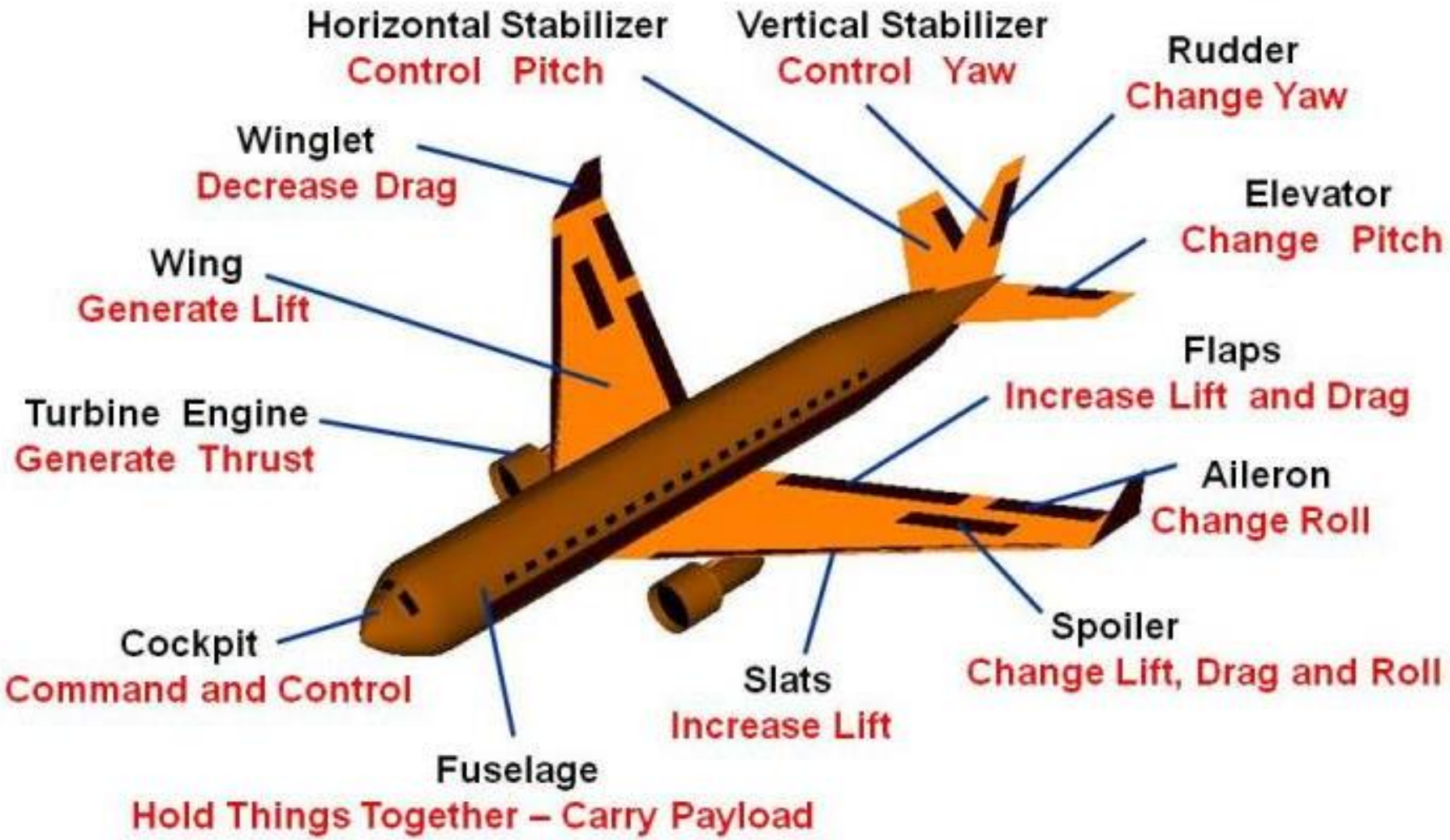
Aircraft Nomenclature and Dimensions

Aircraft Nomenclature



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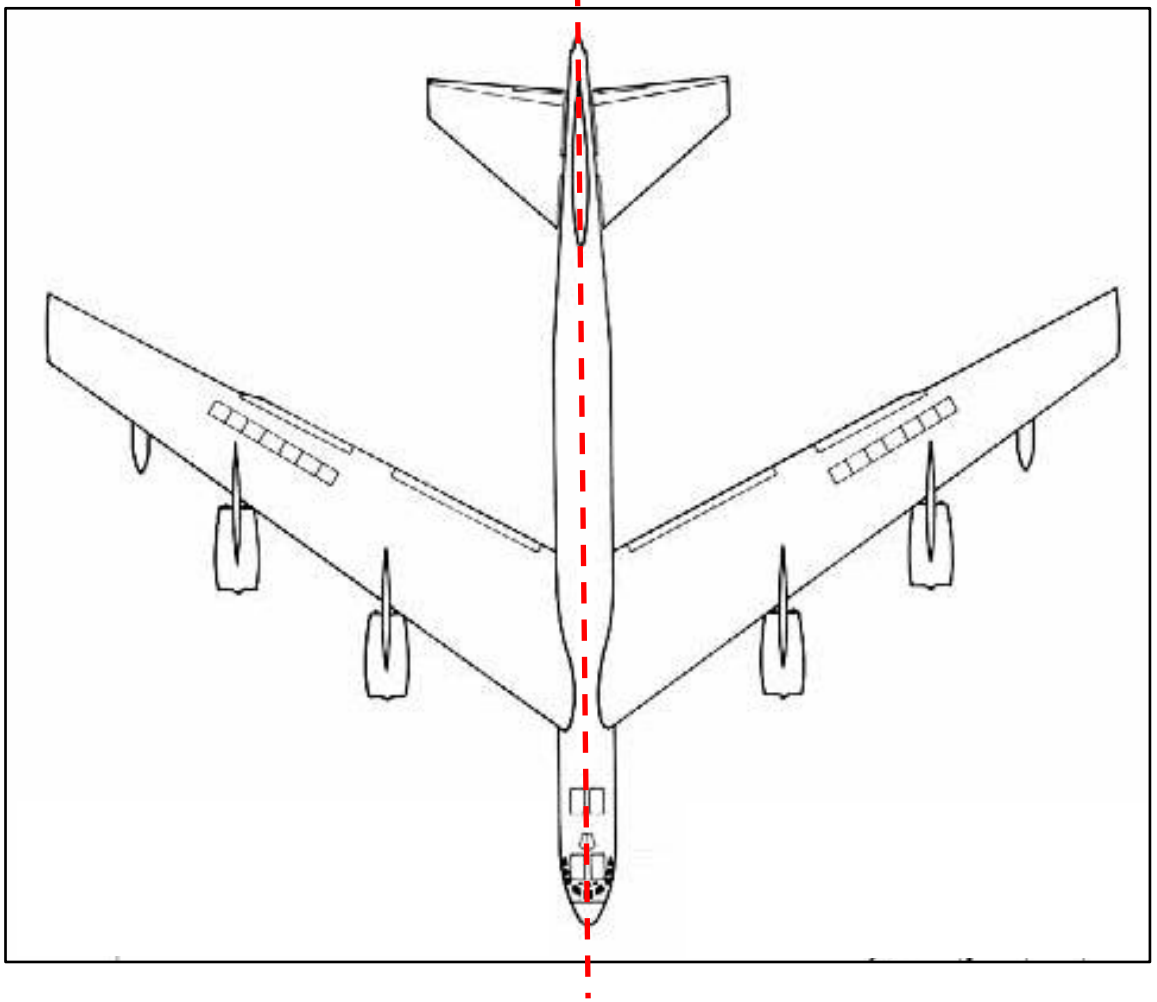
Aircraft Dimensions Nomenclature

Aircraft Centerline ℄



Usually symmetric "mirror images"

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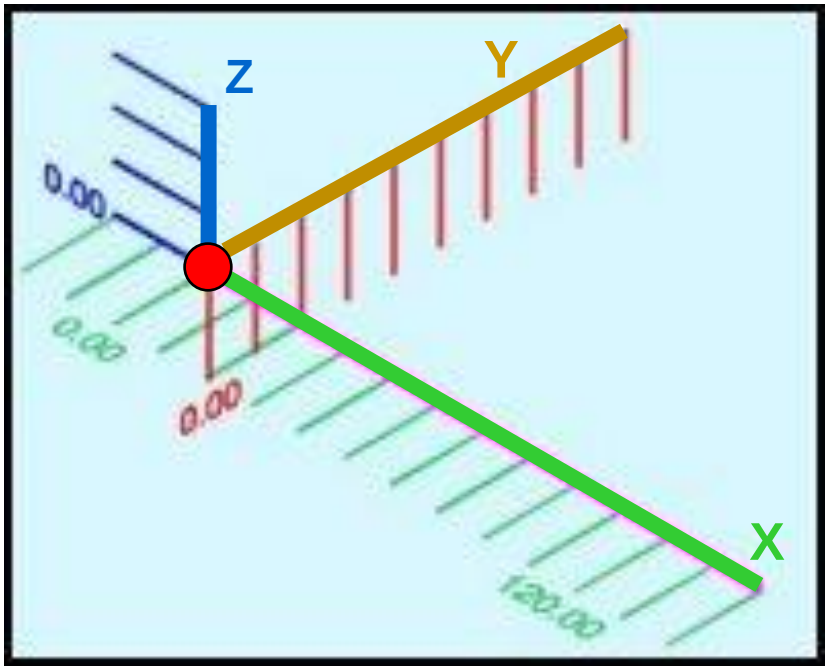
Aircraft Dimensions Nomenclature



Start with an XYZ coordinate system

X axis: front to back

Y axis: from centerline to wing tip

Z axis: from ground to top

Place the Origin at (0,0,0)

Dimensions are usually measured in inches or feet

X axis: Fuselage Station (FS)

Y axis: Buttock Line (BL)

Z axis: Water Line (WL)

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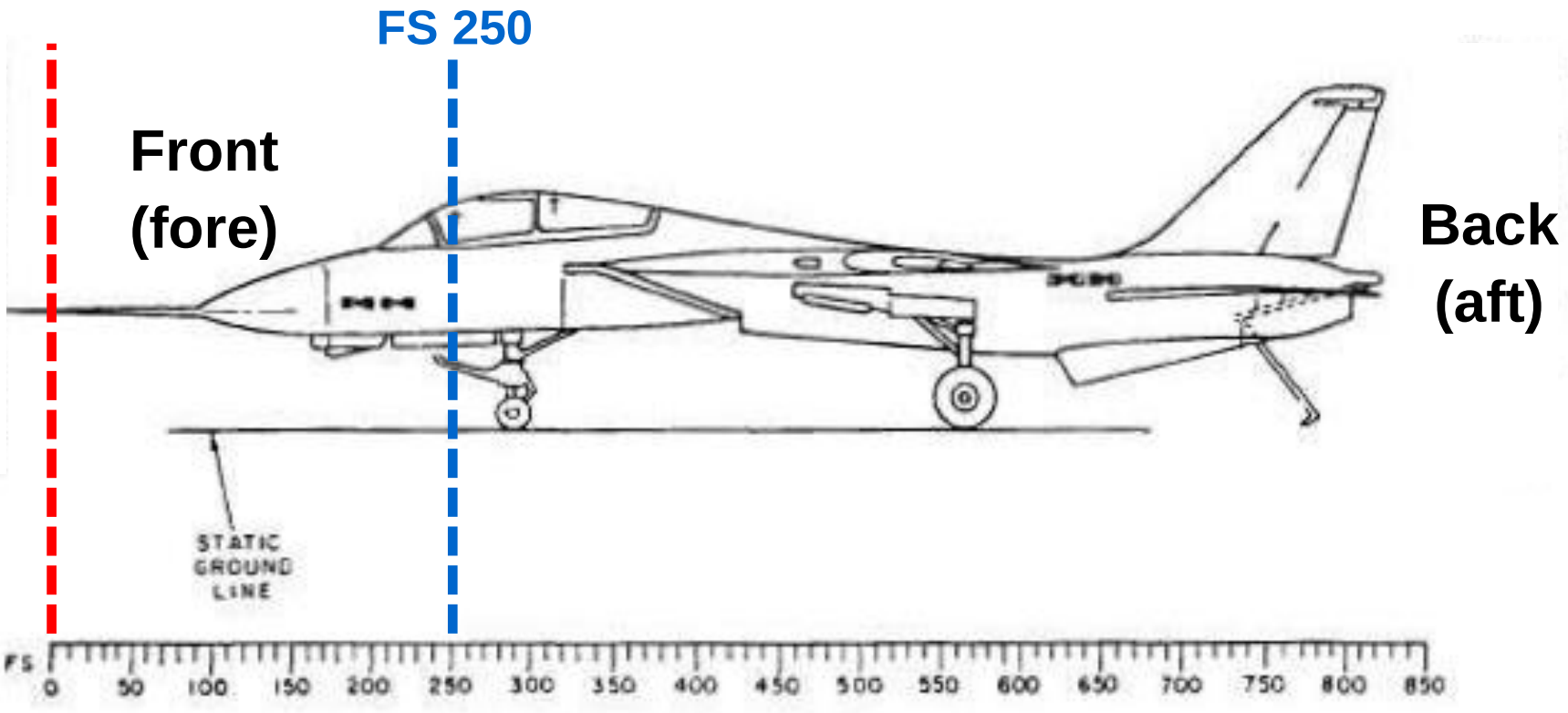
Aircraft Dimensions Nomenclature



0

X axis: Fuselage Station (FS)

