AERONAUTICAL ENGINEERING FACULTY

AIRCRAFT DESIGN I

8th classwork – Lecturer: Juan Pablo Alvarado P.

Date: November 4th

Directions: This classwork will be completed in groups of up to three students. You must provide numerical or textual answers as requested in each problem or question. In the answer report/presentation, you must explain and justify each design's chosen parameters, calculations, and results with analysis. **Answers in the English language are compulsory for this activity**. You must upload the file containing your answers to the Moodle (aula digital) platform. The delivery due date is November 10th, 2025 (11:00:00 pm), so late classwork will not be accepted.

Grade breakdown:

Problem No.	Percentage [%]	Value	Grade
1	5	0.25	
2	23	1.15	
3	9	0.45	
4	20	1.0	
5	20	1.0	
6	23	1.15	
TOTAL GRADE			

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Aircraft weight & balance

You and your colleagues developed an intermediate trainer aircraft design, designated as Tayrona I, for the Air Force. So far, the design has the following restrictions and specifications:

General Characteristics:

- Aircraft overall length: 23.62 [ft]
- Wingspan: 32.8 [ft]
- Cockpit: tandem type
- Crew: One pilot (student - located at F.S. 2.45 [m]; W.L. 1.52 [m]) and one co-pilot (instructor – located at F.S. 3.49 [m]; W.L. 1.57 [m]) (220.0 [lb] each)
- Payload: 2 external tanks or bombs (502.05 [lb] each, located at F.S. 2.944 [m]; B.L. +/- 1.75 [m]; W.L. 0.95 [m])
- Chord at the root (aircraft central axis): 6.234 [ft]
- Quarter chord sweep angle ($\Lambda c/4$): 0
- Taper ratio: 0.614
- Powerplant: One piston prop - Lycoming O-320-E2A
- Propeller: 1 Sensenich M74DM
- Fuel tank type – Integral (located at F.S. 2.75 [m]; B.L. +/- 1.32 [m]; W.L. 1.24 [m]) with a total volume capacity (both tanks) of 69 gal. (Fuel weight per gallon – 5.64 [lb/gal])
- Landing gear – Tricycle retractable-type
- Height from ground to the wings: ~4.2 [ft]
- Certification base: MIL or FAR 23. It can be assumed that this aircraft falls into the category of single-engine propeller-driven aircraft.
- Pressurization: none

The expected aircraft weight of each part is shown in the following table:

Component		Weight [lb]	Location x [mm]	Location y [mm] on each side	Location z [mm]
Wing		320	2690	+/-1620	1280
Empennage	Horizontal tail	74	6120	0	1480
	Vertical tail	26	6630	0	2010
Fuselage		230	3120	0	1410
Landing gear	NLG	38	563	0	530
	MLG	116	2855	+/-1230	550
Engine and installation eq.		280	1020	0	1380
Propeller (including spinner)		40	360	0	1420
Fixed equipment		133.24	2410	0	1320
Trapped fuel and oil in the lines		44	1810	0	1320

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You must determine the following characteristics of the aircraft:

1. The aircraft's center of gravity with the maximum takeoff weight (x_{cg}; y_{cg}; z_{cg}).
2. The x_{cg} limits (forward & rearward) in fuselage stations and MAC percentage terms, and validate the results, according to the following information:

Excursion diagram combinations:

1	W_E
2	$W_E + W_{tfo}$
3	$W_E + W_{tfo} + W_{crew}$ [front]
4	$W_E + W_{tfo} + W_{crew}$ [aft]
5	$W_E + W_{tfo} + W_{crew}$ [front] + W_{crew} [aft]
6	$W_E + W_{tfo} + W_{crew}$ [front] + W_f
7	$W_E + W_{tfo} + W_{crew}$ [aft] + W_f
8	$W_E + W_{tfo} + W_{crew}$ [front] + W_{crew} [aft] + W_f
9	$W_E + W_{tfo} + W_{crew}$ [front] + $W_f + W_{PL}$
10	$W_E + W_{tfo} + W_{crew}$ [aft] + $W_f + W_{PL}$
11	$W_E + W_{tfo} + W_{crew}$ [front] + W_{crew} [aft] + $W_f + W_{PL}$
12	$W_E + W_{tfo} + W_f$
13	$W_E + W_{tfo} + W_{PL}$
14	$W_E + W_{tfo} + W_f + W_{PL}$

