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Aerodynamics

Va and the Left Turning Tendencies

The Whys

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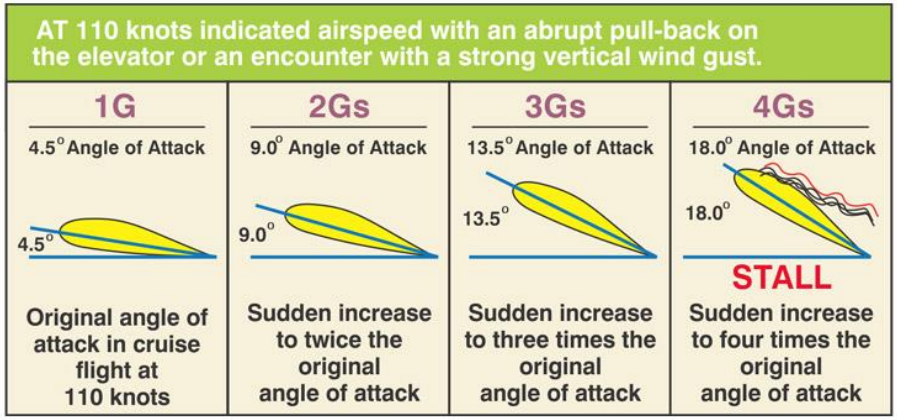
Va – Design Maneuvering Speed

- For a single axis and in one direction of the flight control – Rudder can be fully deflected once to each stop
- The speed at which the airplane can't develop more than the load limit – 3.8g to -1.52g
- The airplane will stall at the load limit



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Va – Design Maneuvering Speed

- Va is determined by:
- $Va * \sqrt{DesignLimit} = Vs * \sqrt{3.8} = Vs * 1.95$
- It is approximately 2* the clean stalling speed
- GA planes have a stall speed of not to exceed 61 Kts CAS
- Maximum Va speed will then be $61 * \sqrt{3.8} = 118.0$

Va – Design Maneuvering Speed

- The load limit force is generated by Load Factor
- Load factor is a function of lift
- Lift increases at the square of the speed

Va – Design Maneuvering Speed

Stall lift (L at CLmax) increases with V²:

$$L_{stall} = \frac{1}{2}\rho V_{stall}^2 S C_{L_{\max}}$$

At Va, we want:

$$L_{stall} = n_{limit} \cdot W$$

But L ∝ V², so:

$$n_{limit} \propto \left(\frac{V_a}{V_s}\right)^2$$

Solve for Va:

$$V_a = V_s\sqrt{n_{limit}}$$

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Va – Design Maneuvering Speed

- The stall speed is a function of weight – Higher weight = Higher Stall Speed
- A control surface will generate an aerodynamic force that will cause a rotational acceleration
- Newtons second law F=M*A
- Rewritten A=F/M
- So a decrease in weight (mass) can cause a higher acceleration
- Va must then go down with a decrease in weight

