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Area of Operation **II** - Task **E**

Airplane Flight Controls

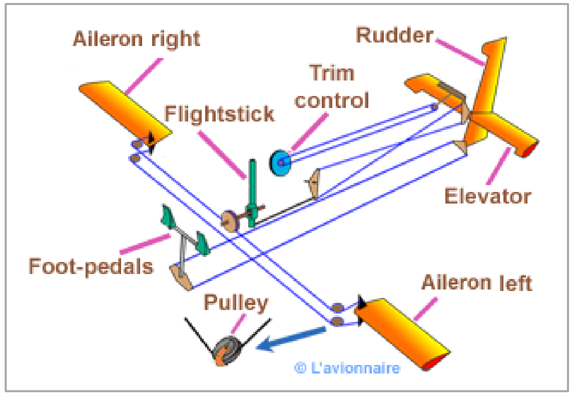
westflying

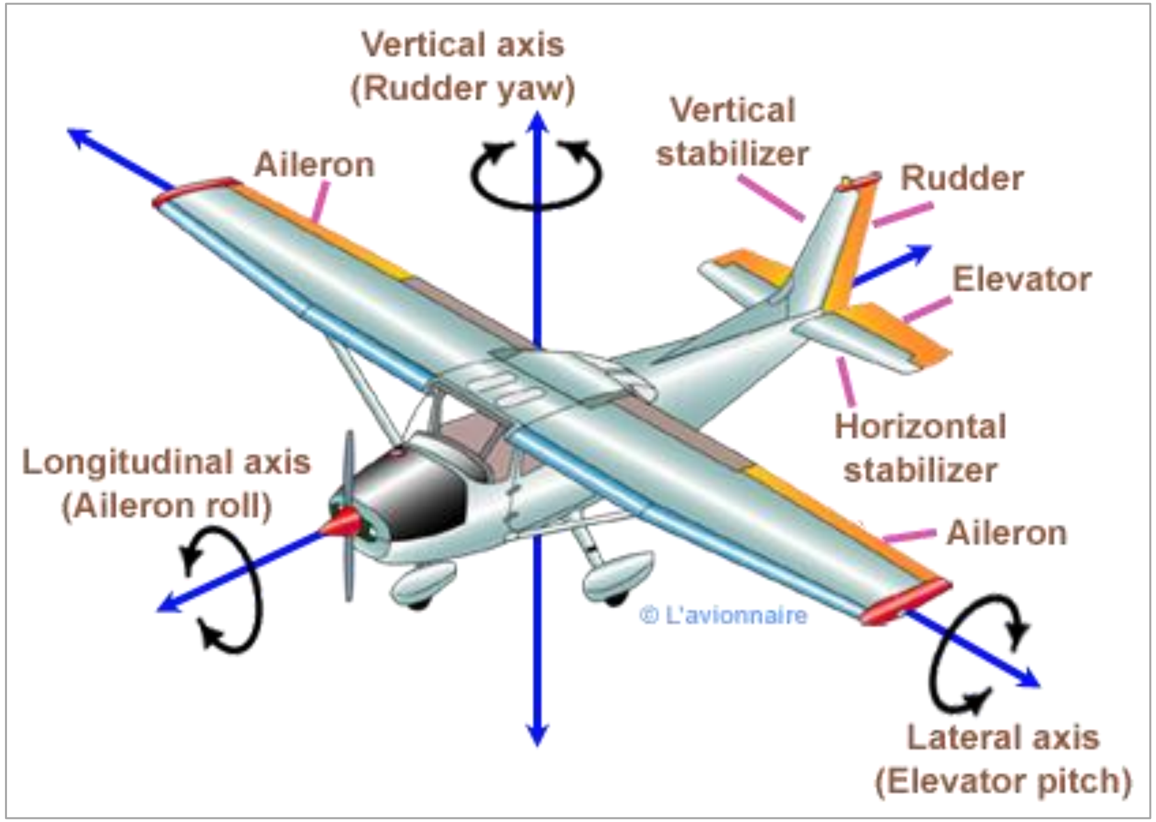
Key References:
- Airplane Flying Handbook
- Pilot’s Handbook of Aeronautical Knowledge