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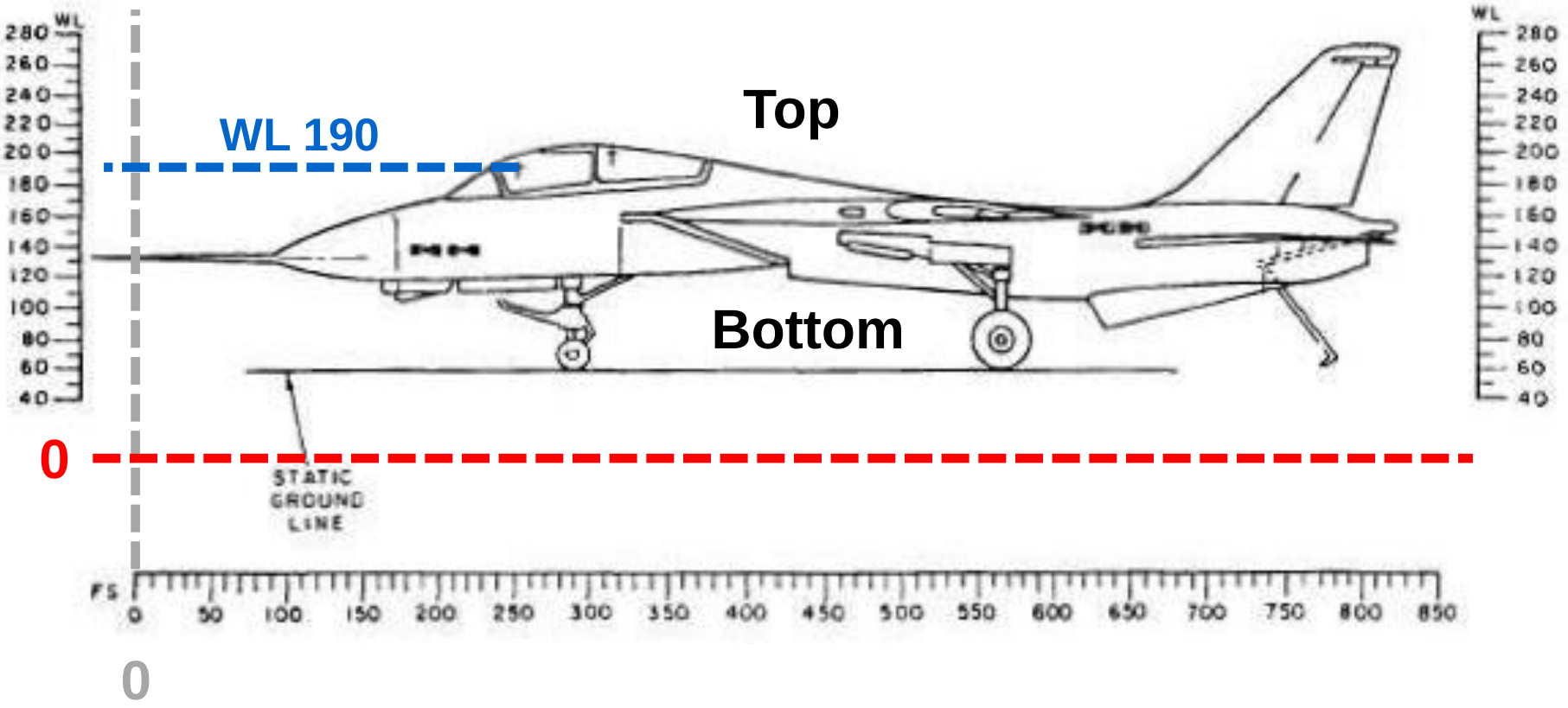
Aircraft Dimensions Nomenclature

Z axis: Water Line (WL)



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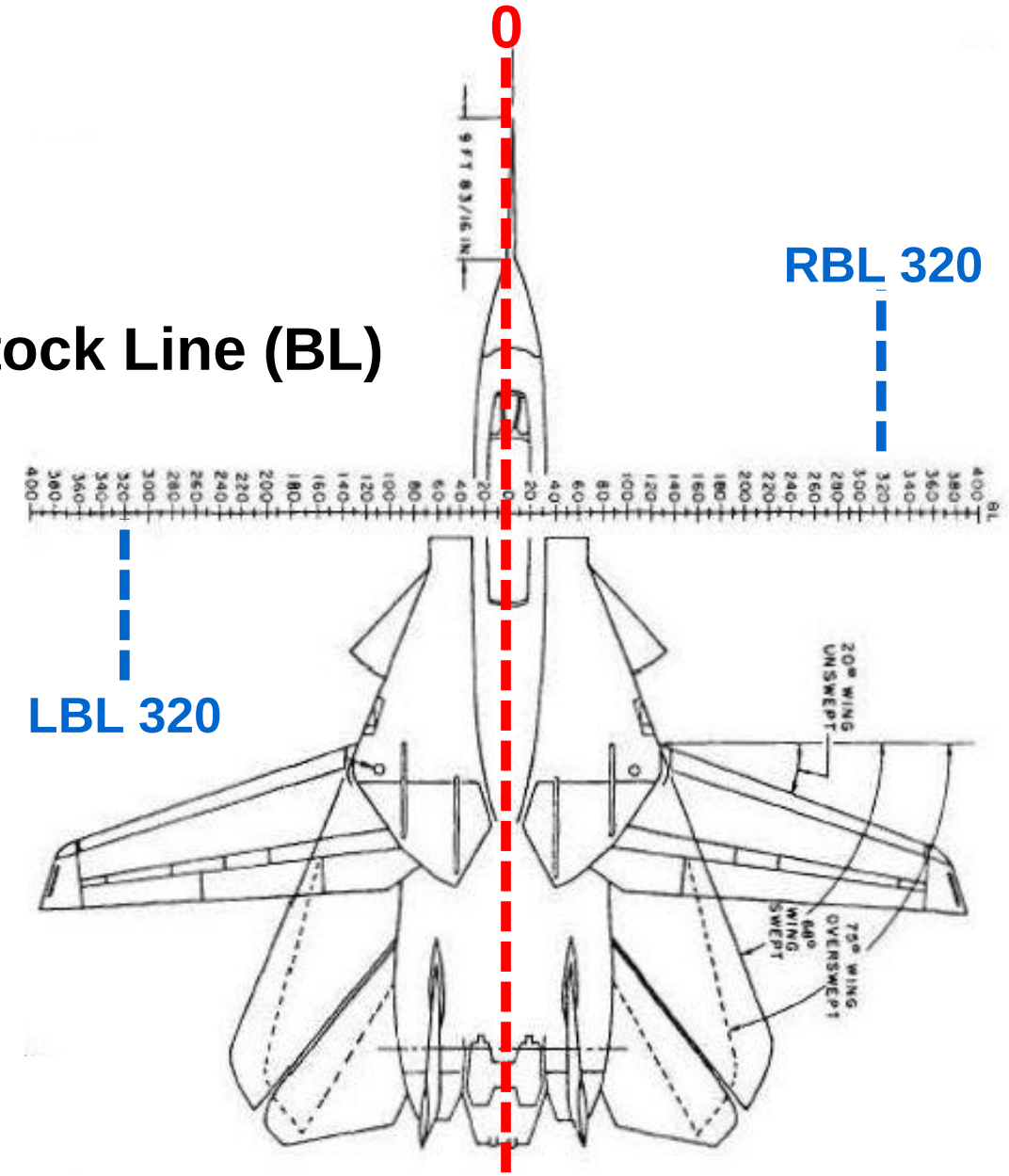
Aircraft Dimensions Nomenclature

Y axis: Buttock Line (BL)



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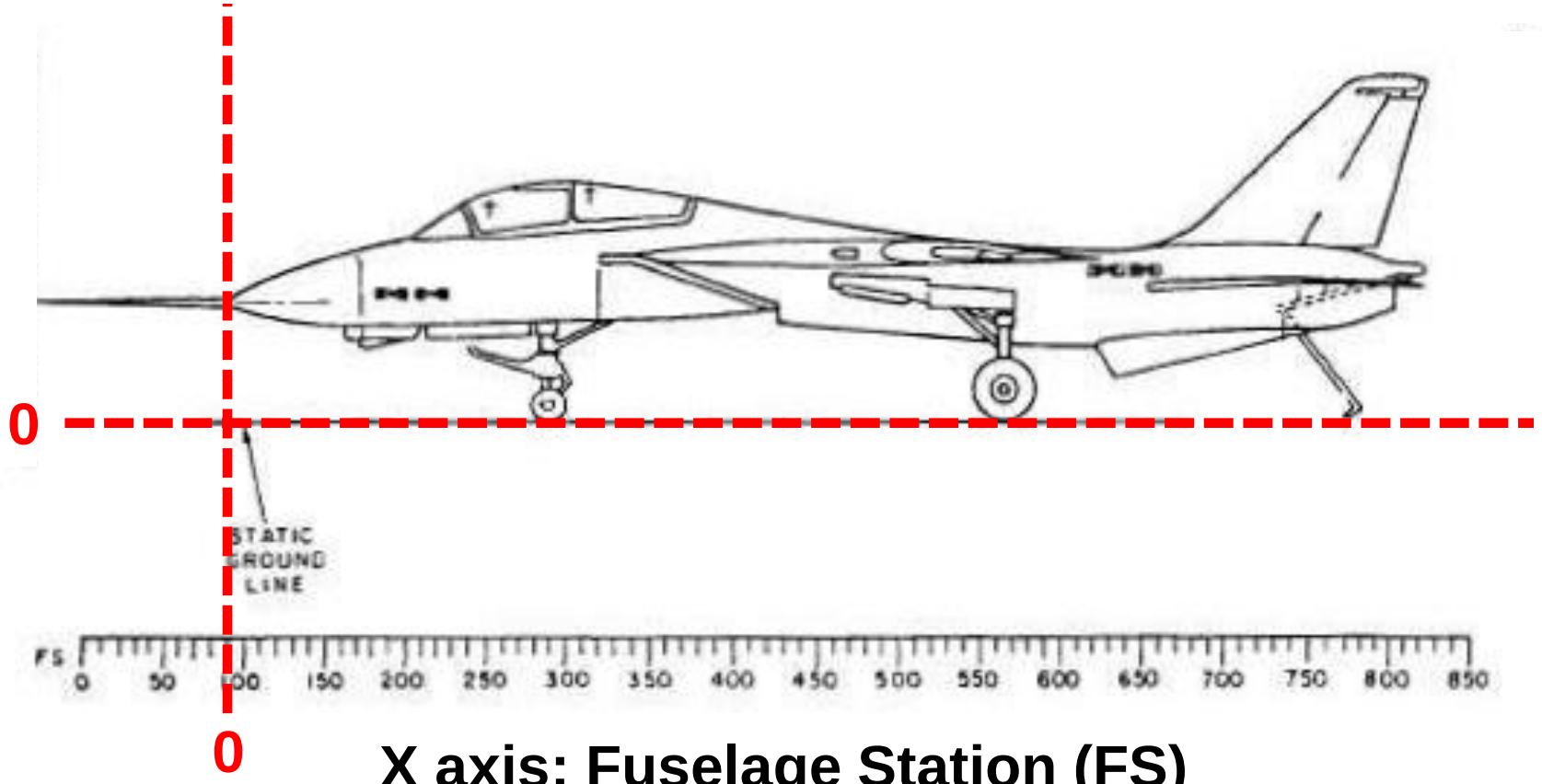
Aircraft Dimensions Nomenclature



X axis: Fuselage Station (FS)

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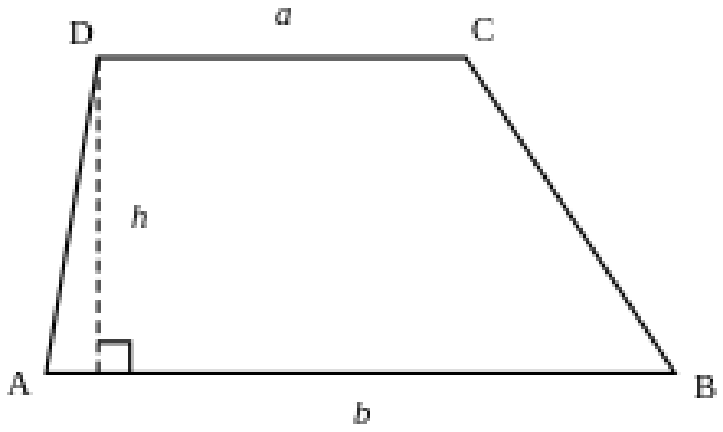
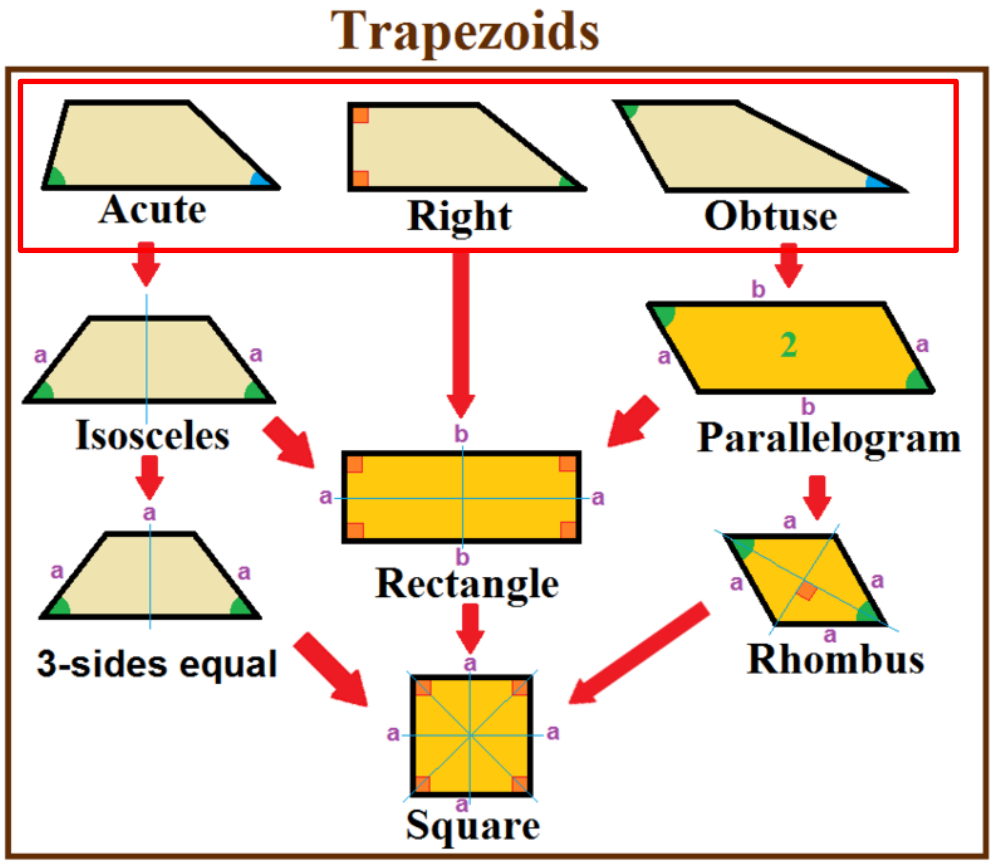
Aircraft Wing Dimensions



