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Slow Flight

- Review Flight for Endurance
- Definition and Motivation
- **Slow Flight** in Clean and Landing Configuration
- **Slow Flight** Climbs, Descents and Turns
- Summary and Questions
- Pre-Flight Briefing

Review Flight for Endurance

- *Attitude plus power equals performance!*
- Mentally configure the aircraft for maximum endurance flight and state all observations and required actions.
- What particular observation applies to the control inputs compared to normal cruise flight?

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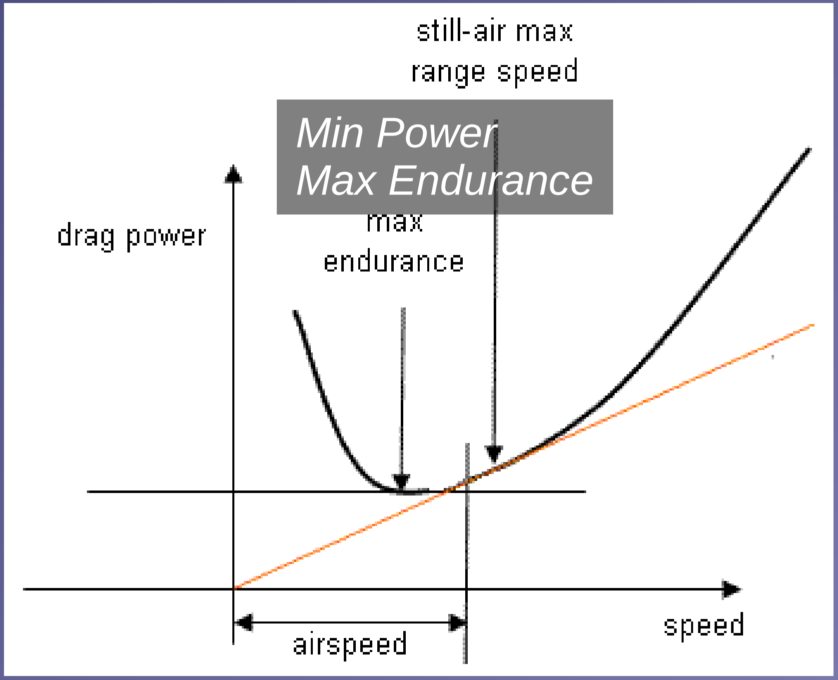
Definition and Motivation



- Flight at airspeeds in the **range** *below* the **maximum endurance** speed down to just above the stalling speed
- Dominating **induced drag** requires *more* **thrust** and **power**
- Control surfaces are *less* effective at slower airspeeds
- (Soft Field) Take-offs, Landings and Go-Arounds

Safety Considerations

- *High* **nose-up attitude** maneuver
- *Limited* forward visibility
- **HASEL**, recovery at or above ***2000 ft AGL***
- Maintain good **lookout** during maneuver
- **Attitude** and **power** are to be controlled *precisely*
- **Yaw** is to be controlled *precisely* with **rudder**
- Remain **coordinated** at all times

Entering Slow Flight (Clean) from Flight for Maximum Endurance

- Perform **HASEL** checks and continue **lookout** during the maneuver
- Configure the aircraft for **maximum endurance** flight *first*, then
- Apply **elevator** back-pressure to establish a *slightly more* **nose-up attitude** to **decelerate** into the slow flight range
- Increase **power** *as required* to keep the **airspeed** *stable* controlling **yaw** with **rudder** maintaining **altitude** and finally **trim**

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Entering Slow Flight (Clean)

- Perform **HASEL** checks and continue **lookout** during the maneuver
- Reduce **power** and **decelerate** into slow flight range
- Apply **elevator** back-pressure and increase **nose-up attitude** *gradually* as required to maintain **altitude**
- Increase **power** *as required* to keep the **airspeed** *stable* controlling **yaw** with **rudder** maintaining **altitude** and finally **trim**