Va – Design Maneuvering Speed

- $Vanew = Vamax * \sqrt{new}\ weight / \max weight$

Special Airworthiness Information Bulletin and Explanation

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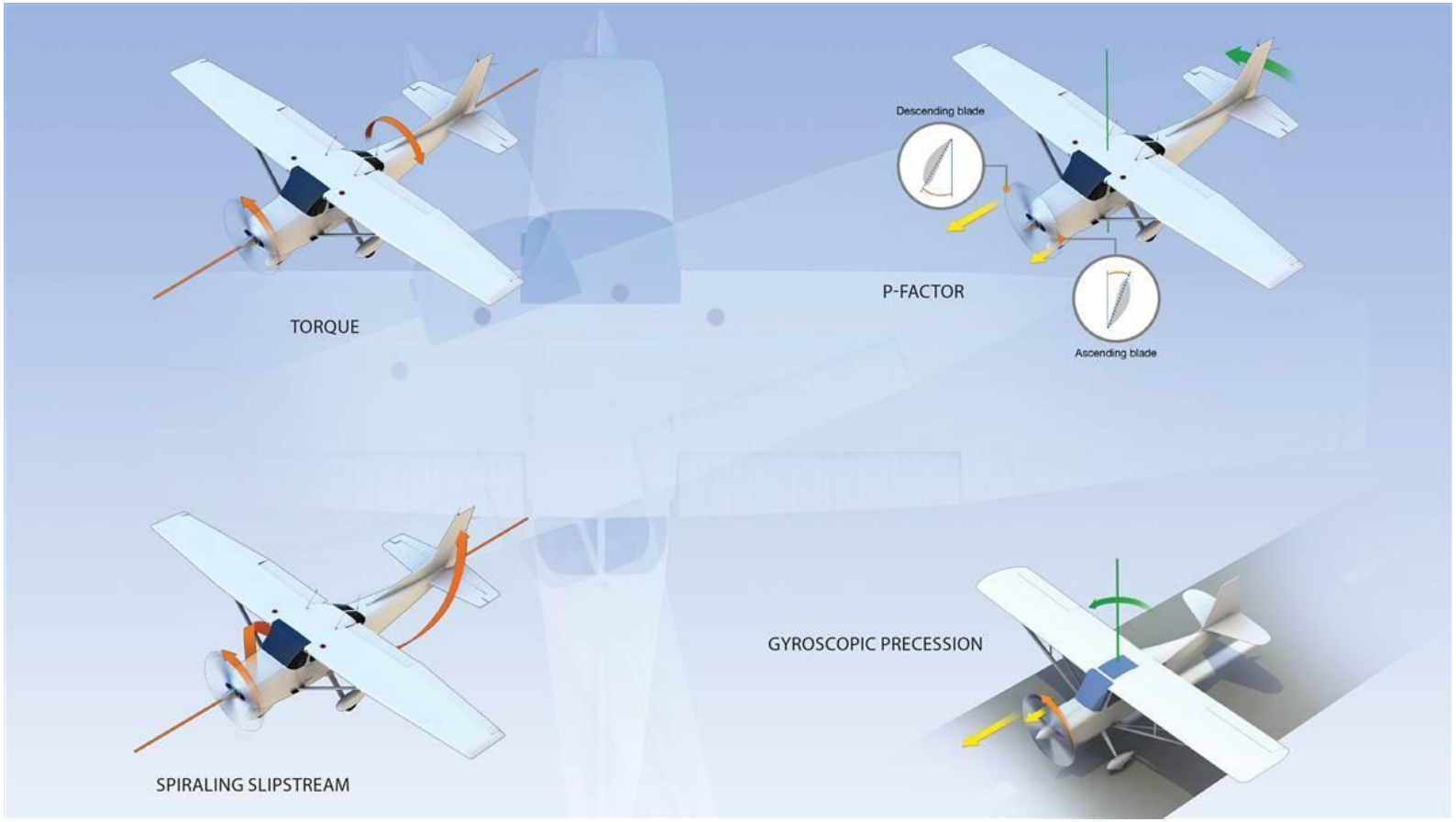
Left Turning Tendencies