Content

1. Introduction

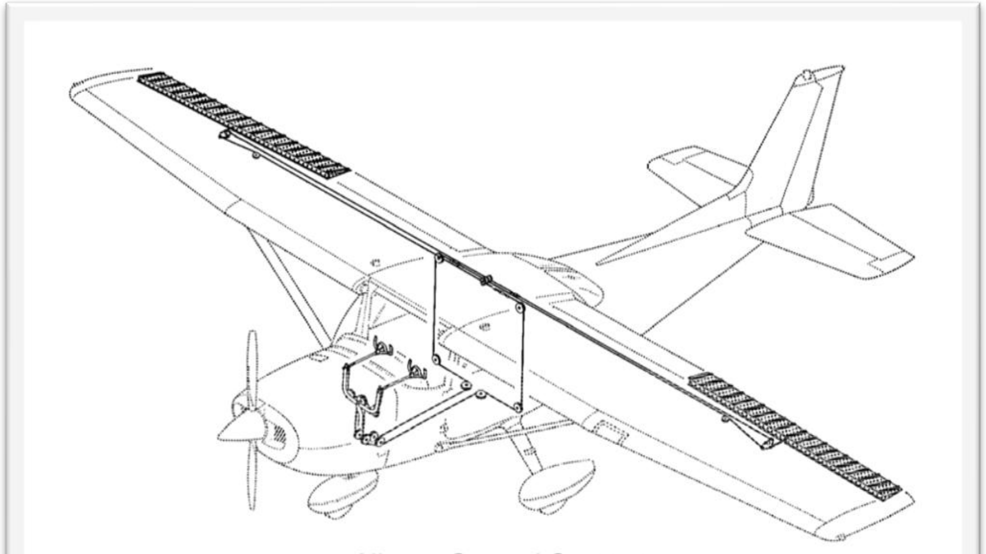
- **What**: Flight controls are the means in which a pilot control direction and attitude of the airplane
- **Why**: Understanding the effects each control input leads to an understanding of how to control the airplane
- **Types of Flight Controls**
  - Primary flight controls
    - ✓ *Aileron*
    - ✓ *Elevator*
    - ✓ *Ruder*
  - Secondary flight controls
    - ✓ *Trim*
    - ✓ *Flaps*
    - ✓ *Spoilers*