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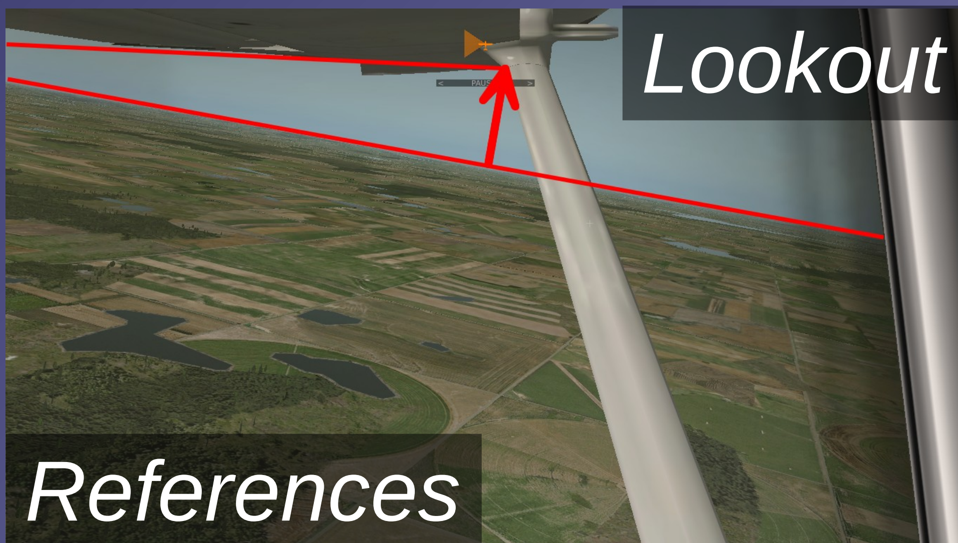
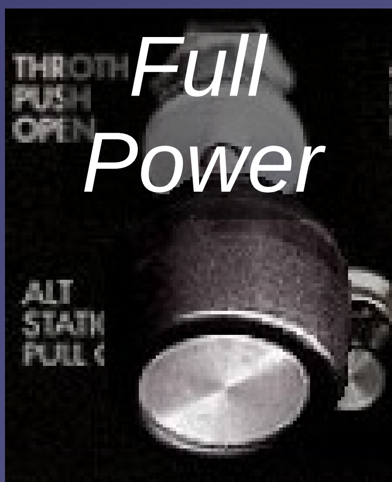
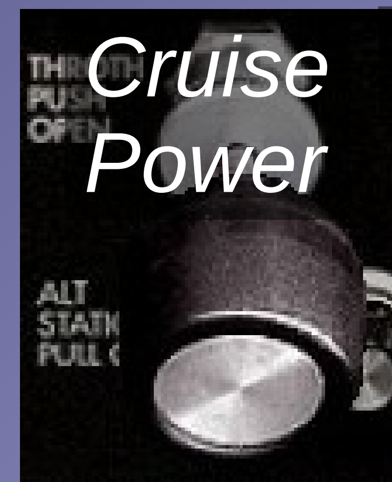
Maintaining Slow Flight (Clean)



- **Stall warning** audible and **ailerons** are *much less* **responsive**
- *More* **power** in slow flight produces *more* **yaw** and requires *continuous* **rudder** input to remain **coordinated**
- *Attitude plus power equals performance!*
- **Pitch** controls **airspeed**, **power** controls **altitude** in practice

Recovering Slow Flight (Clean)





- Apply *full* **power** controlling **yaw** with **rudder** to remain **coordinated**
- Apply **elevator** forward pressure to lower the **pitch attitude** *gradually* while maintaining **altitude**
- Establish **cruise attitude** and accelerate to **cruise airspeed**
- Reduce **power** to **cruise power** setting and finally **trim**

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Entering Slow Flight (Flaps)

- Perform **HASEL** checks and continue **lookout** during the maneuver
- Reduce **power** and **decelerate** into slow flight range
- Apply **elevator** back-pressure to increase **nose-up attitude** *gradually* as required to maintain **altitude**
- Extend **flaps** *in stages* to desired setting while decelerating in **white arc**
- Increase **power** *as required* to keep the airspeed at the bottom of the **white arc** controlling **yaw** with **rudder** maintaining **altitude** and finally **trim**