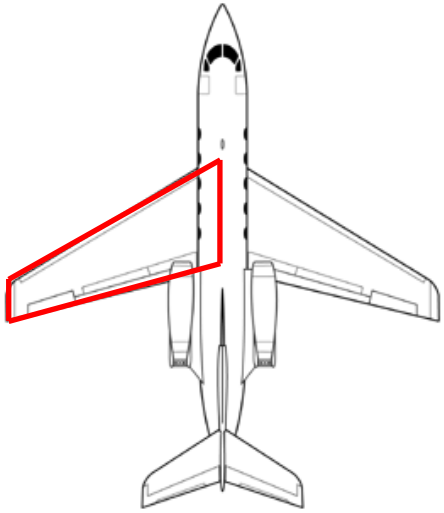
Wing Planform Assumption

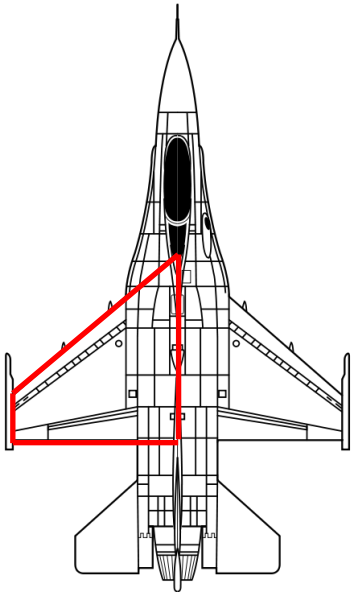
- Convex quadrilateral = trapezoid
- Acute, Right, or Obtuse Trapezoid

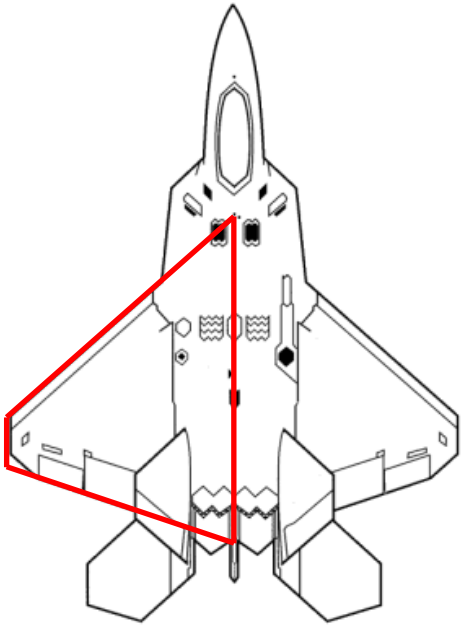
$$\text{Area} = h * \frac{a + b}{2}$$



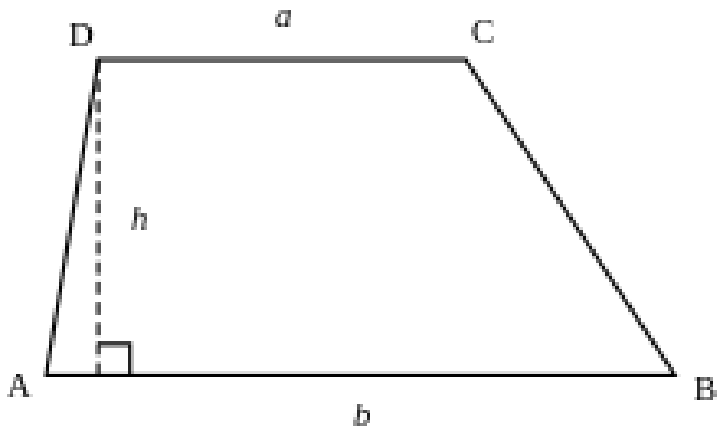
Aircraft Wing Dimensions







Aircraft Wing Dimensions



Wing Planform Assumption

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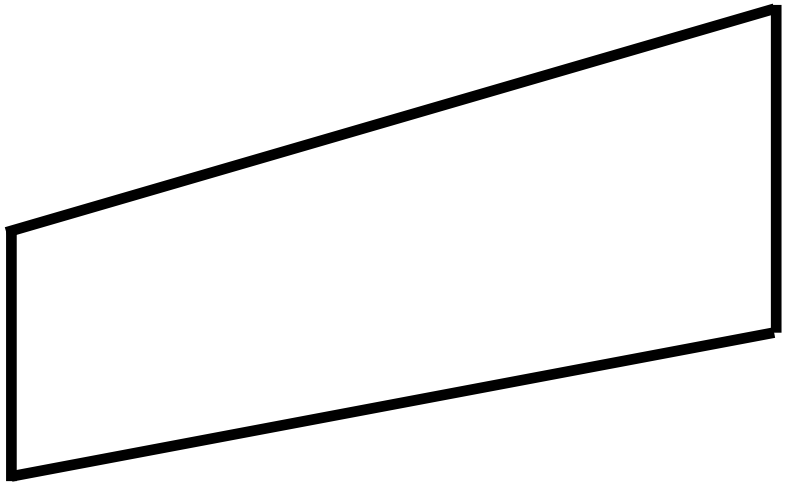
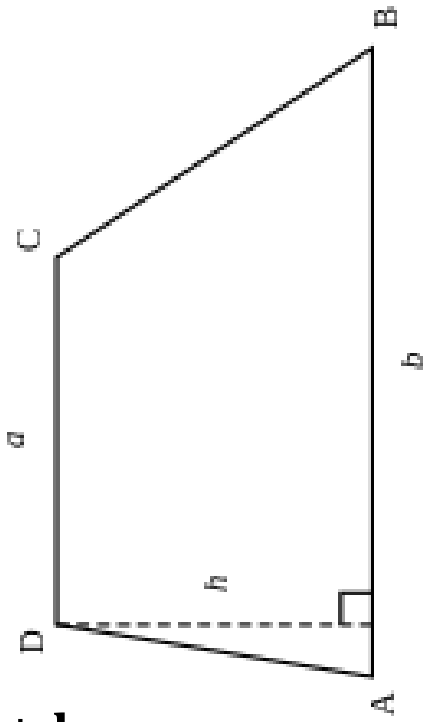
- Acute, Right, or Obtuse Trapezoid





$$\text{Area of Trapezoid} = \mathbf{h} * \frac{\mathbf{a} + \mathbf{b}}{\mathbf{2}}$$

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Aircraft Wing Dimensions

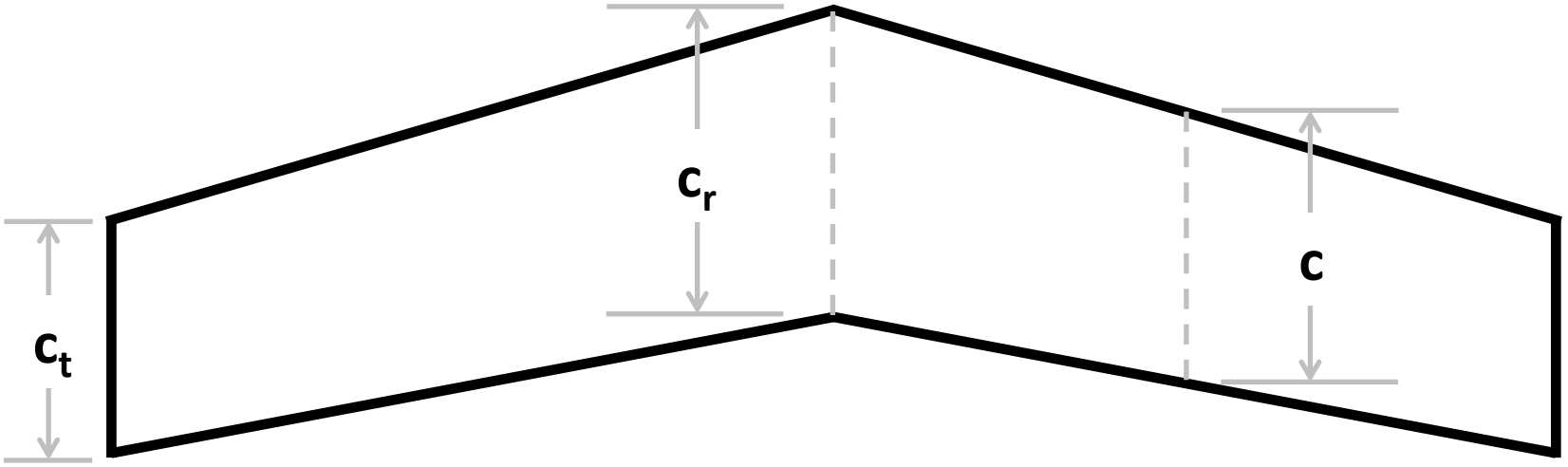
Wing Planform Characteristics

Tip Chord (c_t) **Taper Ratio (λ)**

Root Chord (c_r) **Average Chord (c)**

$$\lambda = \frac{c_t}{c_r}$$

$$c = \frac{c_t + c_r}{2}$$



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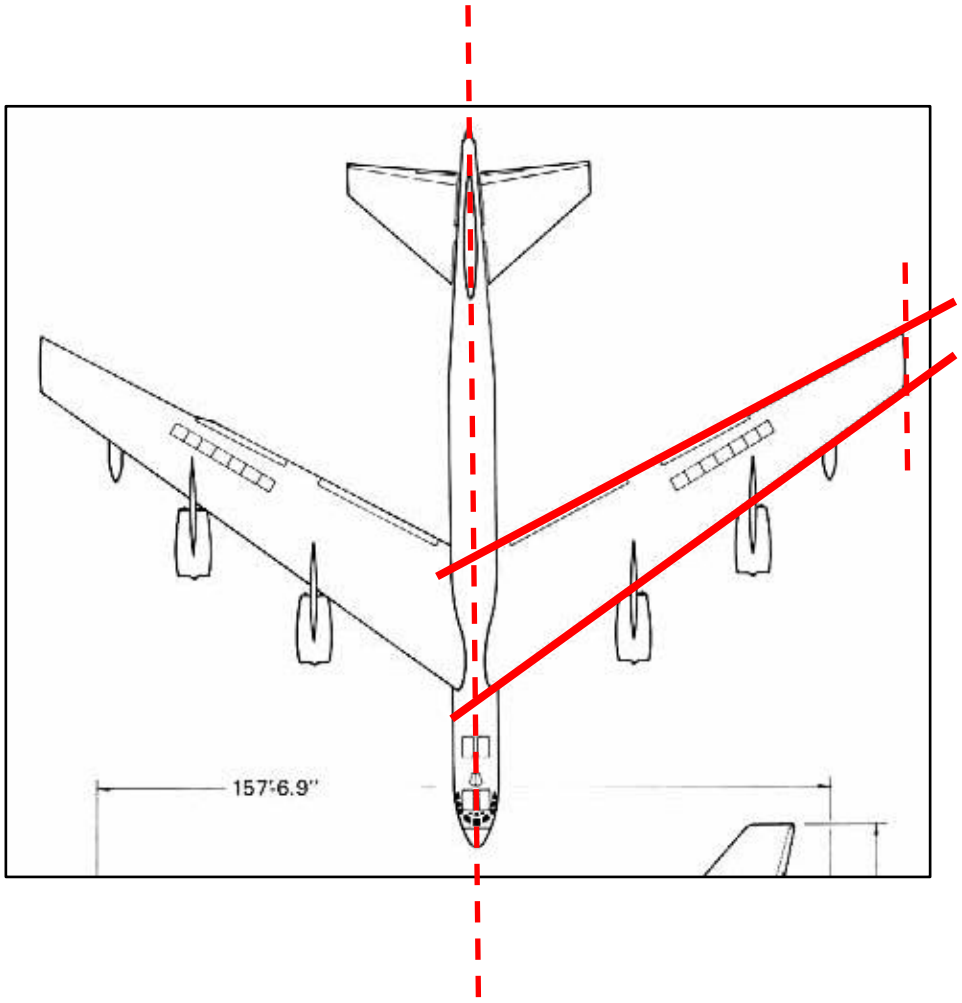
Taper Ratio Graphical Determination



1. Extend the leading edge to the aircraft centerline
2. Extend the trailing edge to the aircraft centerline
3. Draw the aircraft centerline to find the root chord
4. Draw the tip chord
5. Measure the tip chord and the root chord
6. Divide the tip chord by the root chord to get Taper Ratio

$$\lambda = \frac{c_t}{c_r}$$

Aircraft Wing Dimensions

Wing Planform Characteristics

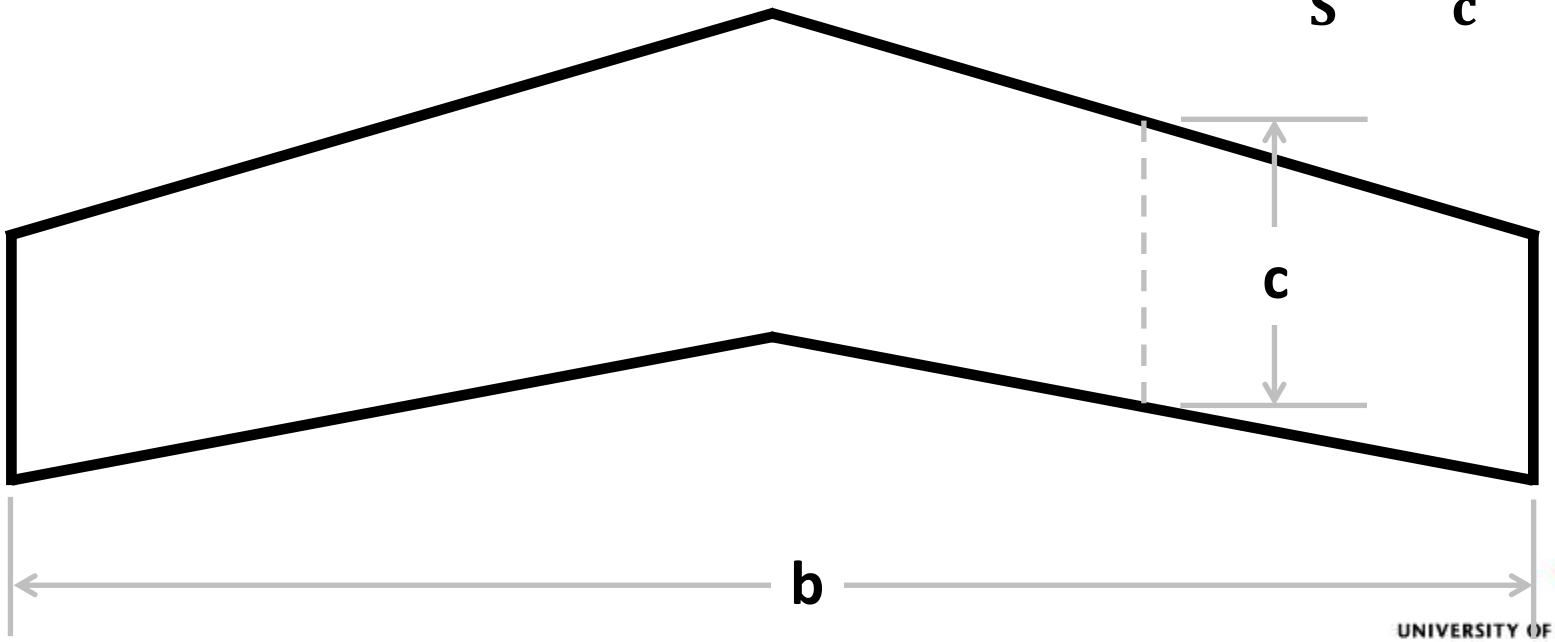
Tip Chord (c_t)
Root Chord (c_r)
Wing Span (b)
Taper Ratio (λ)
Average Chord (c)
Wing Area (S)
Aspect Ratio (AR)

