

Aeronautics Design Project

Hybrid Electric STOL Commuter Aircraft Design

Thomas Andrianne
Ludovic Noels
Paul Dechamps
Jérôme Van Den Berghe

September 2026



1. Context

The students groups shall design an aircraft following the requirements of the AIAA 2027 Graduate Team Aircraft Design Competition: <https://aiaa.org/get-involved/university-students/design-competitions/#design-compe>. In particular they shall comply with the Open Division Graduate/Undergraduate Aircraft – Hybrid-Electric STOL Commuter (https://aiaa.org/wp-content/uploads/2026/08/2026-2027-Open-Division-Aircraft_Hybrid-STOL.pdf).

The objective is to design a Hybrid Electric Short Take off and Landing (STOL) commuter aircraft, including the design of the high-voltage/high-power distribution propulsion system. The entry into service (EIS) is 2035 for a STOL 8-seater with 400 nmi of range. The intent is to have energy storage to supplement takeoff, climb, and full-electric cruise capability via batteries and electric motors. A combustion engine providing additional power and/or direct propulsion for cruise to extend the range and to supply for go-around and emergencies.

One potential mission for such a vehicle includes commuter services between metropolitan centers (San Francisco to LA is ~300 nmi) that originate from and arrive at small airports near urban centers. This would enable point-to-point travel in new markets that otherwise would be difficult to service. Identification of other new markets and how the vehicle can be used to serve them should be considered an important part of the design process.

2. Organization

Each group, of up to **maximum 8 students**, elects a coordinator who will be responsible for:

- Ensuring the transfer of information between the group members;
- Compiling the group reports from the individual contribution of each group member;
- Submitting the letters of Intent and the Report to AIAA.

During the first project session, the work will be organized into tasks for the two Work Packages (WP1 Conceptual design, WP2 Preliminary Design). For each task one student will be responsible for its completion. After the first session, the distribution of tasks between students will be sent to the project supervisors.

Before the beginning of each session, each group will deliver a short report (1 page) with the summary of each student weekly achievements.

3. WP1: Conceptual design

The following items will be studied:

1/ Definition of the design missions and requirements:

- Following the Request for Proposals of the AIAA Graduate Team Aircraft Design Competition: <https://aiaa.org/get-involved/university-students/design-competitions/#design-compe>.
- Following the “Requirements” of the Request for Proposals.
- Ensuring compatibility with the relevant FAA regulation, e.g FAA 14 CFR Part 23: <https://www.ecfr.gov/current/title-14/chapter-I/subchapter-C/part-23?toc=1>

2/ CAD

- Create a realistic CAD view

3/ Wing

- Design the planform (aspect ratio, surface area, taper ratio, twist, sweep angle, chord, ...)
- Choose airfoil profiles
- Design the control surfaces
- Define the position (setting angle, position on fuselage, ...)
- Compute the aerodynamic loads

4/ Empennage / canard (foreplane) / fin

- Design the geometry (aspect ratio, surface area, taper ratio, twist, sweep angle, chord, ...) and choose the airfoil
- Design the control surfaces
- Define the position (setting angle, position on fuselage, ...)
- Compute the equilibrium

5/ Fuselage & Landing gear design

- Fuselage layout
- Landing gear position
- Landing gear design including brakes

6/ Propulsion

- Engines (thermal & electric)
- Tank & battery
- Hybrid system
- First layout of the propeller using empirical formula
- Payload Range diagram
- First estimation of performance
 - Take off & landing
 - Turn
 - Climb rate
 - Cruise

7/ Structure

- Placard diagram & maneuver/gust envelopes (following FAR Part 23)
- Weight and center of gravity position of each component
- Material selection
- This task is also part of the Aeronautical Structures class

8/ Static stability

- Evolution of CG (from nose), neutral point, stability in all the important flight configurations
- Evaluation of aerodynamic center (from nose)
- Calculation of the drag polar
- Calculation of the derivatives of C_L , C_D , C_m , and C_n