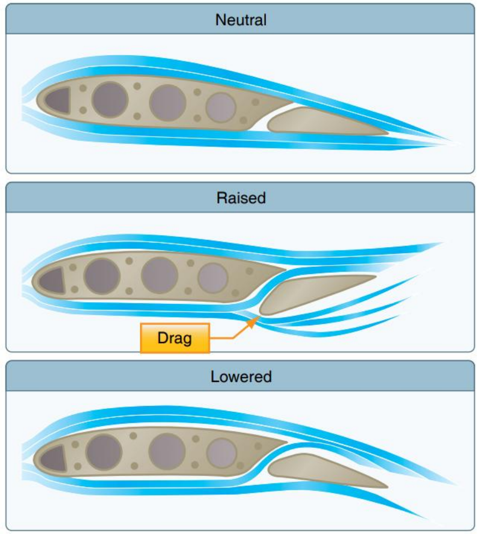


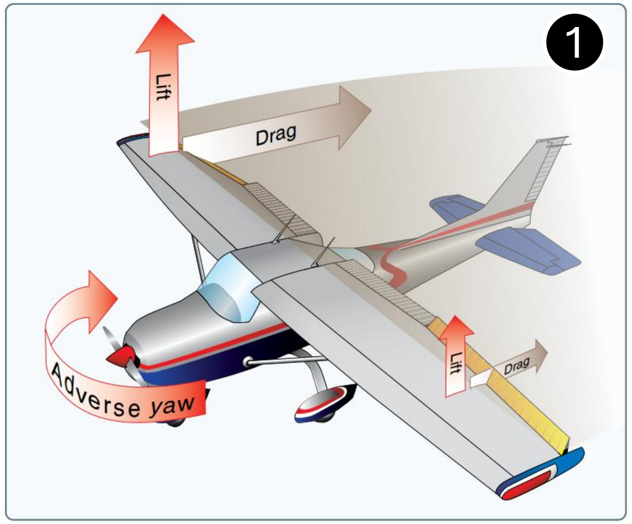


2. Ailerons

- Control roll about the longitudinal axis
- **Operation**
  - Trailing edge of each wing, move opposite each other
  - Right turn: right aileron up, left aileron down
  - Downward deflection increases camber → Increases lift *(vice versa)*
  - Difference in lift causes the airplane to roll
- **Adverse Yaw**
  1. Yaws the airplane in the direction of the raised wing
  - Rudder is used to counter and maintain coordination
- **Types of Ailerons**
  - Differential ➔ *higher deflection when up*
  - Frise-type ➔ *creates interference when up*
  - Coupled ➔ *connected with rudder*
  - Flaperons ➔ *combined w/ flaps*