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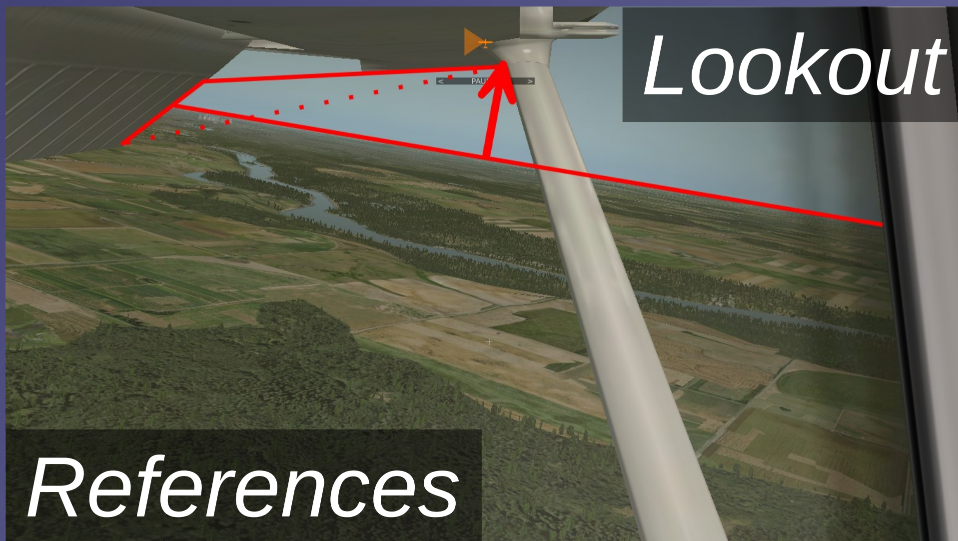
Maintaining Slow Flight (Flaps)



- Additional **flaps** create *more* **drag** and require *more* **thrust** and **power**
- **Stall warning** audible and **ailerons** are *much less* **responsive**
- *More* **power** in slow flight produces *more* **yaw** and requires *continuous* **rudder** input to remain **coordinated**
- *Attitude plus power equals performance!*
- **Pitch** controls **airspeed**, **power** controls **altitude** in practice

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Recovering Slow Flight (Flaps)

- Apply *full* **power** controlling **yaw** with **rudder** to remain **coordinated**
- Apply **elevator** forward pressure to lower the **pitch attitude** *gradually* while maintaining **altitude**
- Raise **flaps** *in stages* to up while accelerating in **white arc**
- Establish **cruise attitude** and accelerate to **cruise airspeed**
- Reduce power to **cruise power** setting and finally **trim**

Climbs and Descents in Slow Flight

- *Attitude plus power equals performance!*
- Increase **power** *as required* to initiate **climb** in practice
- Reduce **power** *as required* to initiate **descent** in practice
- Adjust **attitude** to maintain (slow flight) **airspeed** in practice

Turns in Slow Flight

- **Ailerons** are *less* **responsive** and expect *more* **adverse yaw**
- *Different* **rudder** inputs are required to compensate **yaw** and support **turns** while remaining **coordinated**
- Establish and maintain **banked attitude** (up to ***30°***) with **ailerons** and *continuous* **rudder** support
- Right turns require *more* rudder than left turns

Summary / Quiz

- Define slow flight and give examples for when slow flight is applicable.
- Mentally enter a slow flight in landing configuration from cruise flight and state all observations and required actions.
- Mentally perform a turn to the right in slow flight and state all observations and required actions.
- Mentally recover from a slow flight in landing configuration and state all observations and required actions.

Pre-Flight Briefing

- Exercise
- Training Area
- Departure and Arrival Procedures
- Weather Briefing / NOTAMs
- Aircraft and Documents
- Time and Fuel Requirements
- Safety Considerations and Responsibilities

Additional Materials

- Additional materials for Slow Flight
- Flight Instructor Guide – Exercise 11, Lesson Plans 5, 6, 7