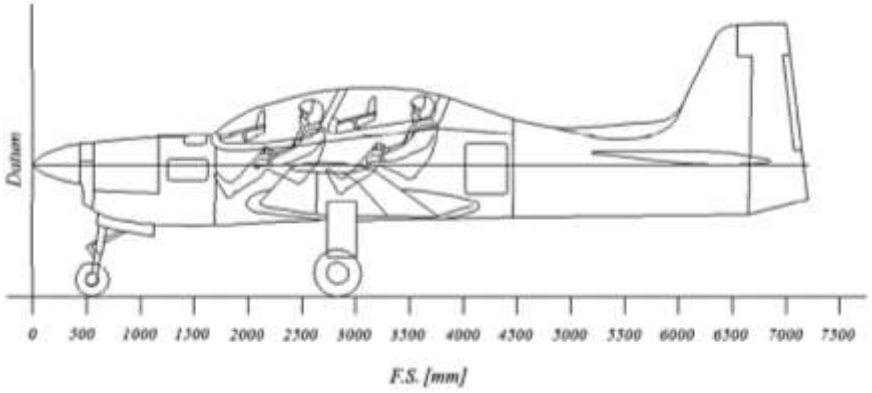
Possible operational scenarios:

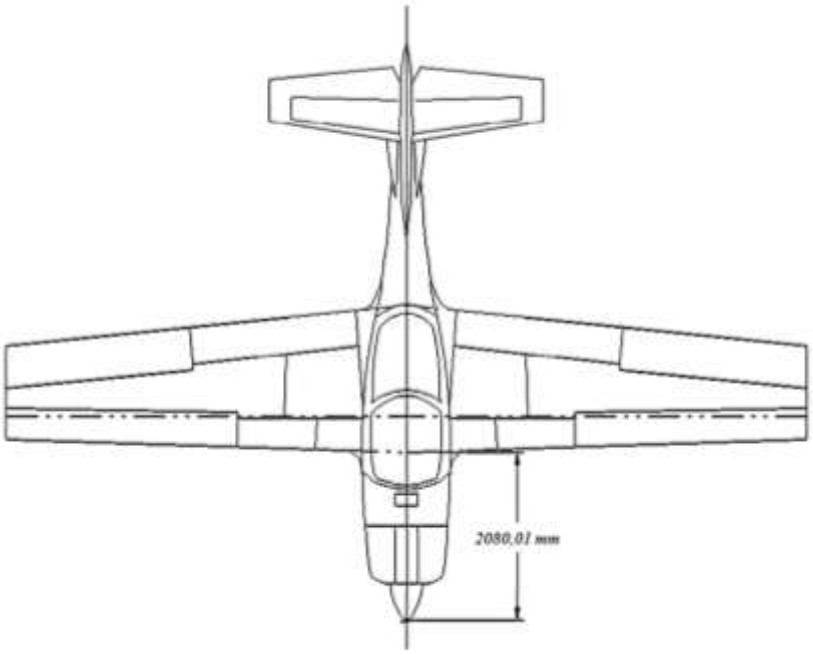
Scenarios
1-2-3-6-9
1-2-4-5-8-11
1-2-4-7-10
1-2-12-6
1-2-12-7
1-2-13-14-9
1-2-13-14-10
1-2-13-14-11

3. From the longitudinal static stability study, it is known that the neutral point needs to be located at an F.S. of 2.87 [m] to have an S.M. of ~15.0%. Verify how x_{cg} limits affect this condition.

4. Recalculate point two under the condition of the landing gear retracted (up) and analyze whether there is a significant change in the x_{cg} limits. When retracted, the new F.S. for the NLG is 1.02 [m], and the MLG remains at the same F.S.
5. The design board has decided that the cockpit must be side-by-side. You are asked to make this change in the design and verify what needs to be done to maintain the airplane's stability characteristics established in point 3.
6. Calculate the approximate values of I_{xx}, I_{yy}, and I_{zz}, for the wing and the fuselage.

The following are the left side and top views of the aircraft:





Note: Develop the calculations under sea level conditions. You'll have to find and/or assume any data not given in this document.

Glossary

- ✓ F.S. – Fuselage Station
- ✓ B.L. – Buttock Line
- ✓ W.L. – Water Line
- ✓ MAC – Mean Aerodynamic Chord
- ✓ NLG – Nose Landing Gear
- ✓ MLG – Main Landing Gear
- ✓ S.M. – Static Margin