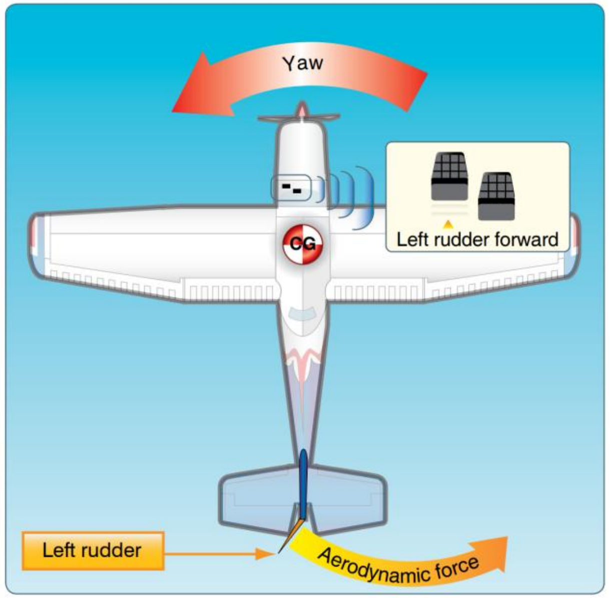

Aileron Control System

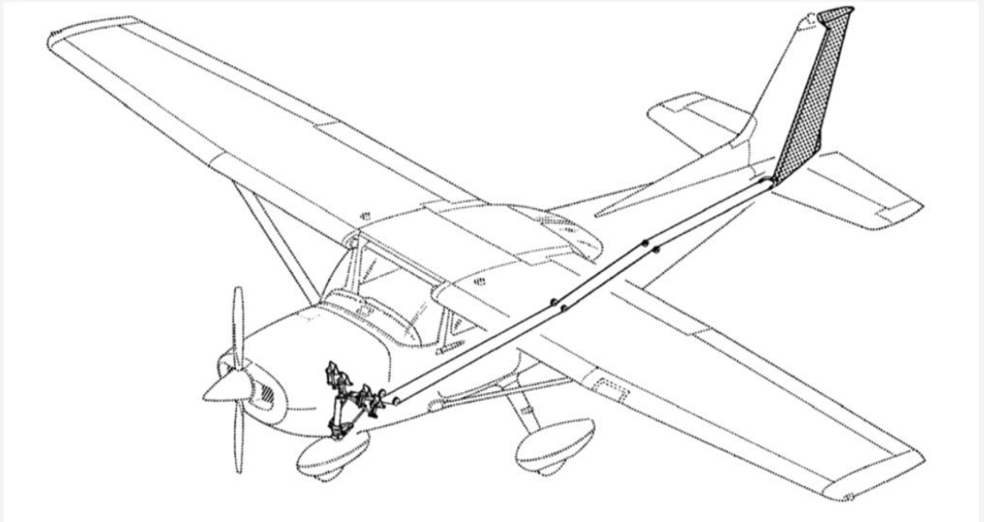




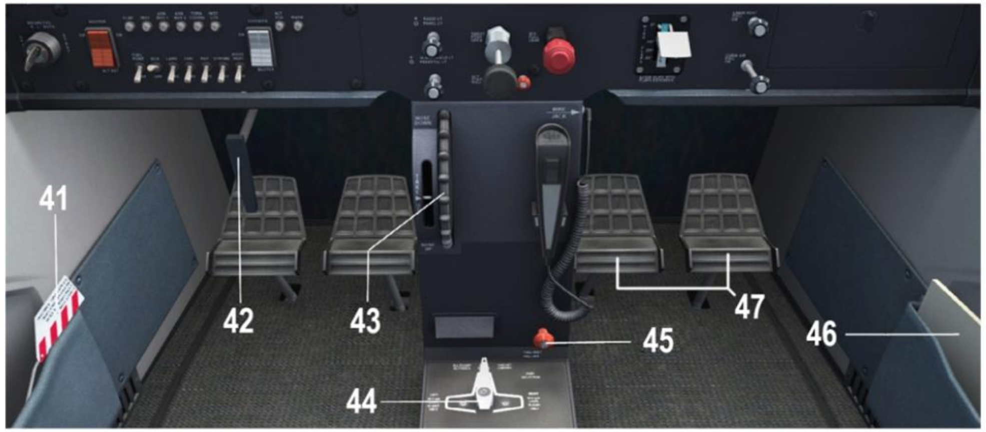
3. Rudder

- Controls yaw about the vertical axis
- **Operation**
    - Left pedal moves the rudder left
    - Rudder deflected ➔ horizontal force in the opposite direction
        - ✓ *Tries to align to the relative wind*
    - Yaws the nose in the direction of pedal pressure





Rudder Control System

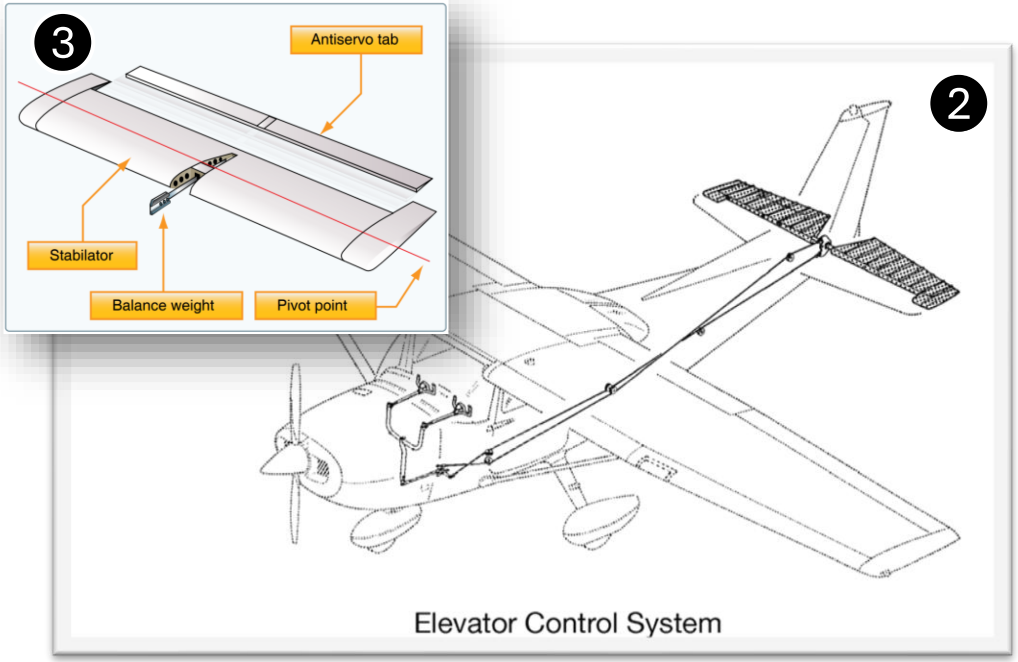


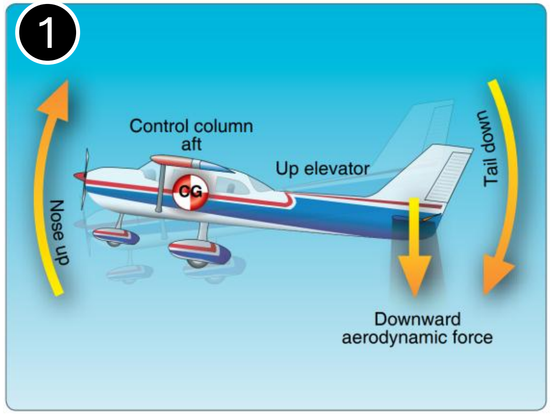
4. Elevator

- Controls pitch about the lateral axis

- **Operation**
  - ❶ Pulling the <u>control backward</u> deflects the <u>elevator up</u> (and vice versa)
  - ○ Changes the camber of the horizontal stab
    - ○ <u>Elevator up</u> ➔ Force down, <u>nose up</u>
    - ○ <u>Elevator down</u> ➔ Force up (or "less down"), <u>nose down</u>