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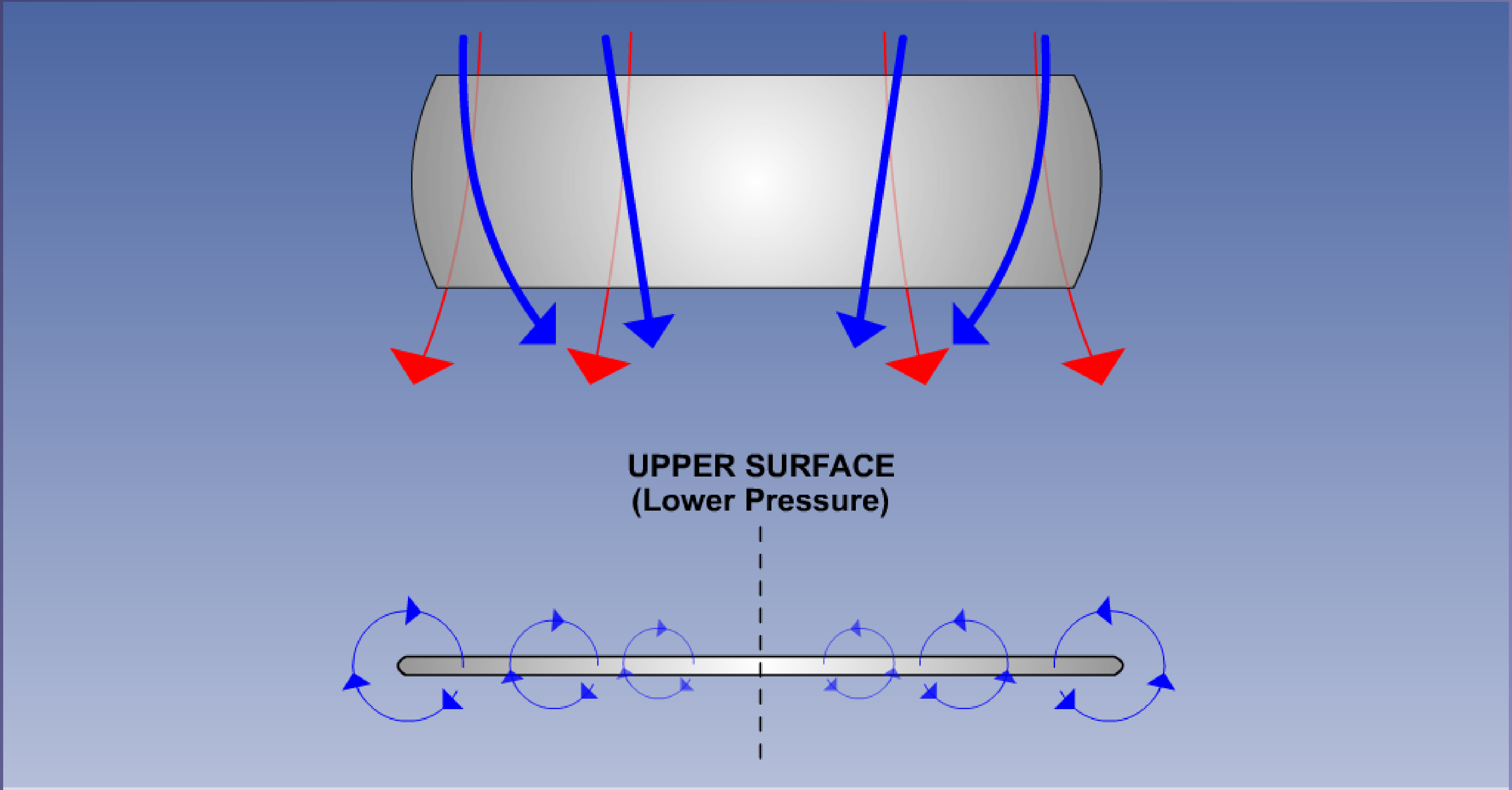