$$\text{Area of Trapezoid} = h * \frac{a+b}{2}$$

$$c = \frac{c_t + c_r}{2}$$

$$S = b\,c$$

$$AR = \frac{b^2}{S} = \frac{b}{c}$$



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Aircraft Wing Dimensions

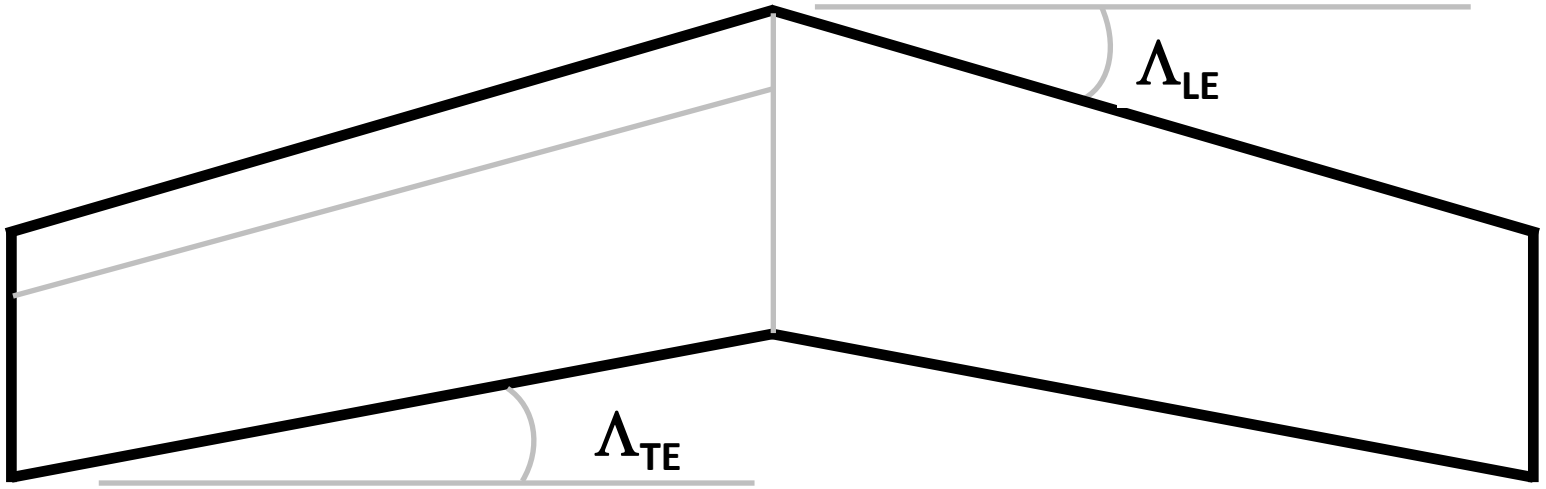
Wing Planform Characteristics

Tip Chord (c_t)
Root Chord (c_r)
Wing Span (b)

Taper Ratio (λ)
Average Chord (c)
Wing Area (S)
Aspect Ratio (AR)

Leading Edge Sweep (Λ_{LE})
Trailing Edge Sweep (Λ_{TE})

Quarter-Chord Sweep ($\Lambda_{c/4}$)



$$\Lambda_{c/4} = \tan^{-1}[\tan\Lambda_{LE} - 0.25 * c_r * (1-\lambda)/(b/2)]$$

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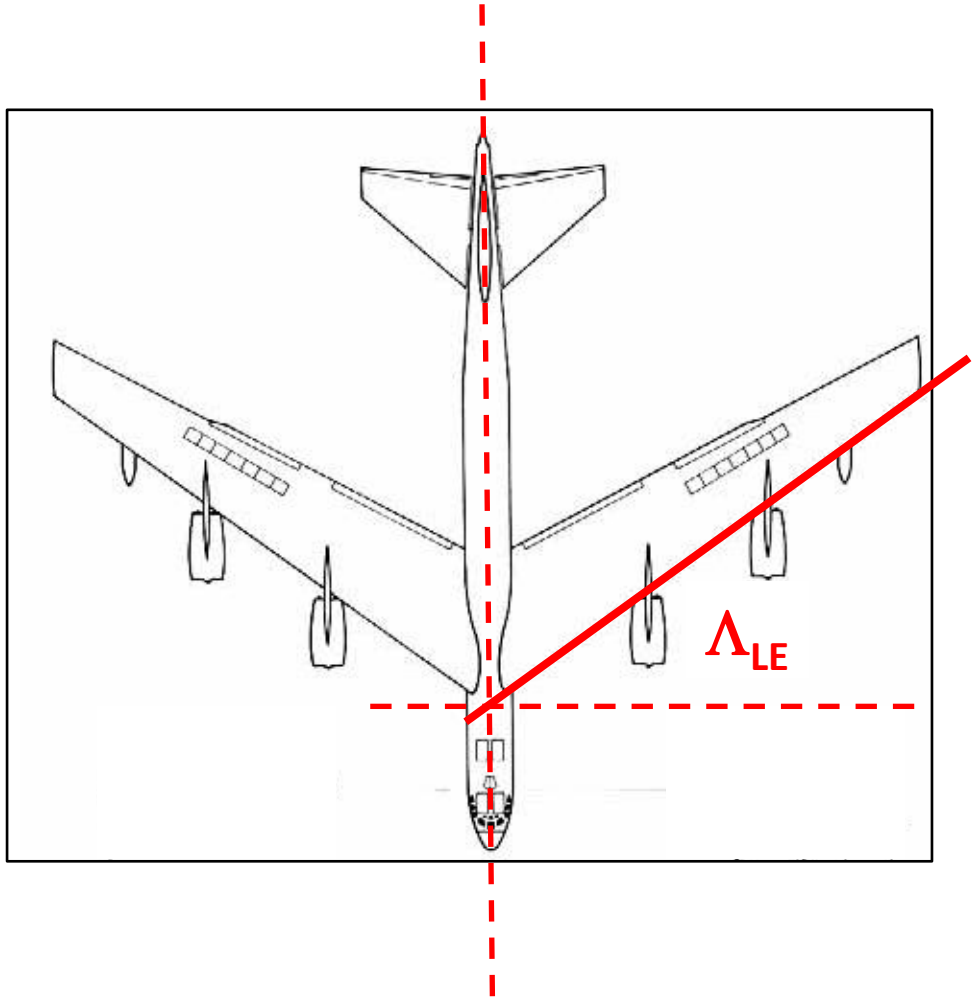
LE Wing Sweep Graphical Determination



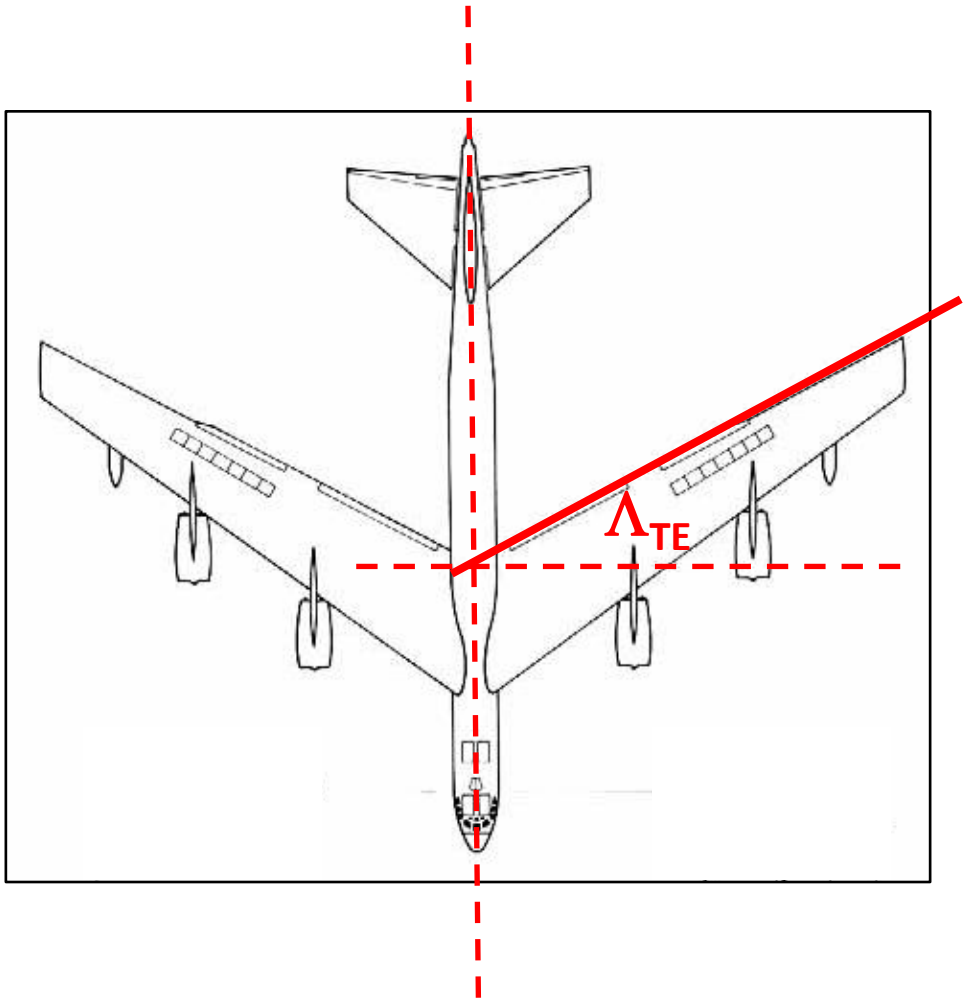
1. Extend the leading edge to the aircraft centerline

2. Draw the aircraft centerline

3. Draw the perpendicular to the aircraft centerline

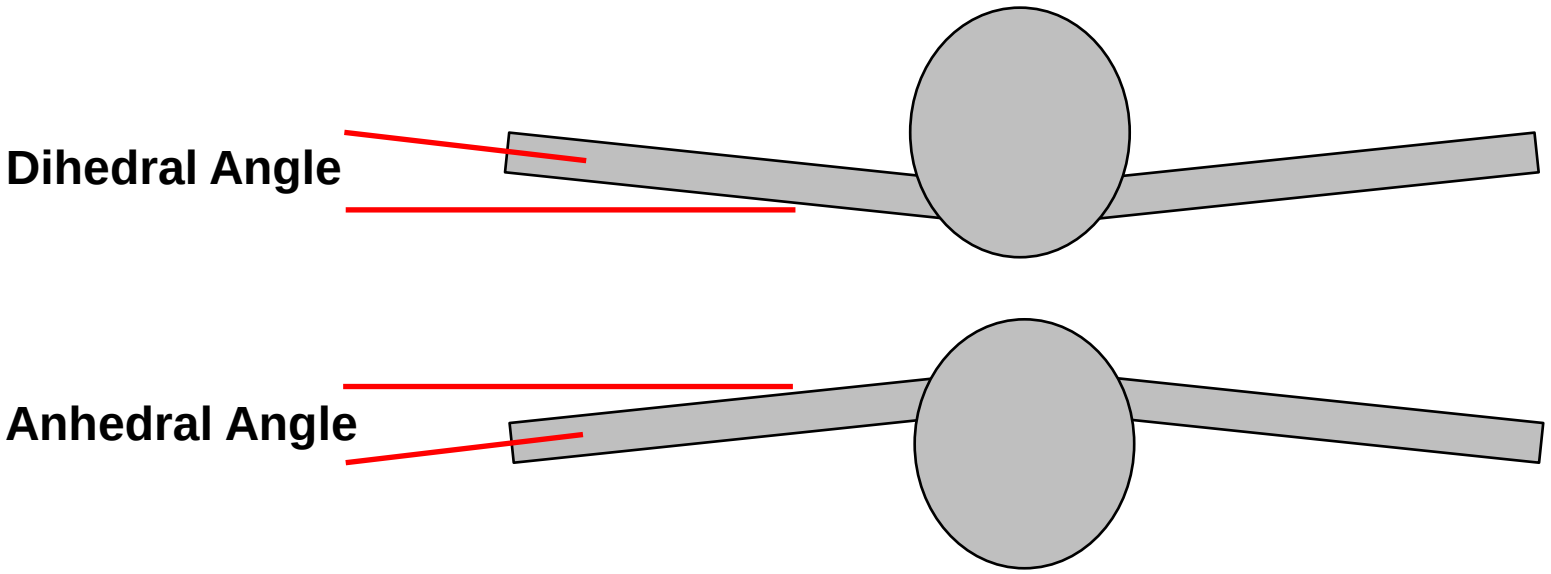
4. Measure the angle from the perpendicular to the leading edge

TE Wing Sweep Graphical Determination



1. Extend the trailing edge to the aircraft centerline
2. Draw the aircraft centerline
3. Draw the perpendicular to the aircraft centerline
4. Measure the angle from the perpendicular to the trailing edge