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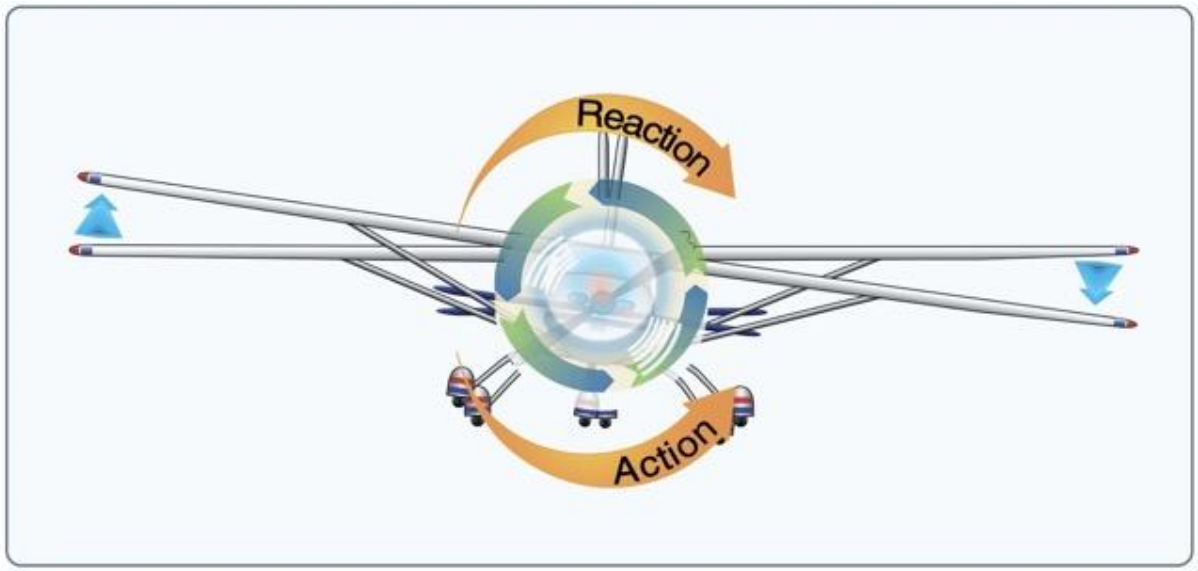
Left Turning Tendencies

Torque

Newtons third law – For every action there is an opposite and equal reaction



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Left Turning Tendencies

Torque

Newtons third law – For every action there is an opposite and equal reaction

The propeller rotates clockwise

The reaction is counter clockwise

This pushes on the left tire causing more drag/friction

Left Turning Tendencies

Torque

Newtons third law – For every action there is an opposite and equal reaction

In the air it is a left rolling tendency that turns into a left yawing tendency

Left Turning Tendencies

Torque

Designers try to minimize torque effect by:

Mounting the vertical stabilizer off of the longitudinal axis

Canting the engine

Providing more incidence on the left wing

Left Turning Tendencies

Slipstream Effect

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Left Turning Tendencies

Slipstream Effect

The propeller causes air to blow backwards and in a corkscrew pattern

The air spirals around the fuselage and hits with vertical stabilizer on the left

The stronger the slipstream (engine power) the greater the effect

Left Turning Tendencies

Slipstream Effect

Also makes the elevator and rudder more effective with more power

The ailerons are not in the slipstream so they aren't affected

The effect is upon the takeoff roll and throughout the flight

Left Turning Tendencies

P-Factor

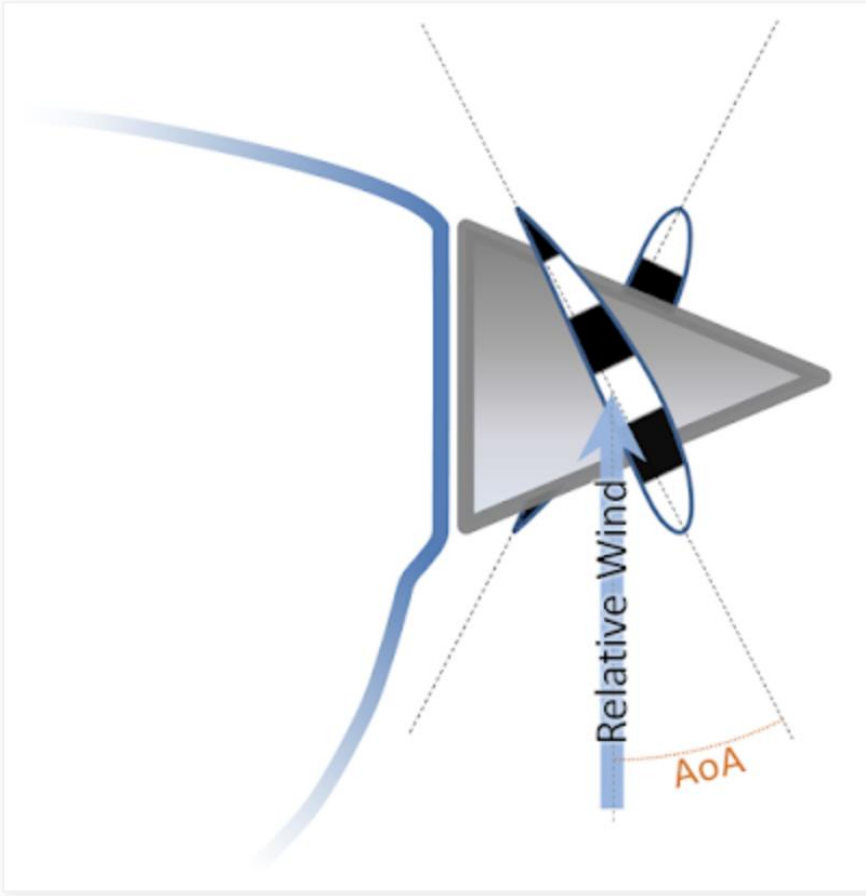
The propeller blades are mounted in opposite angles on each side of the hub and drive shaft

