 100'x50'x30' indoor/outdoor space.
5. Mission requirements
 - (a) Endurance - fly as many figure 8 paths around two pylons separated by 50' in five minutes.



(b) Precision flight – survey a 100’x50’ ground area and acquire a legible image of each of the four 1’x1’ targets.

6. Cost requirements

(a) Total as-built replacement cost of the vehicle and the trainer must be less than \$250.

(b) The cost must be broken down in a Bill of Materials (BOM), in which the Fair Market Value (FMV) of each component must be listed along with the part number, description, and quantity.

© To reduce the out of pocket cost, you can loan a radio transmitter and receiver set from the department and share your trainer among groups.



[GWS Slow Stick, No Power System – Painted Red \(GWAE0018I\)](#)

With fiberglass fuselage boom. Wing Span: 46.3 in, Wing Area: 505.9 sq in, Length: 37.6 in, Flying Weight: 14.3 ~ 15.5 oz.

\$28.00



2.4G Fly-Sky (FS) CT6B 6-Channel Transmitter+Receiver (R6B)

Works for RC Planes &Heli

Sale price: \$31.70



Dynam Brushless motor+18A ESC+3pcs 9g servos for RC Park Flyer

Sale price: \$24.70



\$6.00

WWW.HOBBYPARTZ.COM

7. Product deliverables

- (a) The MAV.
- (b) The preliminary design presentation (PowerPoint slide file)
- (c) The final design presentation (PowerPoint slide file)
- (d) The final printed design report.

Preliminary Design Review:

Make a 20 minute presentation about your project. The grading chart is listed below. It is worth 6% of your course grade.

Preliminary Design Presentation Evaluation Form

Team _____

Reviewer _____

		1 poor	2	3 fair	4	5 excellent	Comments
Delivery	Presentation organization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Technical language	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Professionalism	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Visual aids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Appropriate use of time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Technical Content	Introduction and objectives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Design details	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Design drawings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Parts list and cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Gantt chart	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
	Originality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Additional comments:

Testing:

Build and test the MAV. Record the performance. Observe safety rules during fabrication and testing. Always keep the Lipo battery in a ceramic container while charging and never leave it unattended.

Report:

Prepare an engineering design report (one per group) with the following sections:

summary	description	analysis	
design sketches	Pro/E drawings	material list	
assembly	performance	conclusion	references

Hand in the report during the last class period. It is worth 10% of your course grade.

Final Design Presentation:

Make a 20 minute final presentation using the real product, slides, video (upload to Youtube), and PowerPoint. The rubric is similar to the preliminary design presentation. It is worth 6% of your course grade.

Contest:

Participate in a class/campus wide contest during the final exam time. It is worth 4% of your course grade.

Project Timeline:

Week 2 (1)	Form project groups, elect team leaders, start information search on the Web
Weeks 3-4 (2-3)	Gantt chart , Brain Storming, preliminary design with sketches
Weeks 5-9 (4)	Preliminary Design Review, Detail Design with Pro/E, get material
Weeks 10-15 (5)	Build, test, and document
Week 16 (6)	Presentation, report submission, and competition
(*) summer class	

Grading Policy:

Project 40%	Teamwork (Goggle Code project)	10%
	Background knowledge test	2%
	Trainer flight skill test	2%
	Preliminary Design Review (oral presentation)	6%
	Final Design Presentation	6%
	Flight competition	4%
	Final Design Report	10%