Syllabus

AOE 4065 (Fall)

1. **Course Name:** Air Vehicle Design
2. **Credit and Contact Hours:** 3 Credit Hours (2H + 3L + 3C)
3. **Lectures:** Tuesdays & Thursdays, 3:30 – 4:45 PM, enter *'classroom'*
4. **Instructor:** Enter pertinent info *(name, office, phone, e-mail)*
5. **Co-instructor:** Enter pertinent info *(name, office, phone, e-mail)*
6. **Office Hours:** Enter start & end times or enter '*By appointment'*

7. **Textbook**
   - Nicolai, L.M., and Carichner, G.E., *Fundamentals of Aircraft and Airship Design, Volume I—Aircraft Design,* AIAA Education Series, AIAA, Washington D.C., 2010.
     Although the 'Textbook' covers the fundamentals of most of the technical topics of this course, additional books and reference materials are essential to covering the gaps and adding more details to some topics. Examples include subsystems, configuration layout, computer-aided design (CAD), and engineering analysis software. Therefore, students are expected to use numerous other sources of online and hardcopy reference material. Although we provide an extensive list of books and references, students will most likely need to search for others depending on the nature and scope of their design project.

   a. Select Primary References
   - Raymer, D.P., *Aircraft Design*: *A Conceptual Approach*, 6th Ed., AIAA Education Series, AIAA, Washington, D.C., 2018.
   - Gundlach, J., *Designing Unmanned Aircraft Systems: A Comprehensive Approach*. Reston, VA: AIAA Education Series, 2012.
   - Sadraey, M.H., *Aircraft Design: A Systems Engineering Approach*. West Sussex, United Kingdom: John Wiley and Sons, Ltd., 2013.
   - Kirschbaum, N. and Mason, W.H., *Aircraft Design Handbook: Aircraft Design Aid and Layout Guide*, VPI Aircraft Design Series, 1992-93.
   - Roskam, J., *Aircraft Design*, Parts 1-8, Roskam Aviation and Engineering Corp., Lawrence, KS, 1985.
   - Moir, I. and Seabridge, A., *Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration*, 3rd edition, AIAA Education Series, AIAA, Reston, VA, 2008.
   - Mason, W.H., Info for Aircraft Design, *http://www.dept.aoe.vt.edu/~mason/Mason_f/SD1.html*

8. **Specific Course Information**

   a. Catalog Description
   Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation.

b. Course Description

AOE 4065, offered in the fall semester, is the first of a two-semester capstone senior design sequence. In the fall semester, the class is scheduled to meet for two 75-minute periods a week, and is devoted to discussion of key topics related to air vehicle (aircraft) design.

Students learn the aircraft conceptual design process by studying the fundamentals of the design discipline and applying those fundamentals to *independently* conduct a team design project. That is, students ***learn by doing***! Students start out by forming small teams of approximately eight students each and selecting a design project from a set of Request for Proposals (RFPs). The design project lasts the entire semester with a preferred system concept (PSC) as the outcome. Each team's goal is to create an innovative design that best serves the customer needs outlined in the RFP. Since the emphasis is on team effort, most of the assignments are team-based. However, a few individual homework are assigned to assess the level of understanding of the fundamentals of design.

To create feasible candidate concepts for their project, the students focus on the hands-on application of knowledge and skills acquired in this course and in other courses. In addition, they must consult a wide variety of other sources for areas not formally covered in this or other courses they have taken. Examples include avionics, subsystems, cost, manufacturing, and project planning & management.

Each team schedules weekly meetings with the instructors lasting about an hour to discuss accomplishments, plans, and issues related to their project. In addition, each team conducts four formal project reviews: (1) System Requirements Review ("SRR"); (2) Master Project Plan ("MPP") Review; (3) System Concepts Review ("SCR"); and (3) System Design Review ("SDR"). The "SDR", typically held in the 15th week of the semester, covers each team's progress in selecting a PSC which forms the baseline for preliminary design effort in AOE 4066 in the spring semester. This course also meets the curriculum's "writing intensive" requirement.

c. Prerequisites 2104 (Intro to Aerospace and Performance); 3054 (AOE Experimental Methods); 3114 (Aerodynamics and Compressibility); 3124 (Aerospace Structures); 3134 (Air Vehicle Dynamics); 3164 (Aerothermodynamics and Propulsion)

d. Co-requisites 4105 (Experiments for Aerospace Design I)

e. Required Course Yes

f. Grading Distribution

- ***We do not use any set grade distribution targets (such as a certain percentage of A's and B's) or cut-offs (e.g., A=90 and above, or B = 80-90)***. Your letter grade represents <u>*relative standing*</u>; it's <u>*not*</u> an absolute measure.
- We strongly recommend that you carefully study the **<u>Grading Procedure</u>** document posted on the course site.
- Individual grade is determined by combining the numerical scores of:

Individual Homework	12%
Oral Project Reviews	35%
SRR (10%)	
MPP Review (5%)	
SCR (10%)	
SDR (10%)	

Written Final Report	50%
Peer Performance Assessment	3%
	100%

Note that there are no quizzes, midterm or final exams.