When the airplane isn't moving, both blades have an equal angle of attack

The relative wind to the descending blade is straight up from the ground

The relative wind of the ascending blade is directly from above

Left Turning Tendencies



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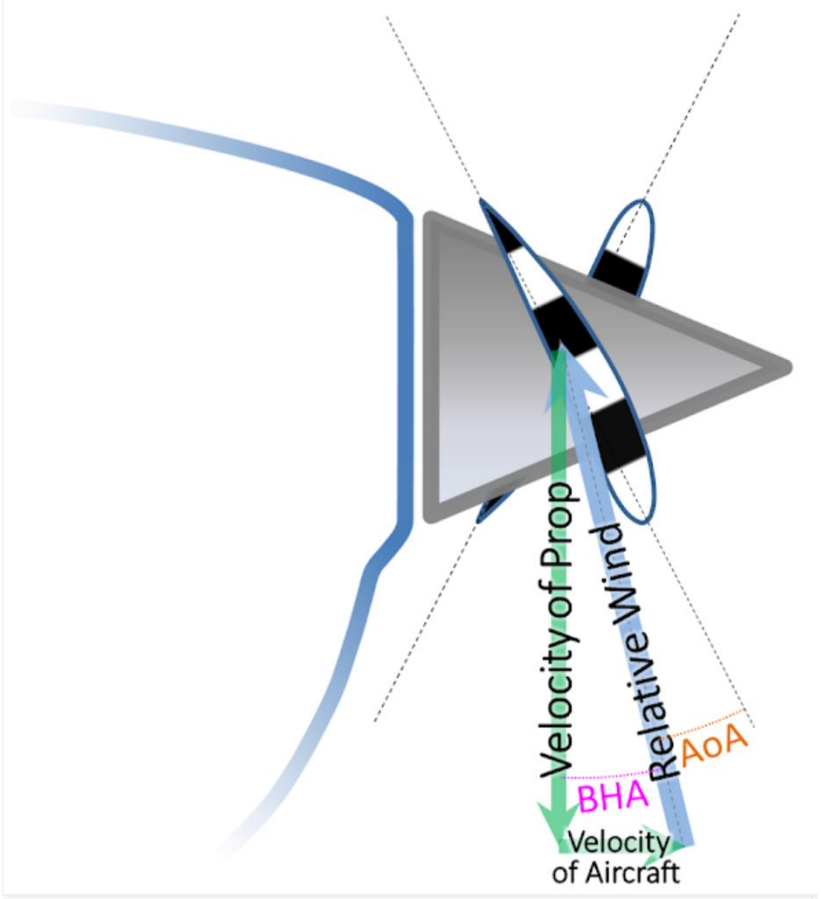
Left Turning Tendencies