9/ Concepts & Trade off-study

- The team shall develop and present the alternative concepts considered leading to the down-select of their preferred concept. The methods and rationale used for the down-select must be included. At a minimum, a qualitative assessment of strengths and weaknesses of the alternatives shall be given, discussing merits, leading to a justification as to why the preferred concept is the best proposal response. Quantitative justification of why the selected proposal is the best at meeting the proposal measures of merit(s) will strengthen the proposal.
- In addition, the report shall include the major trade studies (e.g. with 10 % variation of the main parameters) conducted justifying the optimization, sizing, architectural arrangement, and integration of the specifically selected proposal concept. Quantitative data shall be presented showing why their concept 'works' and is the preferred design compromise that best achieves the requirements of the RFP
- Specific analysis and trade studies of interest sought in proposals include:
 - Mission performance and sizing for the mission profiles.
 - Overall aircraft concept selection (airframe and propulsion system) vs. design requirements objectives

4. WP2: Preliminary design

For this study, the following points will be addressed:

1/ Drag study

- Using the CAD geometry from part 2/, extraction of wetted areas, volume, surfaces etc.
- Detailed drag evaluation (following Torrenbeek book)

2/ CAD

- Create a solid CAD model (with mass, inertia and system integration)
- Evaluate mass, inertia and position of center of gravity from nose
- Improved realistic CAD view

3/ Aerodynamics

- Consider adapted code (VLM or DART), and make a convergence analysis
- Compute the aerodynamic loads in various flight conditions (cruise, maneuver, ...)
- Use the loads to size the structure
- Update the aerodynamic loads and stability derivatives
- Compare the drag obtained using different methods (including drag study of part 1/)

4/ Propulsion

- Design of the propeller using BEMT software

5/ Structure design

- Estimation of aerodynamics forces during maneuvers/gusts (acceleration, etc. following FAA-Part requirements)
- Estimation of the structural forces
- First design of the structure using analytical formula

- This task is also part of the Aeronautical Structures class

6/ Structure study

- CAD model with FE simulation
- Discussion of the application of aerodynamic loads
- This task is also part of the Aeronautical Structures class

7/ Performance

- Reassess performance
- Reassess pitch, roll and yaw derivatives
- Reassess Payload range diagram
- Dynamic stability & control analysis (Datcom method)

8/ Costs evaluation

- Identify the cost groups and drivers, assumptions, and design choices aimed at the minimization of production costs.
 - Estimate the price required to generate at least a 15% profit: Show how the airplane could be produced profitably at production rates ranging from 4 to 10 airplanes per month or a rate that is supported by a brief market analysis.
 - Estimate of direct operating cost per airplane flight hour:
 - Fuel, oil, tires, brakes, battery cost and other consumable quantities
 - Estimate of maintenance cost per flight hour
 - Flight and cabin crew costs per hour

5. Reports and presentation

- Follow deadlines and requirements of AIAA (<https://aiaa.org/get-involved/university-students/design-competitions/#design-compe>)
- Reports
 - In English
 - Content in the AIAA Request for Proposal (https://aiaa.org/wp-content/uploads/2026/08/2026-2027-Open-Division-Aircraft_Hybrid-STOL.pdf)
 - Submission of Final Design Report (see)
 - Each team or individual must provide an electronic copy of their design report as outlined below to the online Submission site, <https://www.aiaa-awards.org/a>
 - An electronic copy of the report in Adobe PDF format must be submitted to AIAA using the online submission site. Total size of the file cannot exceed 25 MB.
 - Electronic report files must be named(ex): “2027_[university]_DESIGN_REPORT.pdf”
 - A “Signature” page must be included in the report and indicate all participants, including faculty and project advisers, along with students’ AIAA member numbers and signatures. If the submitting team is comprised of at-large student members, each student member needs to include the name of the university he or she attends.
 - Electronic reports should be no more than 100 pages, double-spaced (including graphs, drawings, photographs, and appendices) if it were to be printed on 8.5”x11.0” paper, and the font should be no smaller than 10 pt. Times New Roman.