- *Your team must work together for the entire semester. Conflicts or concerns will not magically go away over the next 15 weeks. Each of you needs to be proactive when you see potential problems, trying to work it out within the team when possible and asking for help from your instructors sooner rather than later. You will have the opportunity to provide feedback using a Peer Performance Assessment process. Individual grades may be adjusted in cases of a large and clear imbalance in a team at the instructor's discretion.*

9. Specific Goals for the Course

a. Course Learning Objectives for the Fall Semester

1. Apply systems thinking and an aircraft design process to create feasible air vehicle concepts.
2. Apply qualitative decision-making tools to compare candidate concepts and choose the one that best meets design requirements.
3. Estimate initial air vehicle weight, wing size, and engine size based on mission profile.
4. Perform tradeoff studies to select values of design variables.
5. Assess air vehicle feasibility for meeting design requirements through engineering analysis.
6. Design innovative air vehicles that meet *all* customer requirements.
7. Develop a project plan. assess risks, and prepare risk mitigation plans.
8. Contribute to a multidisciplinary design team as a member with the highest levels of ethics, integrity, and professionalism.
9. Deliver oral presentations for informal and formal design reviews.
10. Write an engineering design report in proposal style (response to Request for Proposal).

b. ABET Outcomes Addressed by the Course

Coverage of the seven ABET outcomes (*listed below the table*) in relation to each course learning objective is assessed on the following scale: **0 (blank) = none, 1 = low, 2 = moderate, 3 = high**.

Course Learning Objective ▼ / **ABET Outcome ►**	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*
1. Apply systems thinking and an aircraft design process to create feasible air vehicle concepts.	1	3		2			2
2. Apply qualitative decision-making tools to compare candidate concepts and choose the ones that best meet design requirements.	3	3		2			2
3. Estimate initial air vehicle weight, wing size, and engine size based on mission profile.	2			2		2	
4. Perform tradeoff studies to select values of design variables.			2		2		
5. Assess air vehicle feasibility for meeting design requirements through engineering analyses.					2	3	2
6. Design innovative air vehicles using systems thinking to meet all customer requirements.	1	3		2			2
7. Develop a project plan, assess project risks, and prepare risk mitigation plans.	2			2			
8. Contribute to a multidisciplinary design team as a member with highest levels of ethics, integrity, and professionalism.	2	2	2	3	3	2	2
9. Deliver oral presentations for informal and formal design reviews.	2	3	3	1	2	1	2
10. Write an engineering design report in proposal style (response to Request for Proposal).	2	3	3	1	2	3	2

ABET Specify the Following Seven (7) Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge, as needed, using appropriate learning strategies.

10. Brief List of Topics

TOPIC	% OF COURSE (estimate)
Design Basics and Aircraft Design Process	15%
Systems Thinking & Systems Engineering	15%
Initial Sizing	15%
Aircraft Layout	15%
Tradeoff Studies	15%
Risk Management	10%
Oral Communication	5%
Written Communication	10%
	100%

- Basics of design and systems thinking including role of multiple stakeholders including customer, government, and society
- Three phases of aircraft design, and the critical importance of the Conceptual Design phase
- Conceptual design process driven by requirements and measures of merit
- Aircraft weight sizing, wing sizing, and engine sizing to meet mission requirements
- Aircraft layout: external (outer mold line) and internal (with structures and subsystems)
- Tradeoff and parametric studies
- N^2 Diagram and Multidisciplinary Analysis, Design, and Optimization (MADO)
- Project planning and management
- Effective teamwork with the highest levels of ethical and professional conduct
- Communications: Oral (Design Reviews) and written (Design Report in Proposal style)

11. Honor Code

The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states:

"As a Hokie, I will conduct myself with honor and integrity at all times.
I will not lie, cheat, or steal, nor will I accept the actions of those who do."

Students enrolled in this course are responsible for abiding by the Honor Code. The University Undergraduate Honor Code applies to all work for this course. Bear in mind that honesty in your academic work is a reflection of your personal and professional integrity.

All work you submit must be your own (for individual assignments) or the team's (for team assignments). For team assignments, the work must reflect uniform participation across all team members; team members should be prepared to provide feedback about their own and their team members' involvement. Note that differential grades are likely on team assignments. We will report suspected violations of the Honor Code to the Office of Undergraduate Academic Integrity. A student who has doubts about how the Honor Code applies to any assignment may obtain specific guidance from the course instructor or teaching assistant before submitting the assignment for evaluation. *Ignorance of the rules does not excuse any member of the University community from the requirements and expectations of the Honor Code*.