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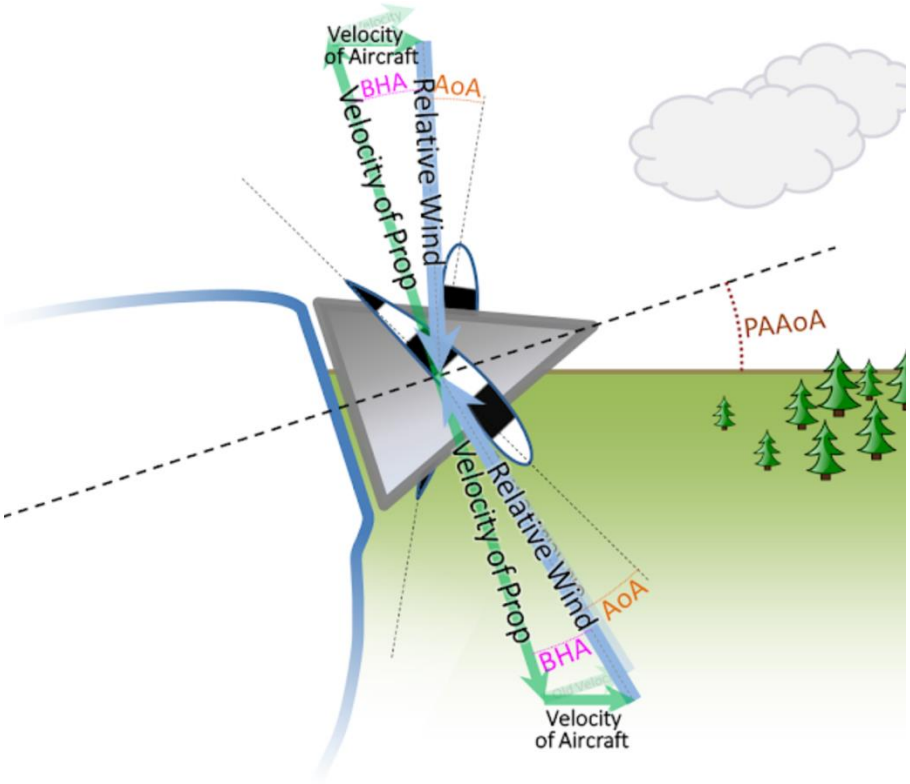
Left Turning Tendencies



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Left Turning Tendencies

P-Factor

When the airplane has an angle of attack of more than 0°, the descending blade will have a higher angle of attack than the ascending blade

This means the right blade will develop more lift - Thrust

This causes a left yawing tendency

This is felt upon rotation and climbing and when the speed is low in level flight (High Angle of Attack)

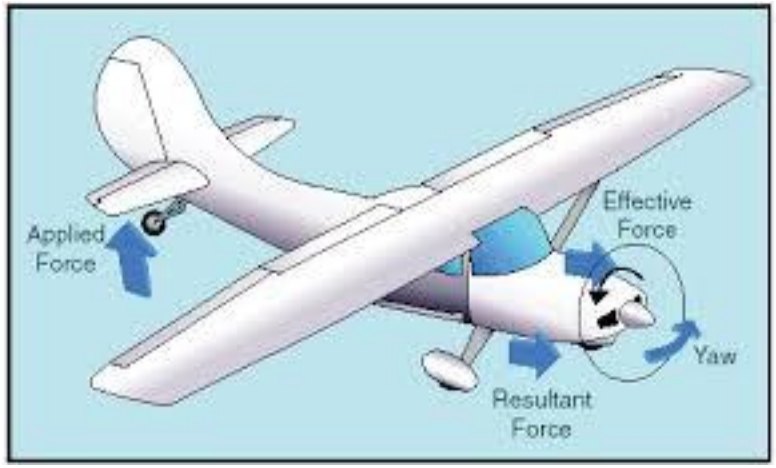
Left Turning Tendencies

Gyroscopic Precession - Sometimes

The propeller is rotating

It can be considered a disc for practical purposes

If a force is applied to a rotating disc the effect of that force will be 90° from the applied point in the direction of the rotation



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Left Turning Tendencies

Gyroscopic Precession - Sometimes

On rotation in a nosewheel airplane the force is applied to the bottom of the disc

The force is applied 90° later – on the left side of the disc

This causes a RIGHT turning tendency

Left Turning Tendencies

Gyroscopic Precession - Sometimes

On a tailwheel airplane the force is applied to the top of the disc on the takeoff roll to lift the tail