- Intermediate reports shall be of up to 50 pages.
- Presentations
 - In English
 - Describe and justify your design choices
 - Describe your methodology
 - Insist on the interactions between the parts
 - Around 35 minutes (20 minutes of presentation and 15 minutes of discussion)
- Important dates
 - Register to AIAA (**with receipt and credit card record in order to apply for refund**): before **13 November 2026**. **Apply for refund before end of November**
 - Letter of intent: to be submitted to AIAA (<https://www.aiaa-awards.org/a>) by **5 February 2027 11:59pm (MIDNIGHT)** Eastern Time!!! Require AIAA account!!!!
 - First report (Conceptual Design) for feedback/grading: **12 February 2027 (hand out printed reports to L.Noels before 6pm)**
 - First presentation for feedback: **01 March 2027** at 1:45pm (to be confirmed)
 - Second report (Corrected Conceptual Design and Preliminary Design) for feedback/grading: **23 April 2027**
 - Final Presentations for grading: **10 May 2027** at 1:45pm (to be confirmed)
 - Final report to be submitted to AIAA Headquarters (<https://www.aiaa-awards.org/a>): **14 May 2026 11:59pm (MIDNIGHT)** Eastern Time!!! Requires AIAA account!!!

Appendix 1: Structure part guidelines

1. Tasks

1/ Conceptual Design

- Placard diagram & maneuver/gust envelopes
- Weight and center of gravity position of each component
- Initial layout of internal structures

2/ Preliminary Design

- Estimation of aerodynamics forces during maneuvers/gusts
 - Acceleration etc. following FAA Part requirements
 - Wing loading
 - Empennage/canard loading
- Evaluation of the structural loads
 - On fuselage directly aft/front of the wing for tail/canard configuration
 - At wing root
 - In different flight configurations
- First design of the structure using analytical formula
 - Using the most critical structural loads
- Finite element verification
 - Using shell models based on a CAD representation
 - Discussion of the applied aerodynamics loads and boundary conditions
 - Verification of the structure integrity

2. Resources

- [Lectures] Aircraft Design (Structure & conceptual design)
- [Lectures] Aeronautical structures (available Q2)

3. Deliverables

1/ Conceptual Design

- Written chapter *Structure/weight* (or equivalent) included in conceptual design report
- Weekly short oral report on project progress

2/ Preliminary Design

- Written chapter *Structure* (or equivalent) included in final design report
- Weekly short oral report on project progress

3/ Aeronautical structures

- Extended version of the written chapter *Structure* (or equivalent), with all the details to be handed by the 22nd of May 2026.

Appendix 2: List of parameters

Parameters	USI	US/Imp
<u>Fuselage</u>		
Height: HEIGHTfus		
Width: WIDTHfus		
Length: LENGTHfus		
<u>Wing</u>		
span: b		
Aspect Ratio: AR		
Gross Surface: S		
Exposed: S_exp		
Taper Ratio: Lambda		
Cord at root: Croot		
Cord at tip: Ctip		
Sweep angle at chord quarter: Lambda_quart		
Geometric twist: Eps_gtip		
Mean Aerodynamic Chord: MAC		
X coordinate of Aerodynamic center: Xac		
Y coordinate of Aerodynamic center: Yac		
Compressibility parameter: BETA		
Cruise Mach: M		
Average airfoil thickness: t_bar		
Fuel volume: V_fuel		
Wetted wing surface: S_wetted_w		
Wing lift coefficient in cruise: C_L_w		

Wing lift coefficient derivative: a		
Angle of attack at root (cruise): Alpha_root		
Zero-lift angle of attack at root: Alpha_L0		
Zero-lift angle of attack of the profile: Alpha_l0		
Aerodynamics twist coefficient: Alpha_01		
Aerodynamics twist: Eps_a_tip		
Maximum lift coefficient of the wing (flaps in): CLmax		
Stall velocity (flaps in): Vs		
Stall velocity (flaps out): Vs0		
Reynolds number: Re		
Airfoil lift coefficient derivative: c_l_a		
Airfoil design lift coefficient: c_l_i		
Maximum camber: cmax		
Lift coefficient (cruise): LW		
<u>Stability (for each flight configuration)</u>		
Plane lift coefficient (cruise): CL		
Empennage/canard plane lift coefficient (cruise): CLT		
Surface of the empennage/canard: ST		
Fuselage angle of attack: Alpha_f		
Zero-lift fuselage angle of attack: Alpha_f0		
Pitching moment coefficient: Cm		
Wing pitching moment coefficient: Cm0		