If you have questions or are unclear about what constitutes academic misconduct, please speak with us. We take the honor code very seriously in the course. The normal sanction we will recommend for a violation of the Honor Code is an F* sanction as your final course grade. The F represents failure in the course. The "*" is intended to identify a student who has failed to uphold the values of academic integrity at Virginia Tech. A student who receives a sanction of F* as their final course grade shall have it documented on their transcript with the notation "FAILURE DUE TO ACADEMIC HONOR CODE VIOLATION." You would be required to complete an education program administered by the Honor System to have the "*" and notation "FAILURE DUE TO ACADEMIC HONOR CODE VIOLATION" removed from your transcript. The "F" however would be permanently on your transcript.

The Honor Code expressly forbids the following academic violations:

A. CHEATING
Cheating includes the intentional use of unauthorized materials, information, notes, study aids or other devices or materials in any academic exercise, or attempts thereof.

B. PLAGIARISM
Plagiarism includes the copying of the language, structure, programming, computer code, ideas, and/or thoughts of another and passing off the same as one's own original work, or attempts thereof.

C. FALSIFICATION
Falsification includes the statement of any untruth, either verbally or in writing, with respect to any element of one's academic work, or attempts thereof.

D. FABRICATION
Fabrication includes making up data and results, and recording or reporting them, or submitting fabricated documents, or attempts thereof.

E. MULTIPLE SUBMISSION
Multiple submission involves the submission for credit—without authorization of the instructor receiving the work—of substantial portions of any work (including oral reports) previously submitted for credit at any academic institution, or attempts thereof.

F. COMPLICITY
Complicity includes intentionally helping another to engage in an act of academic misconduct, or attempts thereof.

G. VIOLATION OF UNIVERSITY, COLLEGE, DEPARTMENTAL, PROGRAM, COURSE, OR FACULTY RULES
The violation of any University, College, Departmental, Program, Course, or Faculty Rules relating to academic matters that may lead to an unfair academic advantage by the student violating the rule(s).

12. Attendance and Classroom Behavior

Virginia Tech has a class attendance policy. Class meetings are an integral part of this course. Students and faculty are expected to attend class at all regularly scheduled times, except for cancellations announced on a university-wide basis by the appropriate authority. When students cannot attend a class, it is their responsibility, as soon as possible, to consult with the course instructor about missed work. Students are expected to respect one another, and the instructors, in and outside the classroom. Computers may be used in the classroom *only for viewing material for this course or for taking notes*. Accessing audio, images, or videos during class may be distracting to other students and is strictly prohibited. *Mobile phone use is prohibited*, except as a student response system.

13. AOE Studio for Design Innovation (ASDI@VT)

Because of the emphasis on teamwork, the ASDI@VT in Surge 118 has been dedicated to senior design activity. Seniors use it on a priority basis. There are three collaboration rooms; a conference room; one presentation theater; and a flexible "white-board" room. The collaboration room and presentation theater are equipped with a hockey-puck system which allows multiple portable computers to be connected via HDMI and selected by tapping one of the pucks.

In addition, there is an ASDI Library with two cabinets full of relevant reference material. *This material is for your use while you are in ASDI*. The material should ***not*** be taken out of the Studio unless expressly authorized by one of the instructors. It is your personal responsibility to maintain the room in good condition. *Leave it in a better condition than you found it.* After all, it is your facility!

Note that you can have remote access to the eight engineering workstations in the studio. Please email your request to (aoe-it-support-g@vt.edu) for setting up a computer account, and for any other information about the workstations that you need.

14. Accommodations

Virginia Tech welcomes students with disabilities into the University's educational programs. The University promotes efforts to provide equal access and a culture of inclusion without altering the essential elements of coursework. If you anticipate or experience academic barriers that may be due to disability, including but not limited to ADHD, chronic or temporary medical conditions, deaf or hard of hearing, learning disability, mental health, or vision impairment, please contact the Services for Students with Disabilities (SSD) office at 540-231-3788 or **ssd@vt.edu**, or visit **www.ssd.vt.edu**. If you have an SSD accommodation letter, please meet with the instructor privately during office hours as early in the semester as possible to deliver your letter and discuss your accommodations. You must allow reasonable time to implement your accommodations, which is generally 5 business days.

15. Emergency Preparedness

If you haven't already, it is strongly recommended that you read the following Emergency Preparedness flyer:
https://emergency.vt.edu/content/dam/emergency_vt_edu/programs-1/online-toolkit/20160613_studentpreparedness.pdf

16. Principles of Community Statement

The Virginia Tech Principles of Community are intended to increase access and inclusion and to create a community that nurtures learning and growth for all of its members. They are defined at http://inclusive.vt.edu/