The force is applied to the top of the disc

The force is applied 90° later – on the right side of the disc

This causes a LEFT turning tendency

Left Turning Tendencies

Gyroscopic Precession - Sometimes

Upon rotation the precession will be a right turning tendency

In nosewheel/tailwheel airplane pushing the control wheel or stick forward applies a force to the top or the disc

This cause a LEFT turning tendency

Left Turning Tendencies

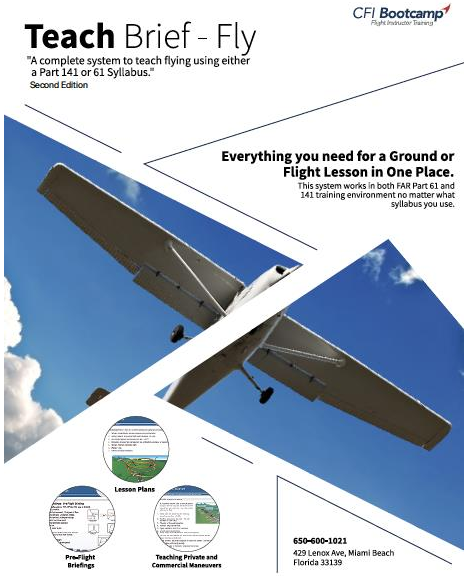
Left turning tendencies video

P-Factor Video

Gyroscopic Precession – Intuitive Explanation

From Us to You!

Preflight Briefings



Teach Brief-Fly!

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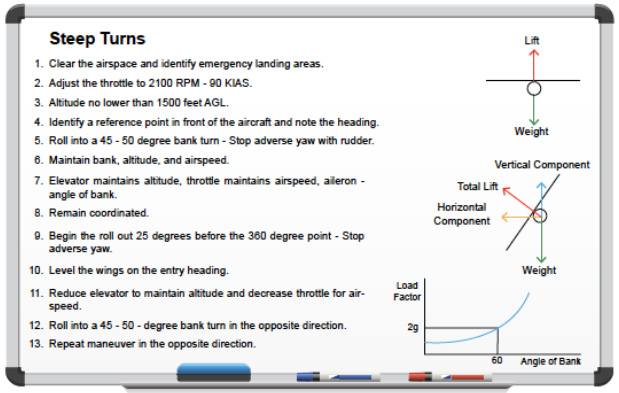
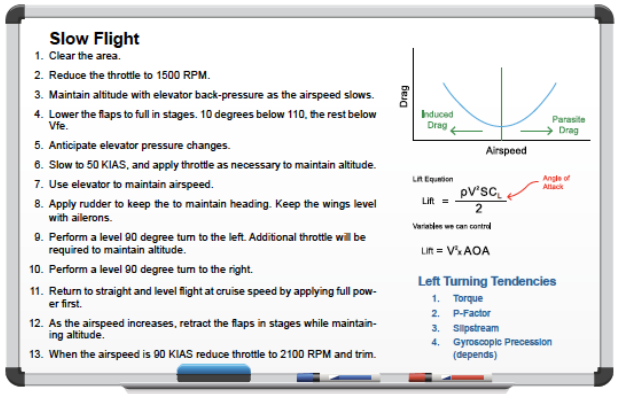
From Us to You!





[Teach Brief-Fly!]

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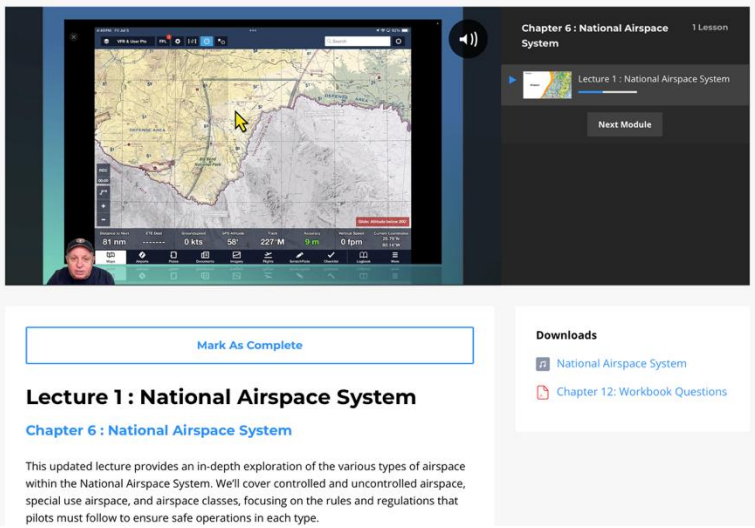
From us to you…

Free Preview of Our Online Course for Initial CFI-A

[Click here to get a Preview of the Online Course]



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Built for audio – Driving etc.