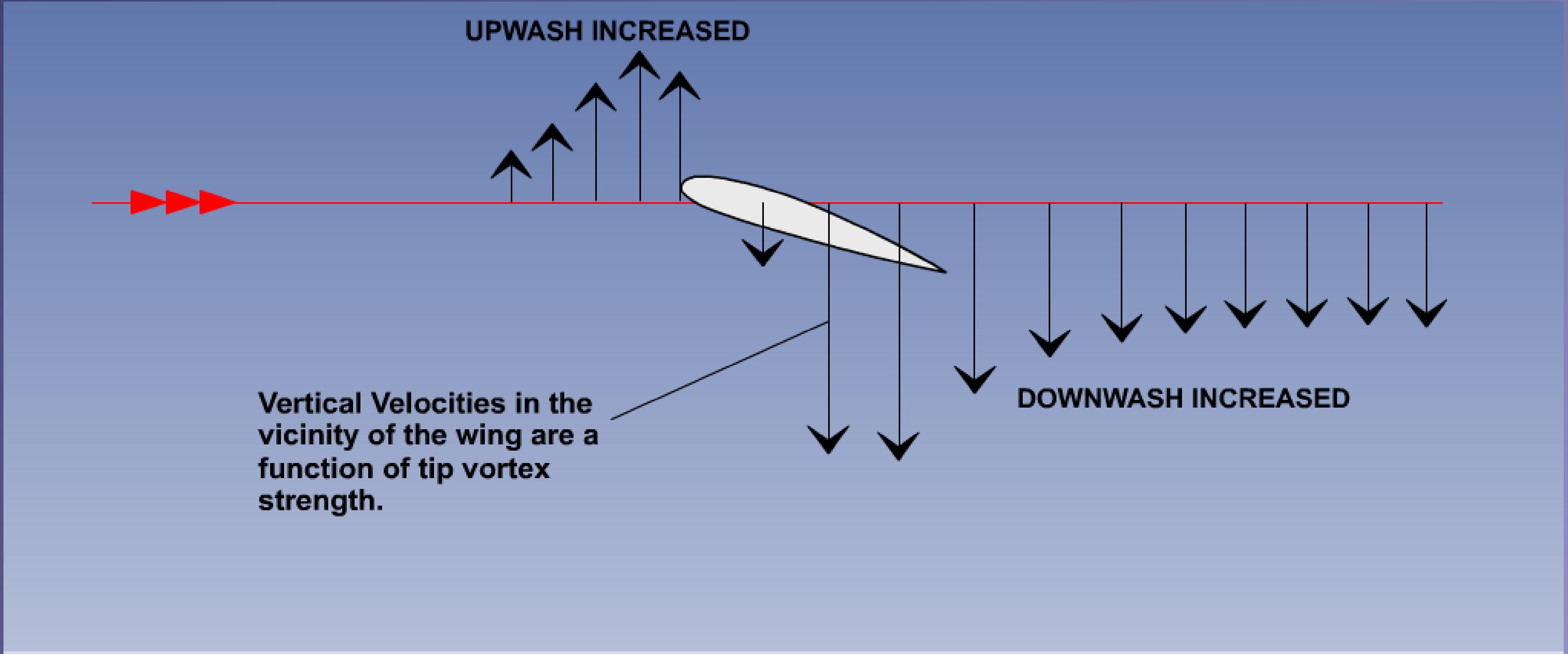
Wingtip Vortices