Wing Dihedral



Anhedral angle = - Dihedral Angle

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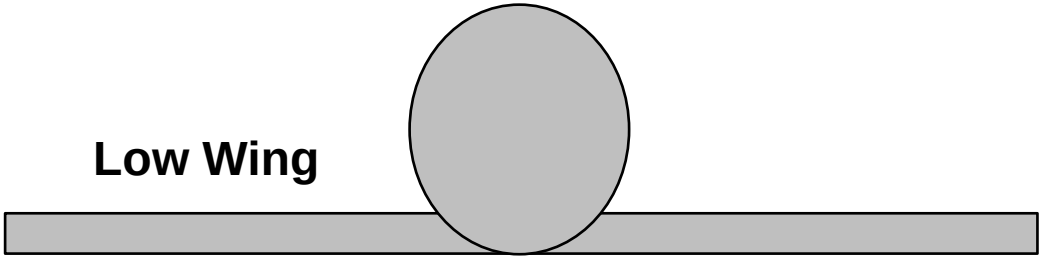
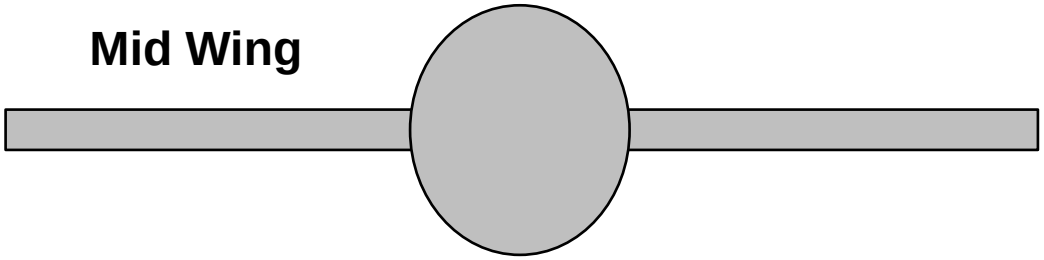
Wing Placement

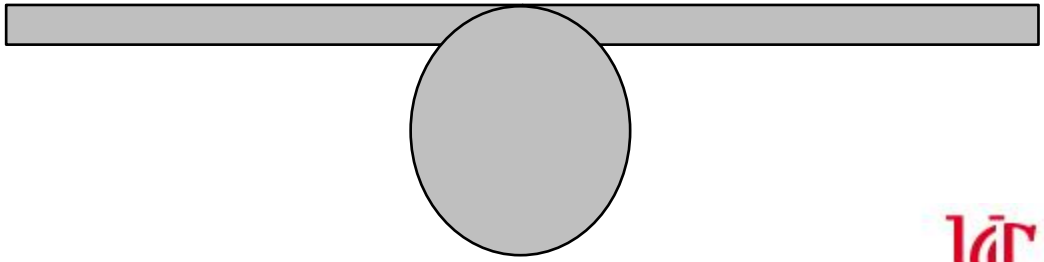
Low Wing



Mid Wing



High Wing



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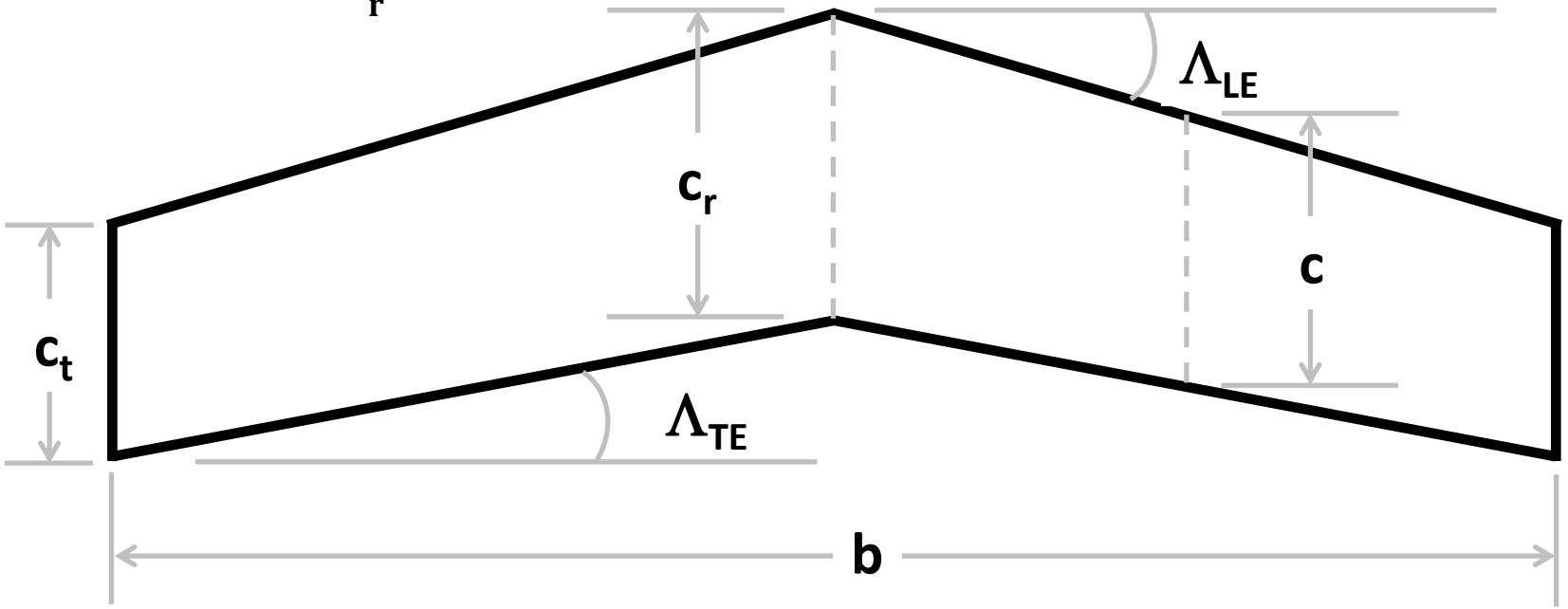
MAC Graphical Determination

$$\lambda = \frac{c_t}{c_r}$$



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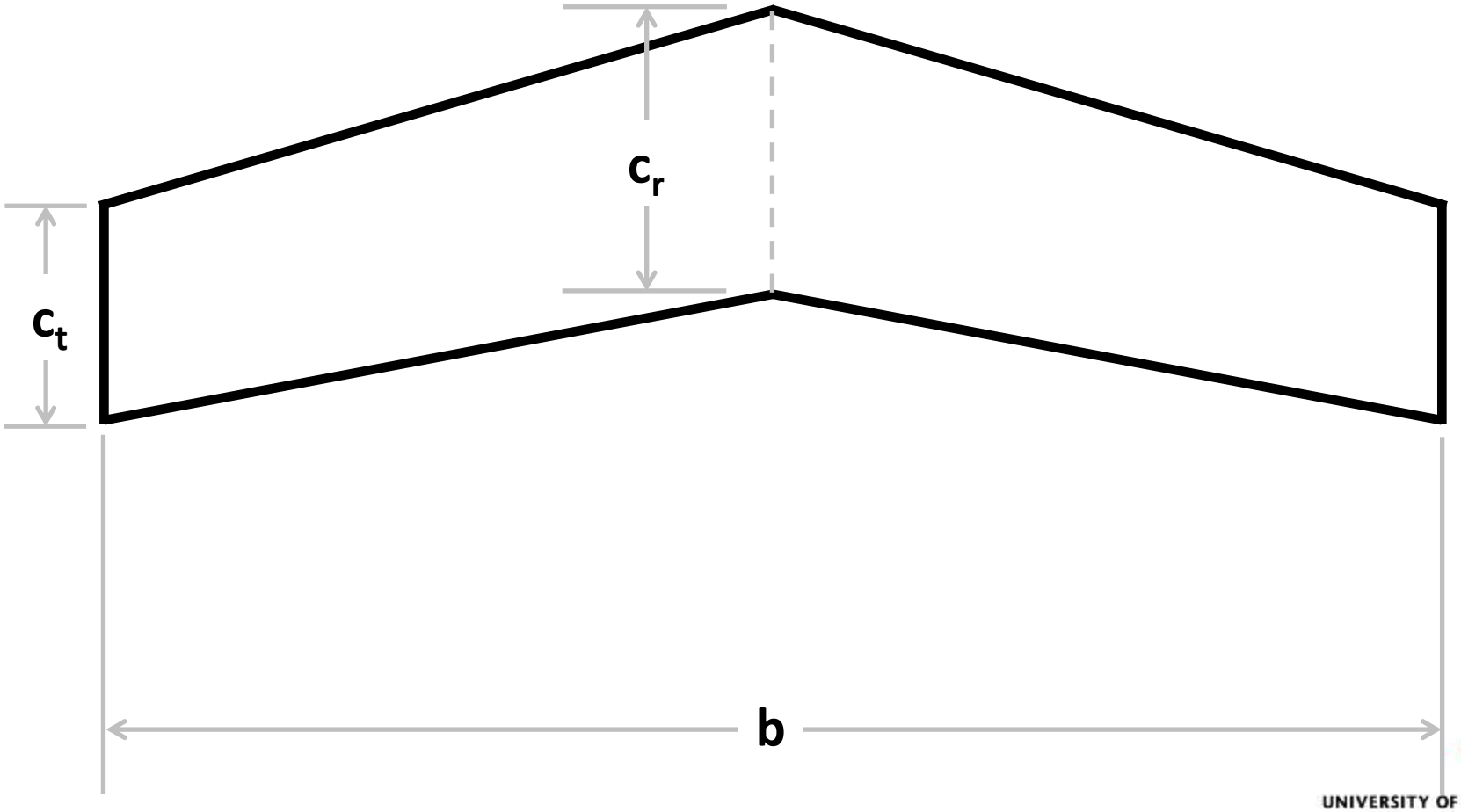
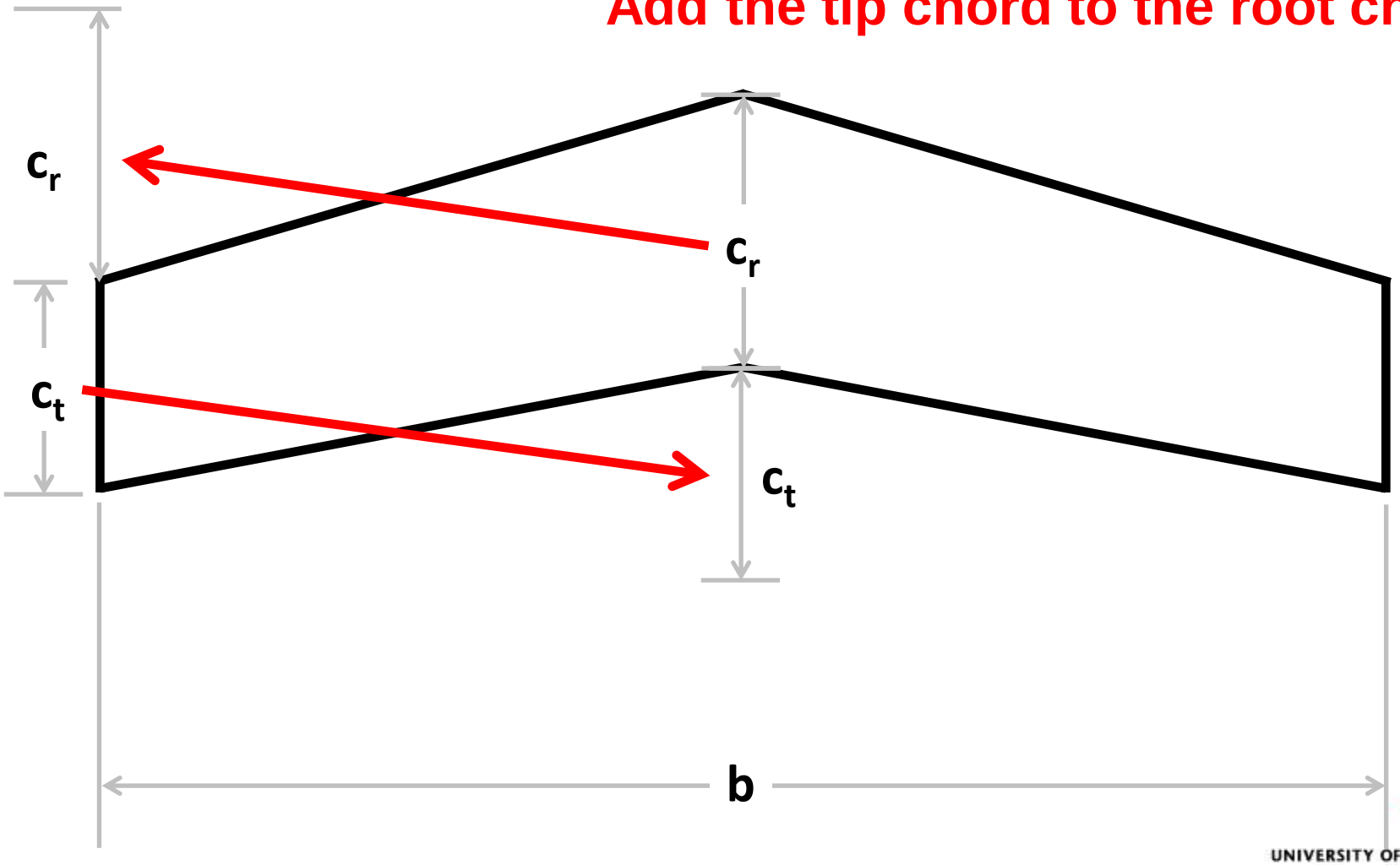
MAC Graphical Determination