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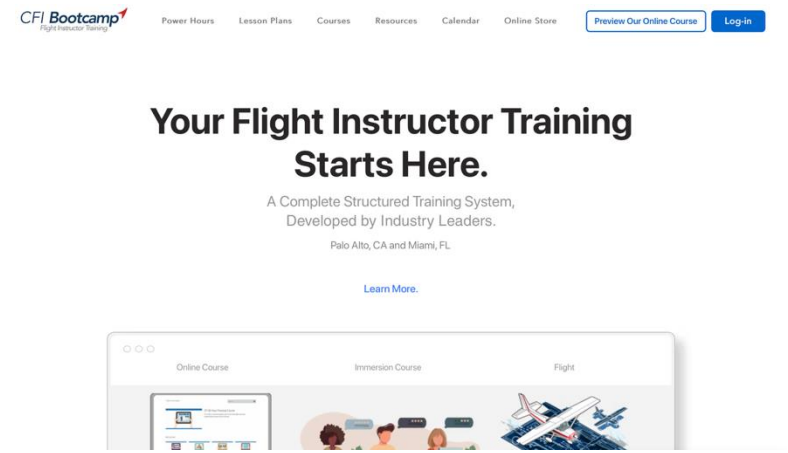
From us to you…

Start your CFI Training and Finish it!



We get the job done

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In Conclusion…

Past Power Hour Information

[Click here to get outlines of previous power hours]

Power Hour Lesson Outlines

Created Around Hour Long Weekly Live Topic Specific Instructional Training.

Powered by Bootcamp +

How to Make Being a Flight Instructor a Career

March 8, 2025 at 12:00:00 PM

A look into the products CFI Bootcamp has to offer

February 22, 2025 at 12:00:00 PM

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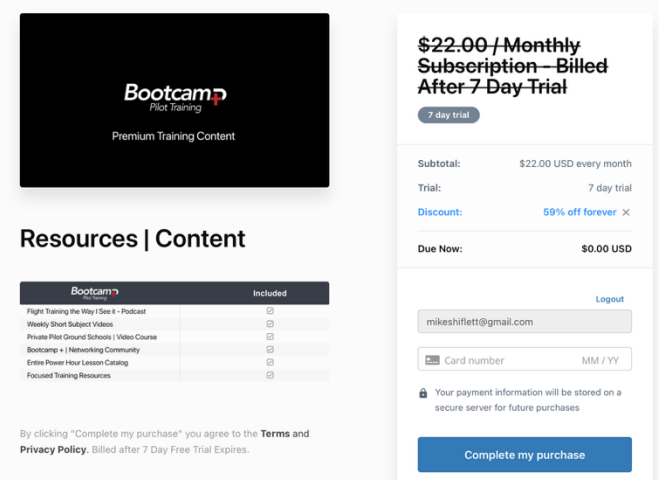
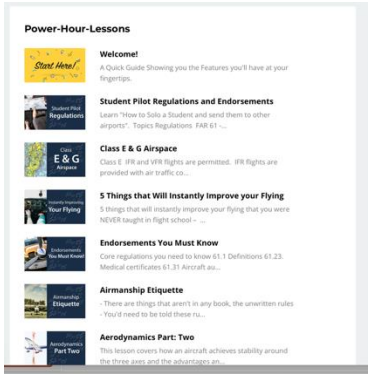
See Every Full-Length Power Hour

[Click here to get a huge discount to our membership site to see every previous power hour – Over 240 of them]



It will work out to be $9/month after the 7-day Free TrIal!



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