X-coordinate of the gravity center: Xcg		
Empennage/canard pitching moment coefficient: CmT		
Empennage/canard lift: LT		
Non-dimensional center of gravity position: h		
Non-dimensional AC position: h0		
Non-dimensional stability limit of the center of gravity position: hn		
Incidence angle of the wing on the fuselage: iw		
Plane lift coefficient derivative: CL_alpha_plane		
Empennage/canard angle of attack: Alpha_T		
Downwash: Eps		
Downwash gradient: d_eps_d_alpha		
Vertical distance between wing and empennage/canard: m		
Stability margin: Kn		
Incidence angle of the empennage/canard on the fuselage: iT		
<u>Horizontal empennage/canard</u>		
Span: bT		
Aspect Ratio: AR_T		
Taper ratio: Lamba_T		
Sweep angle at chord quarter: Lambda_quart_T		
Chord at root: CTroot		
Chord at tip: CTtip		

Distance between the plane gravity center and the empennage AC: IT		
<u>Vertical empennage</u>		
Height: bF		
Aspect Ratio: ARF		
Surface: SF		
Taper Ratio: Lambda_F		
Sweep angle at chord quarter: Lambda_quart_F		
Chord at root: CFroot		
Chord at tip: CFtip		
Distance between the plane gravity center and the empennage AC: IF		
Lift coefficient (critical case): CLF		
Lift coefficient (critical case): LF		
Yaw moment coefficient (critical case): CN		
Yaw moment coefficient derivative: CNbeta		
Rudder height: hr		
Rudder surface: Sr		
<u>Drag</u>		
Drag (cruise): D		
Drag coefficient: CD		
Zero-lift drag coefficient: CD0		
e-factor: E		
Compressibility drag coefficient: CompCD		
Security velocity: V2		
Drag coefficient at security velocity: CDV2s		
<u>Engine</u>		
Take-off thrust: Tto		

Cruise thrust: T		
<u>Weights</u>		
Wing: Ww		
Empennage/canard weight: WT		
Vertical empennage weight (without rudder): WF1		
Vertical empennage weight (with rudder): WF2		
n_ultime		
Cabin pressure: DeltaPmax		
n_limite		
Fuselage weight: Wfus		
Gear weight: Wgear		
Control weight: Wsc		
Propulsion weight: Wprop		
Instrument weight: Winst		
Electrical devices weight: Welec		
Electronical devices weight: Wetronic		
Payload: Wpayload		
Fuel weight for take-off: Wto		
Fuel weight for landing: Wland		
Reserve fuel weight: Wres		
Fuel weight for climb: Wclimb		
Fuel weight for cruise: Wf		
Manufacturer empty weight: MEW		
Zero-fuel-weight: ZFW		
Take-off weight: Wto		
Wing loading W/S		
Thrust to weight T/W		
Fuel ratio Wf /Wto		
Range at maximum payload: d_etoile		

<u>Landing gear</u>		
Maximum pitch angle: Theta		
Maximum roll angle: Phi		
Dihedral angle: Gamma		
Wing height: Hg		
Distance between landing gears: t		
Angle of attack at lift-off: AlphaLOF		
Lift-off speed: V_LOF		
Touch down angle: ThetaTD		
Distance between plane gravity center and aft landing gear: lm		
Plane gravity center height: Zcg		
<u>Positions of centres of gravity:</u>		
Xwing		
XempH		
XempV		
Xfus		
Xsyst_elec		
Xelec_instr		
Xpayload		
Xfuel		