Wingtip Vortices

The pressure differential creates a flow towards the wing root above the wing, and towards the tip below it, the flows interacting at trailing edge and wingtips. Viewed from astern, the vortices rotate clockwise on the left and anticlockwise on the right. At lower IASs, the smaller chordwise vector combined with the greater spanwise vector result in a greater spanwise flow and stronger vortices.

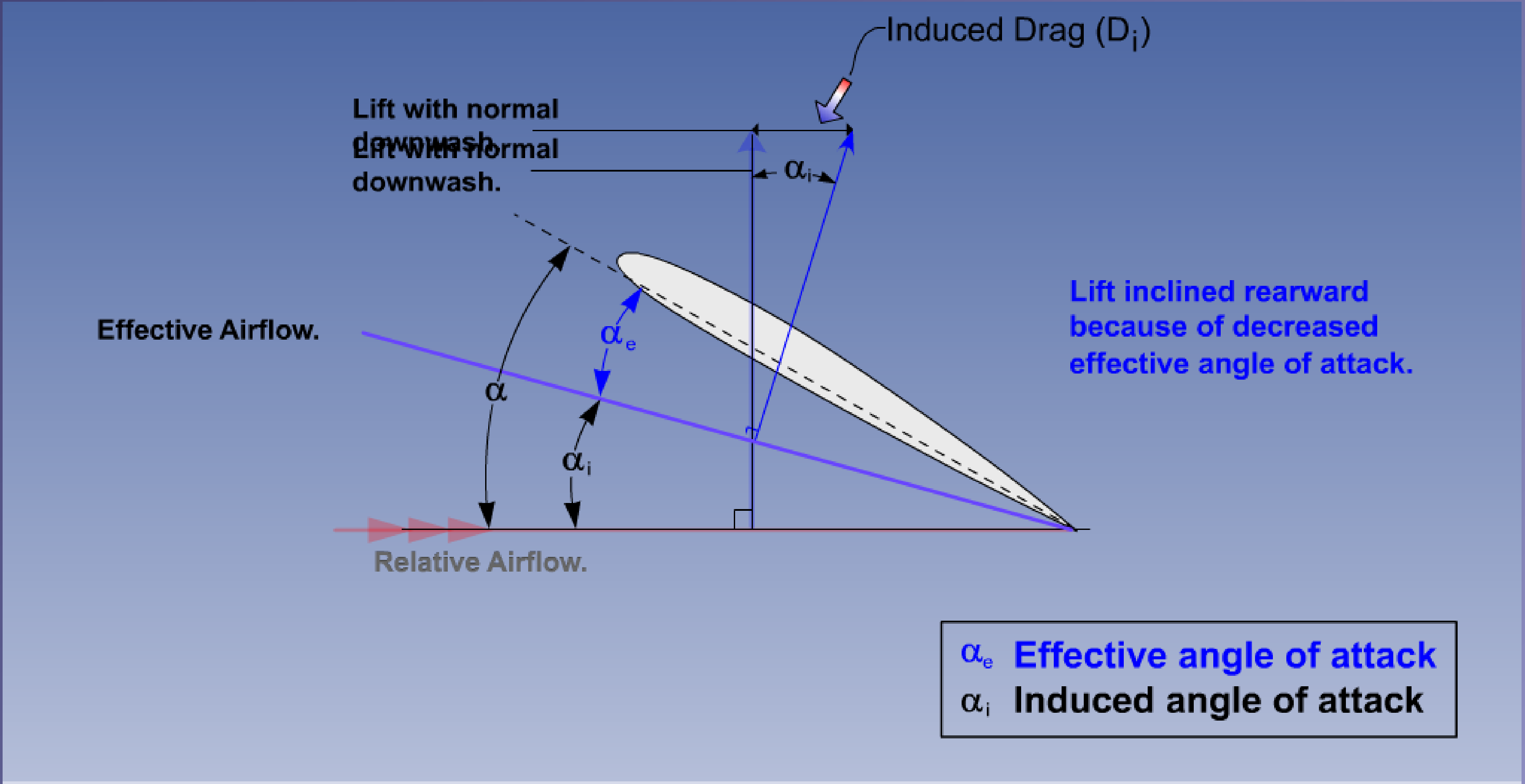
Induced AoA – Upwash and Downwash



Induced Downwash

The vertical velocities are greatest close to the wing and are a function of vortex strength, with a proportional reduction in effective angle of attack.

Effective Angle of Attack



Induced Downwash

The localised reduction in effective angle of attack causes the lift generated to be less than it would be if there were no spanwise flow. To replace this lost lift, the wing must be flown at a higher angle of attack, tilting the lift vector rearwards and creating induced drag.

Induced Drag Factors

More lift will produce more induced drag. Higher weight will require greater lift, which will also produce more induced drag.

Manoeuvres such as turns require lift to exceed weight, and induced drag will increase in proportion to the load factor, or ‘g’, the ratio of lift to weight.

Induced drag will increase in proportion to the square of the lift force.

Induced drag varies inversely as the square of the speed.

The induced drag coefficient is inversely proportional to the aspect ratio.

Familiarization Demonstration

- Employ an obvious and dramatic example
- Stall: Power Idle, increase nose-up attitude while maintaining straight-and-level, control yaw and demonstrate falling leaf / nose-drop