MAC Graphical Determination

Add the root chord to the tip chord
Add the tip chord to the root chord



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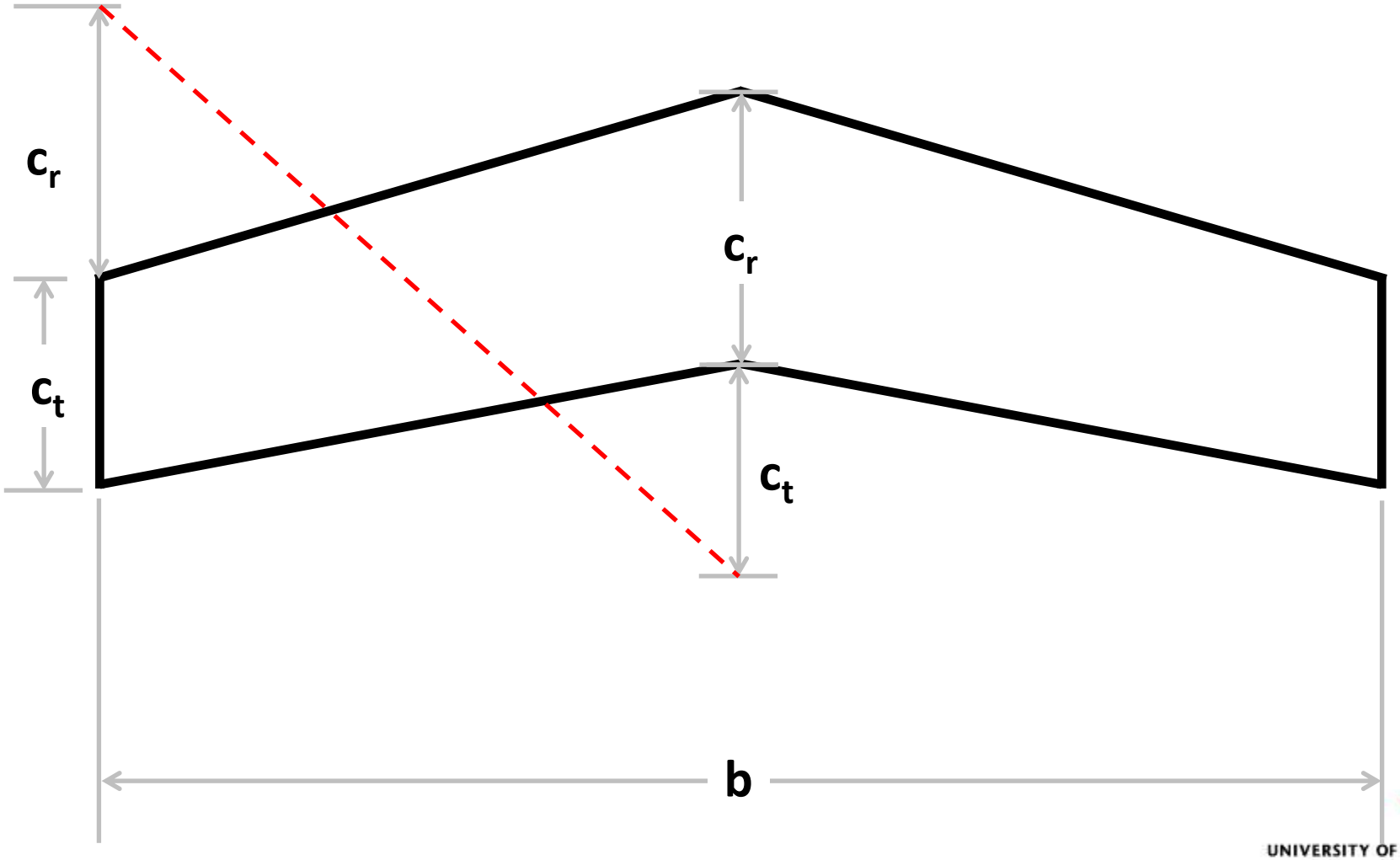
MAC Graphical Determination

Draw a line connecting the two extensions



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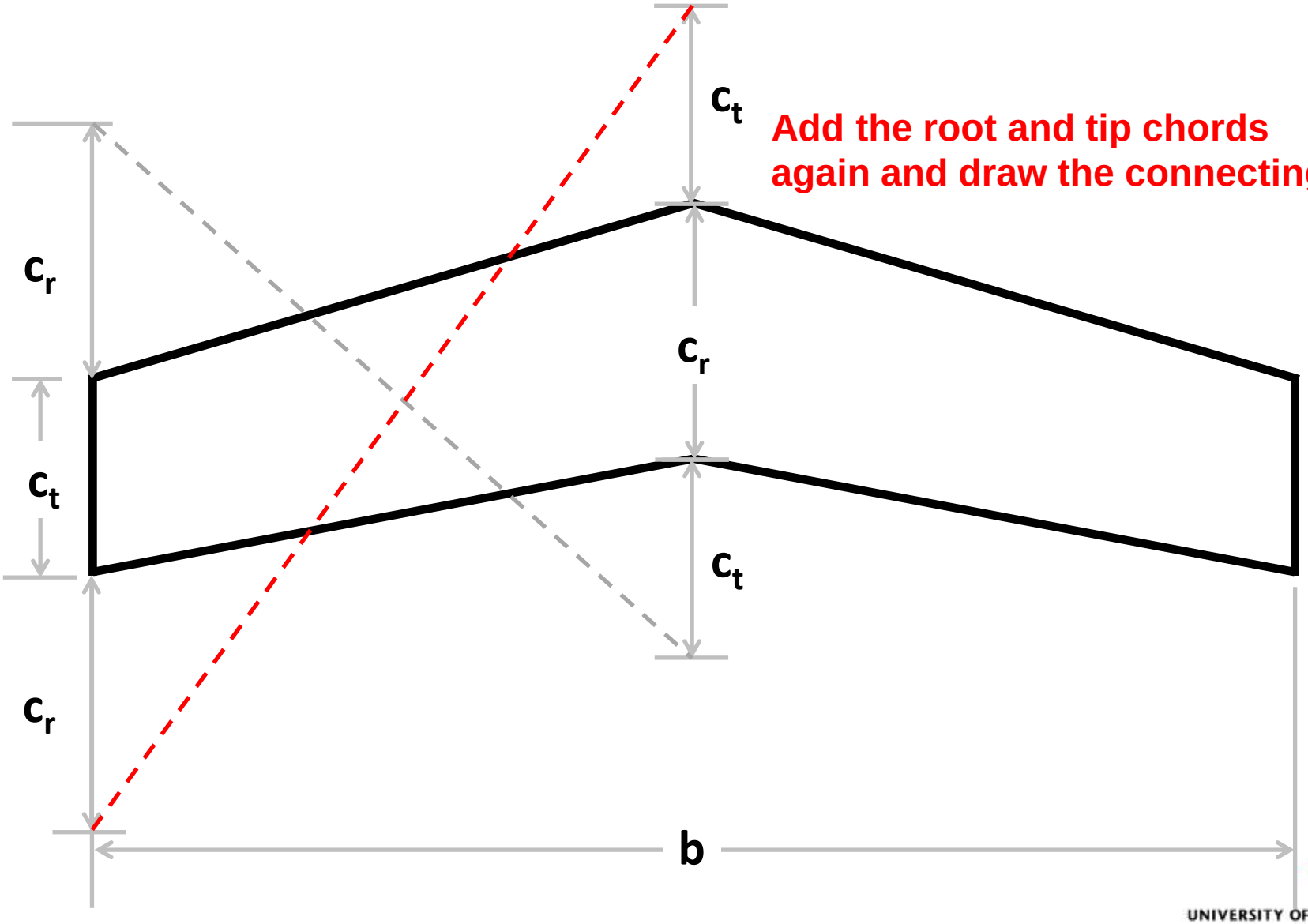
MAC Graphical Determination



Add the root and tip chords again and draw the connecting line

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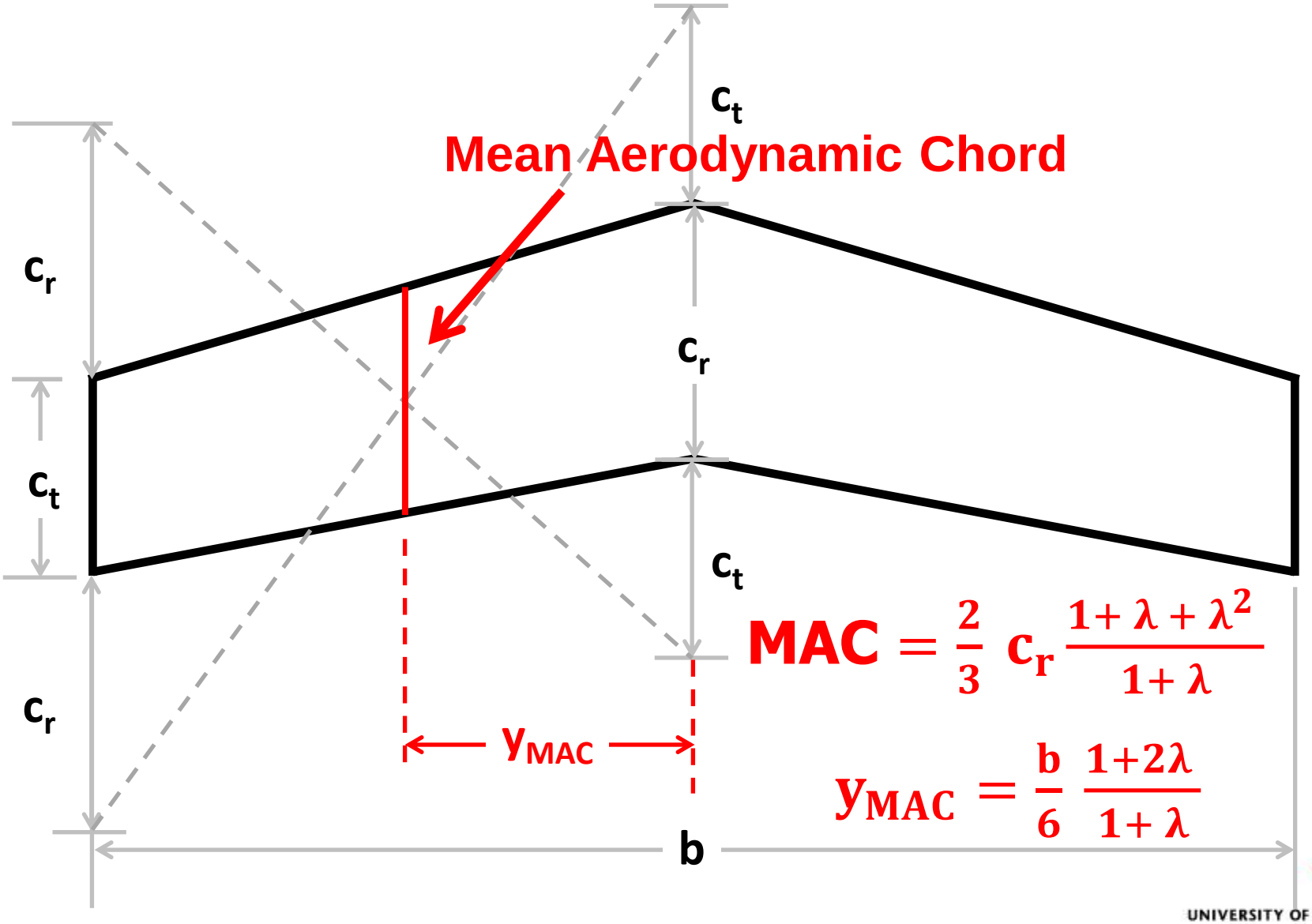
MAC Graphical Determination



$$MAC = \frac{2}{3} c_r \frac{1+\lambda+\lambda^2}{1+\lambda}$$

$$y_{MAC} = \frac{b}{6} \frac{1+2\lambda}{1+\lambda}$$

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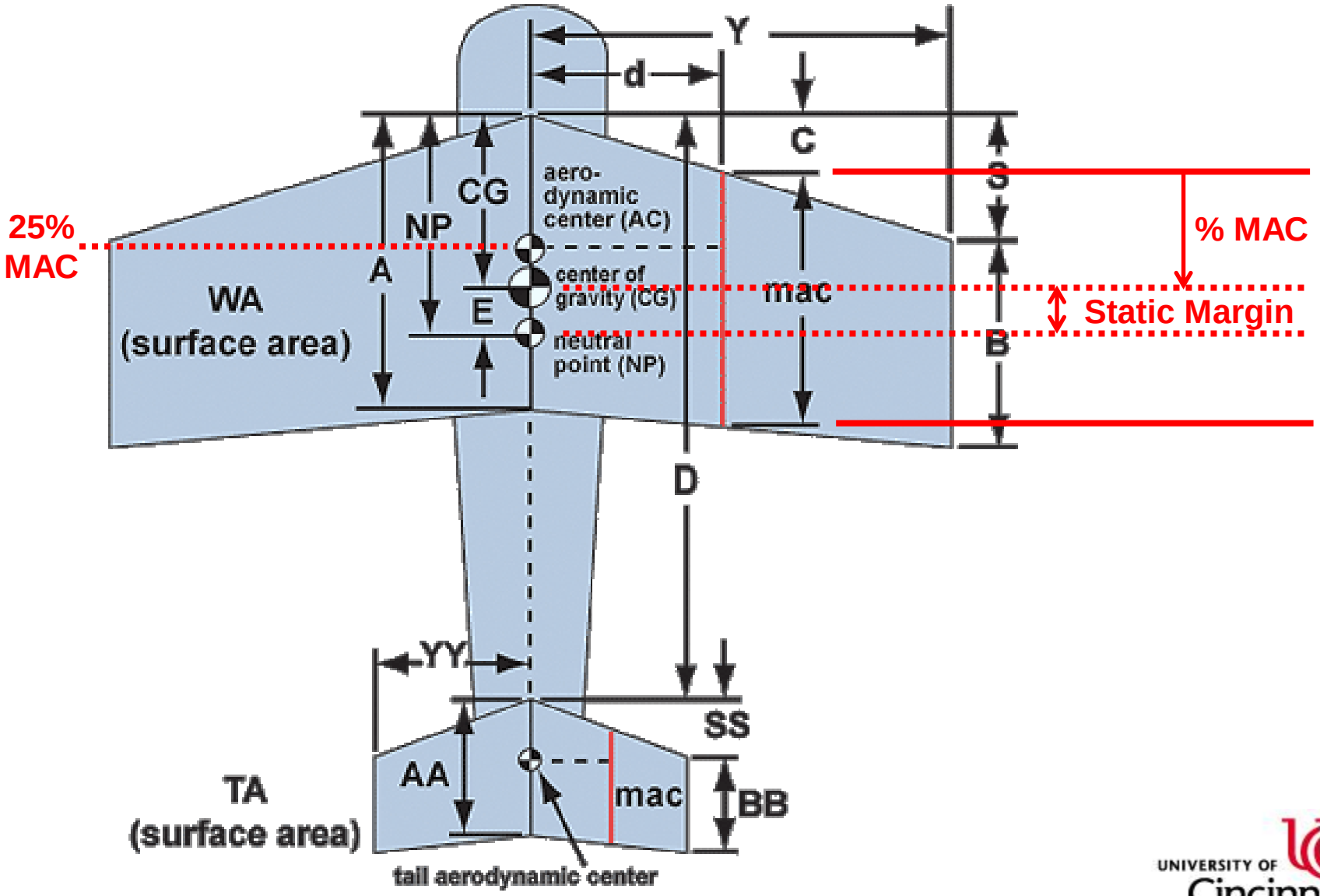
CG Location as % MAC



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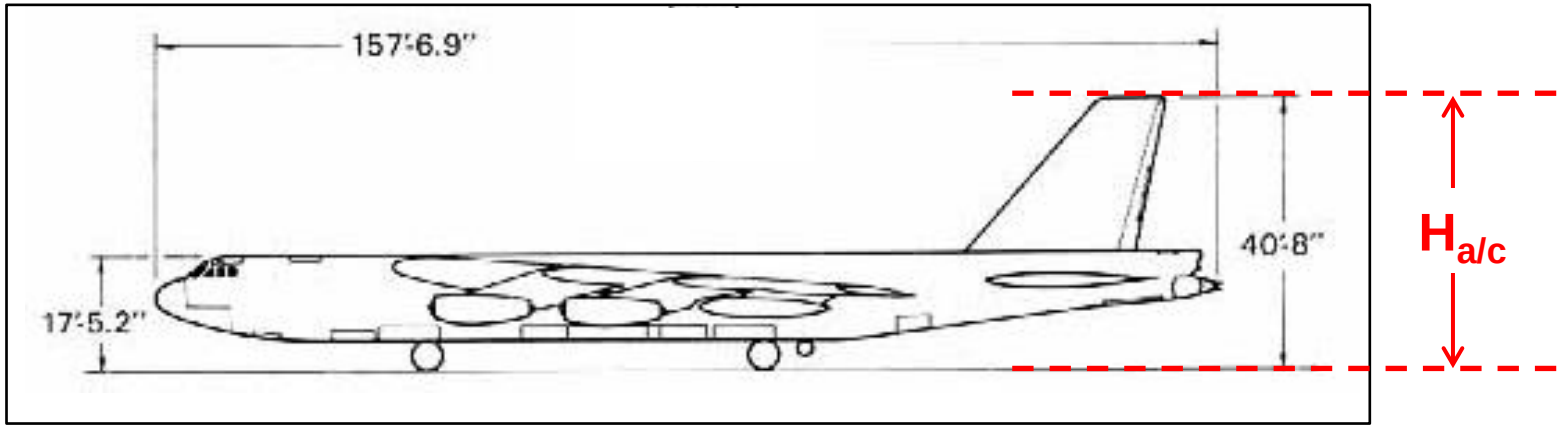
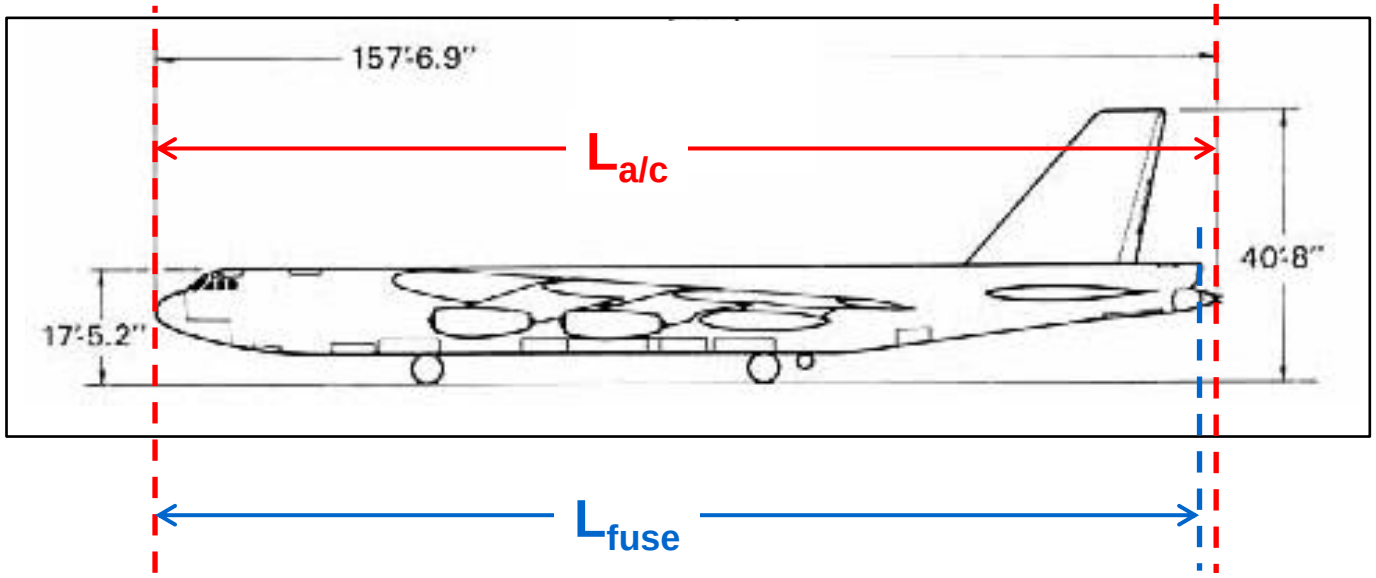
Aircraft Height Graphical Determination



Aircraft Length Graphical Determination



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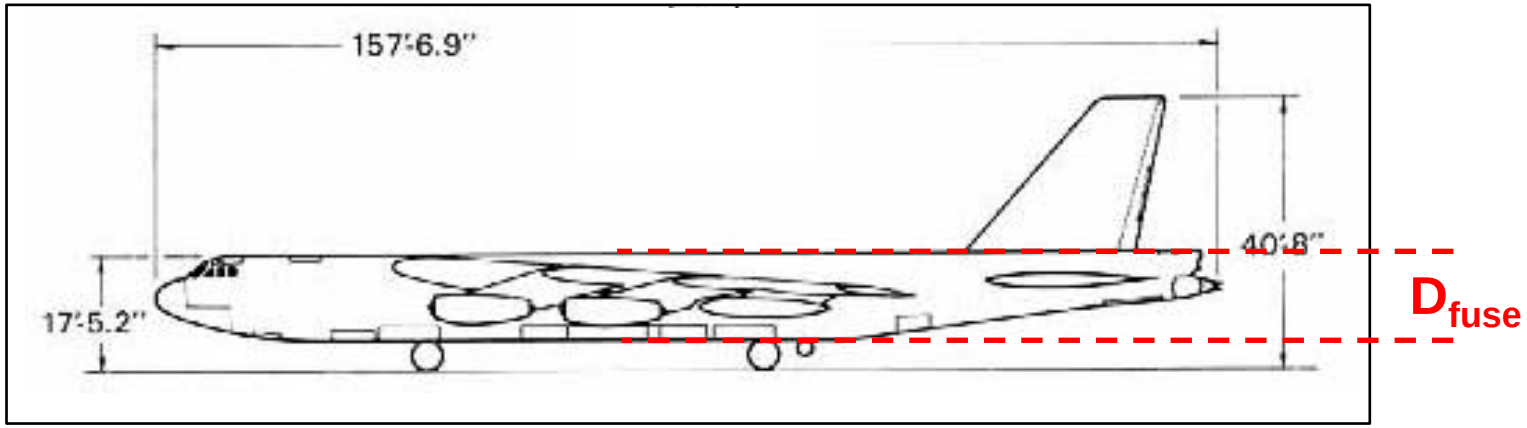
Fuselage Diameter Graphical Determination



Fineness Ratio: length / diameter

$$\text{Fuselage Fineness Ratio} = \frac{L_{fuse}}{D_{fuse}}$$

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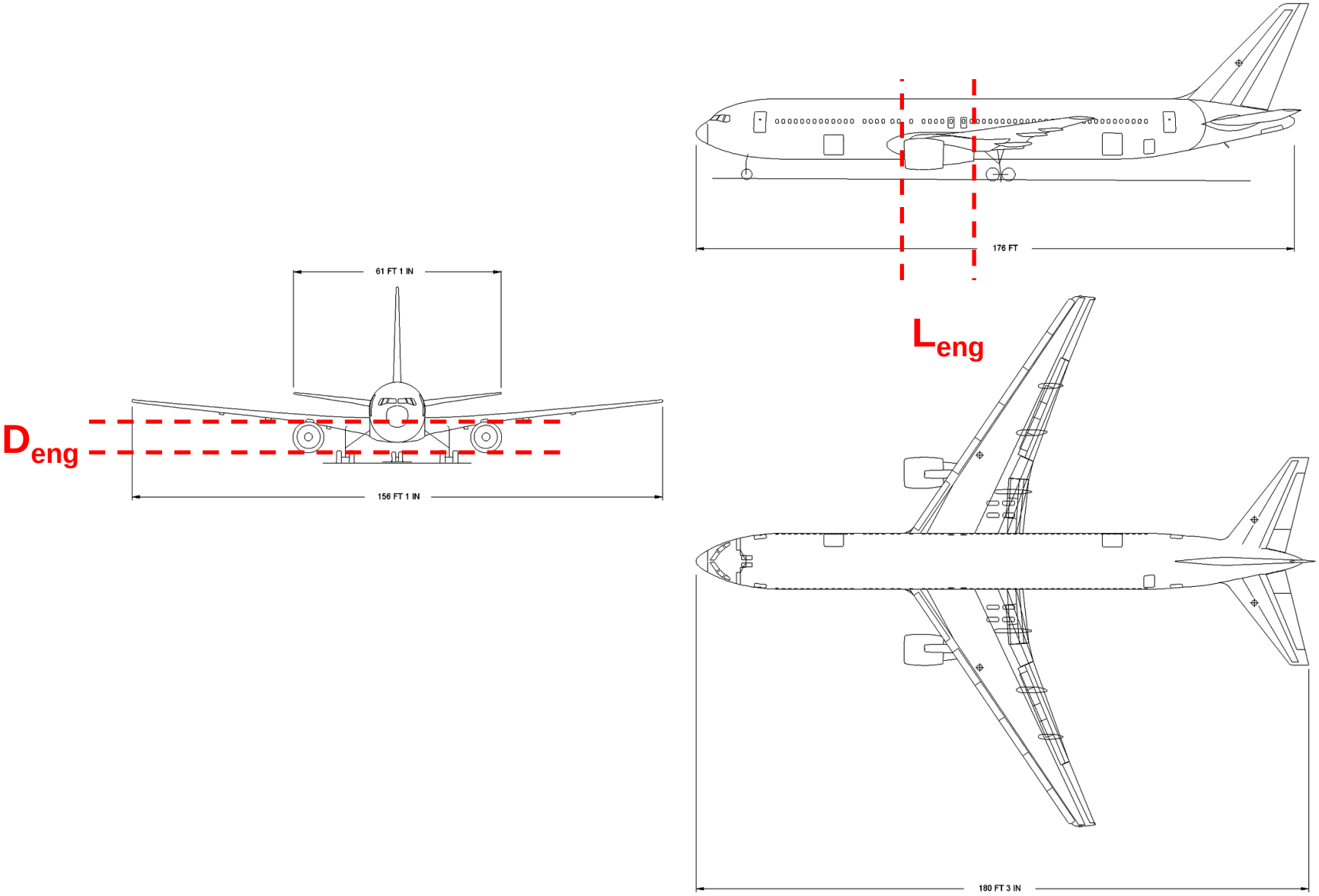
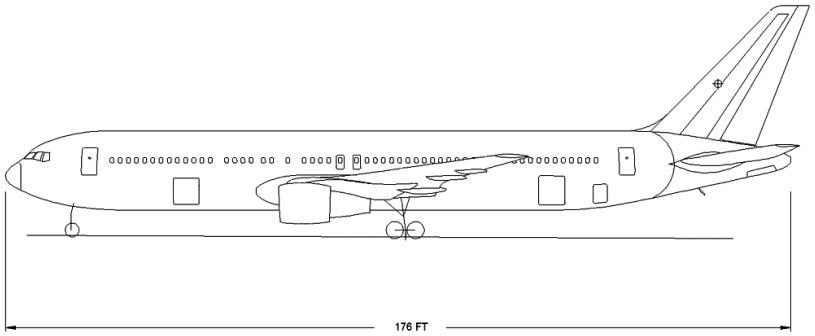
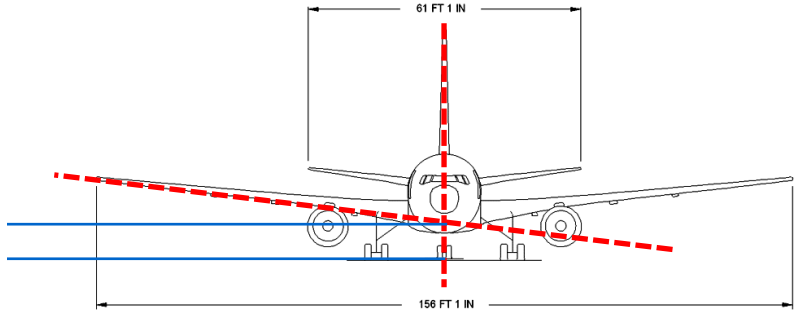
Engine Dimensions Graphical Determination



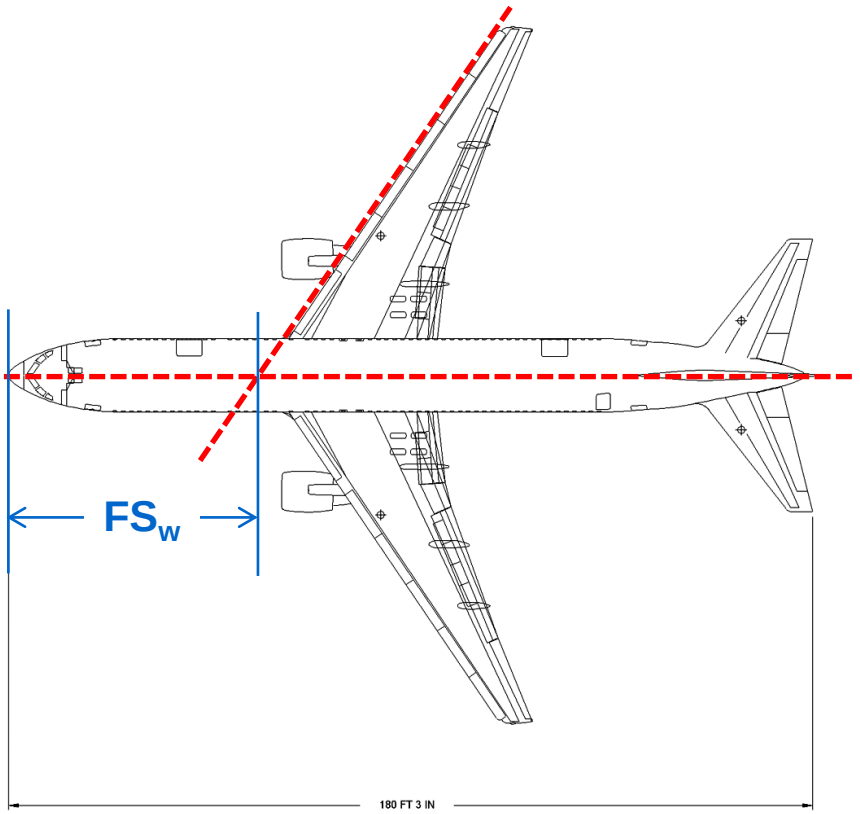
Wing Position Graphical Determination





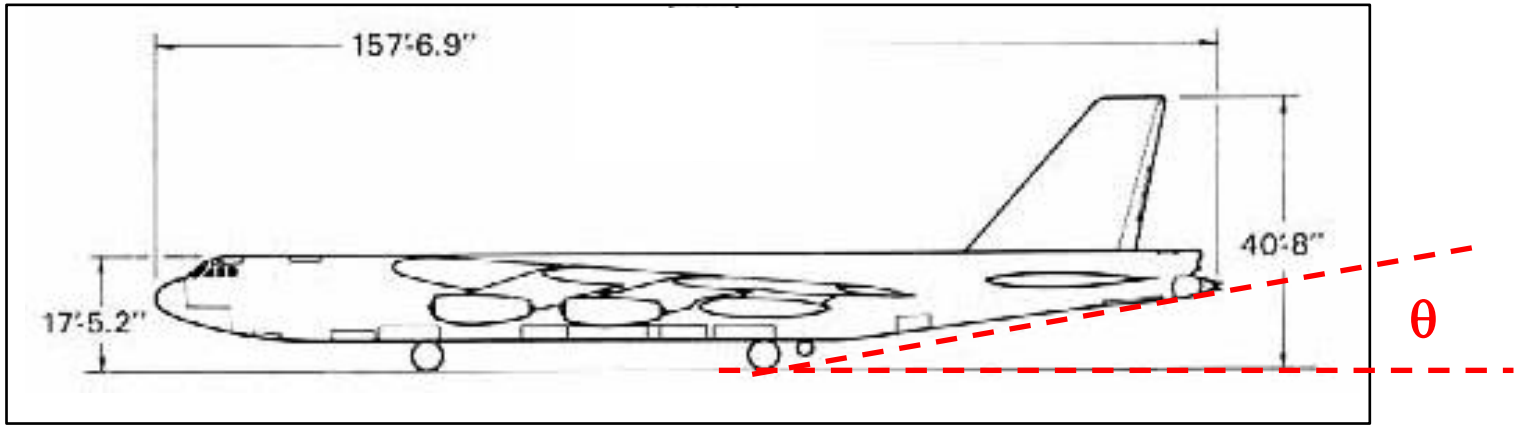
WL_w

$BL_w = 0$



Wing Position = (FS_w , BL_w , WL_w)

Tail Bump Angle Graphical Determination



1. **Draw a line along the ground**
2. **Draw a line from the most rear wheel to the point where the tail would bump on rotation**
3. **Measure the Tail Bump Angle (θ)**

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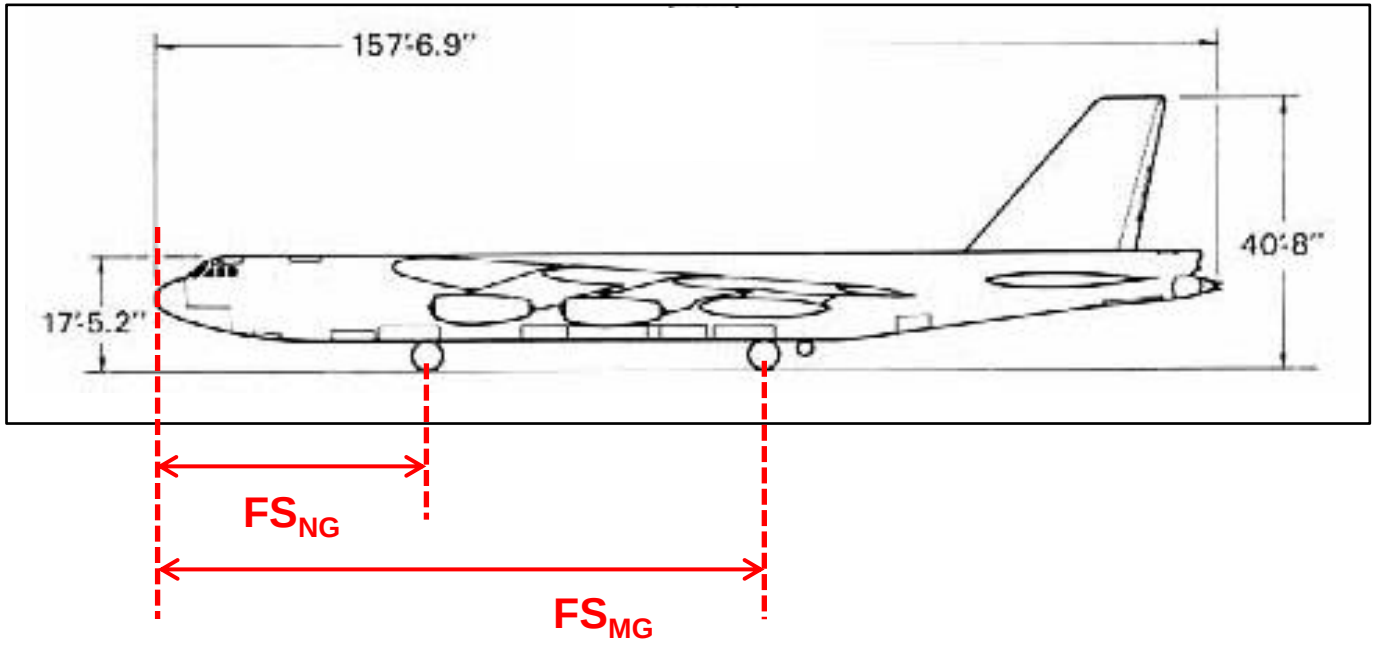
Landing Gear Graphical Determination



1. **Draw a line in the middle of the nose landing gear**
2. **Draw a line in the middle of the main landing gear**
3. **Measure the distance to those two lines from the nose tip**

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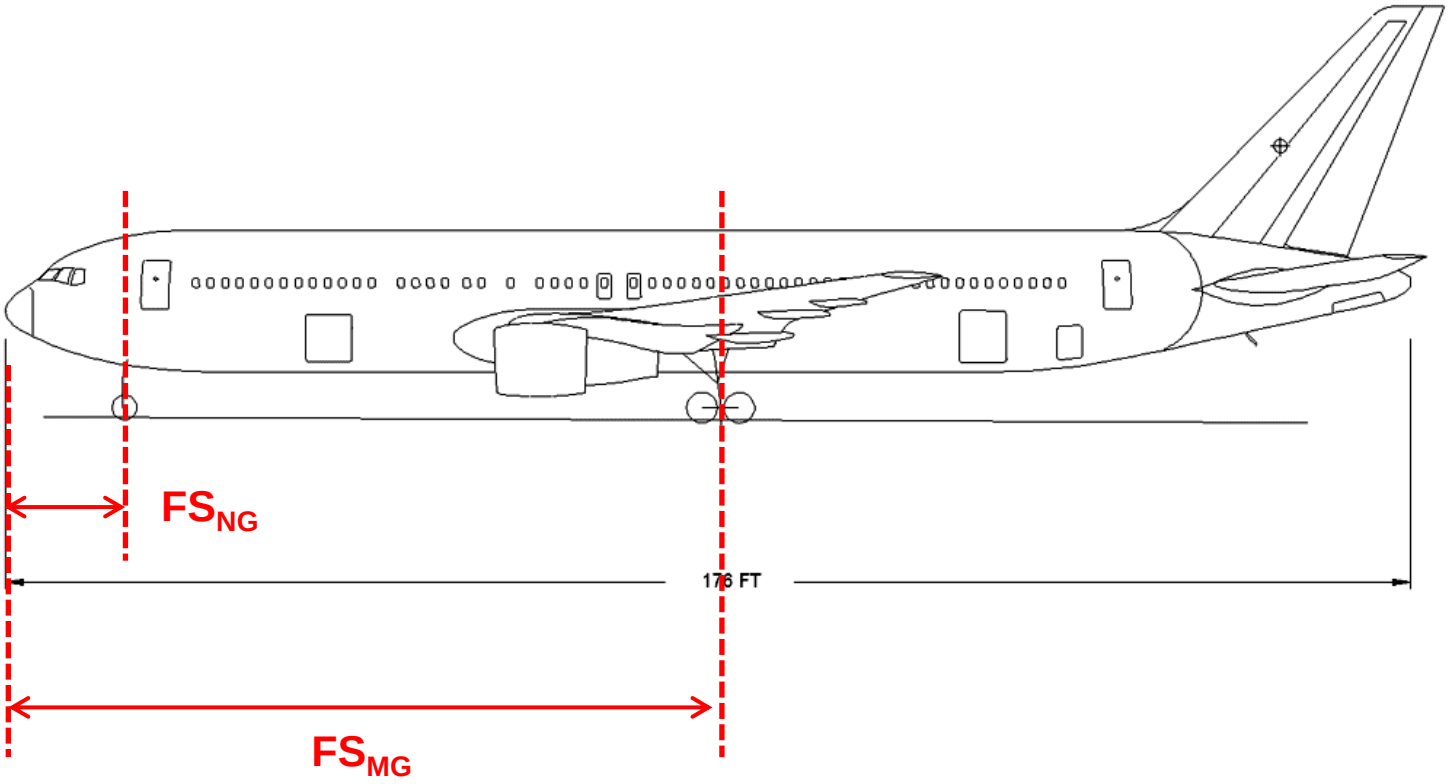
Landing Gear Graphical Determination



1. Draw a line in the middle of the nose landing gear
2. Draw a line in the middle of the main landing gear
3. Measure the distance to those two lines from the nose tip

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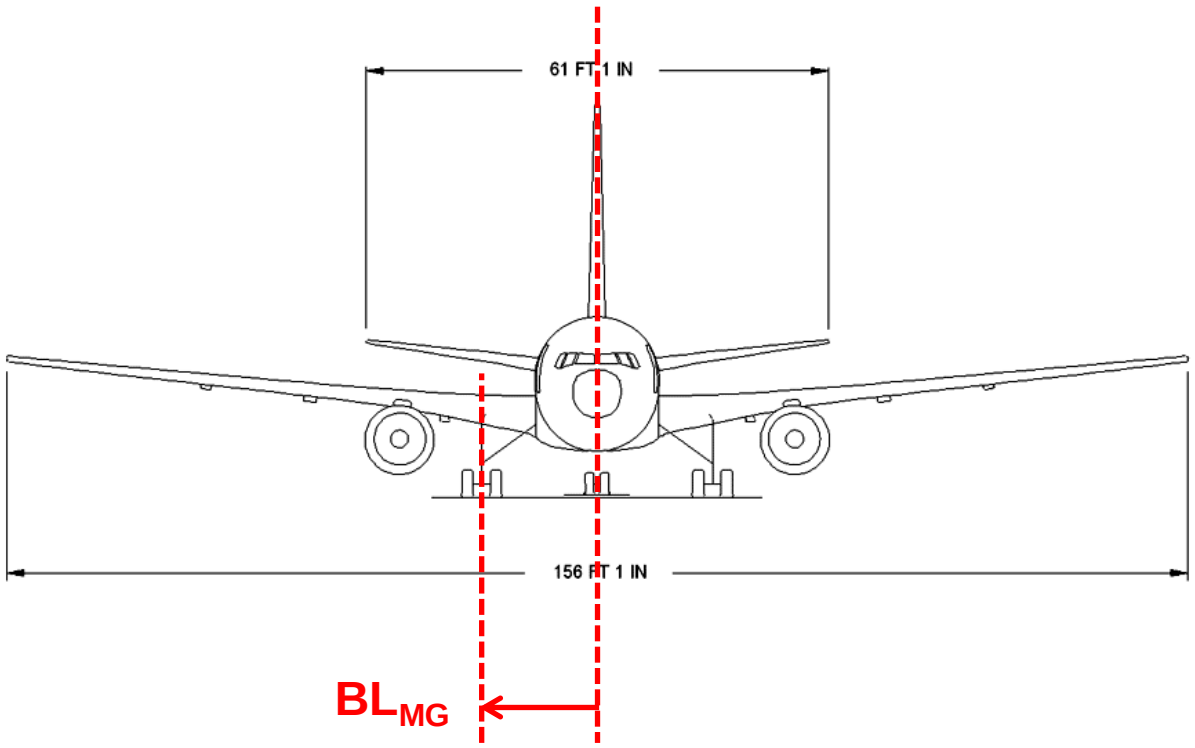
Wing Position Graphical Determination



Nose Landing Gear Position = (FS_{NG} , 0 , 0)

Main Landing Gear Position = (FS_{MG} , BL_{MG} , 0)

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Homework Assignment

HW #2 – Aircraft Dimensions
(due by 11:59 pm ET on Monday)

<u>HW Help Session</u>
Monday 1:00 – 2:00 pm ET

<u>Posted on Canvas</u>
HW #2 Assignment with instructions, tips, and checklist
HW #2 Template for data table in Excel
HW #2 WING Excel worksheet
HW #2 Protractor & Ruler

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Questions?