- **Types of Elevators**
  - ❷ <u>Conventional</u> (trailing edge of the horizontal stabilizer)
  - ❸ <u>Stabilator</u>
    - ✓ *All moving, one-piece horizontal stabilizer*
  - ❹ <u>T-Tail</u>
    - ✓ *Away from wing turbulence (cleaner flow)*
    - ✓ *Loses authority at high AoA*
    - ✓ *May be harder to recover from stall*

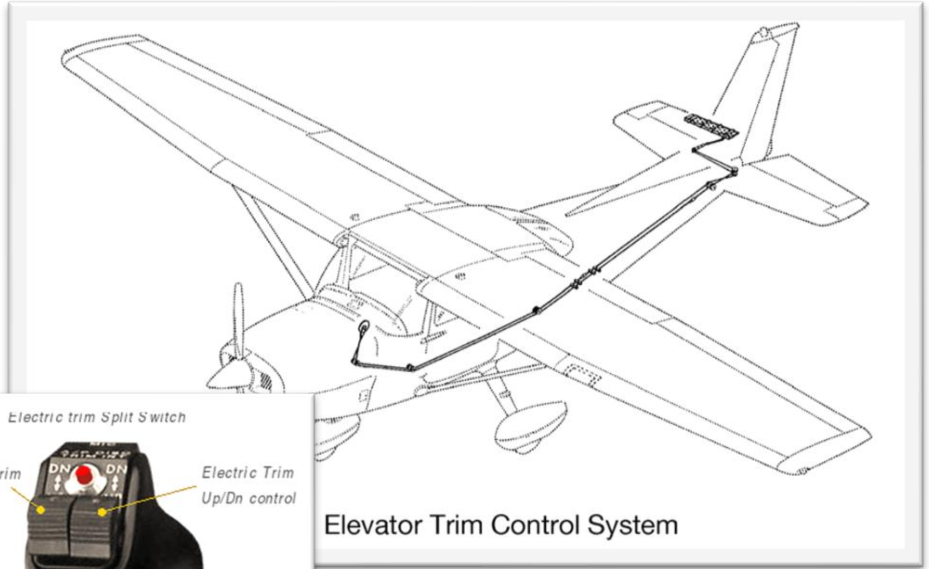


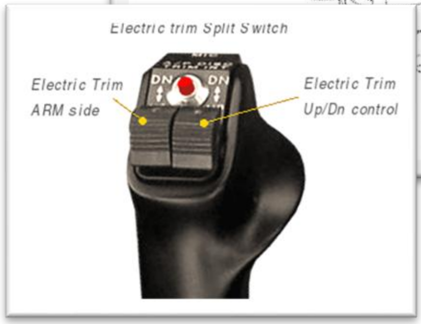


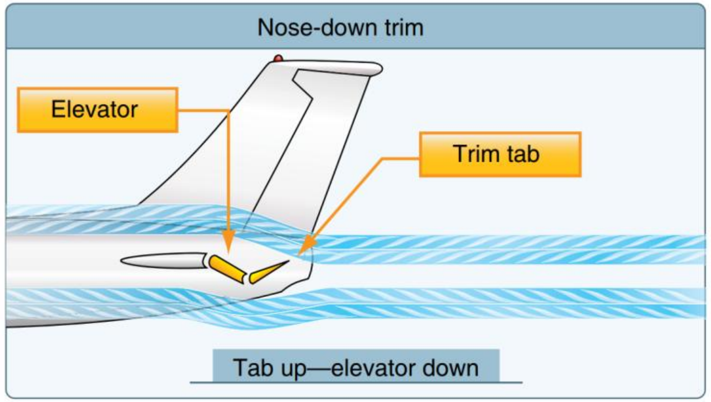
5. Trim

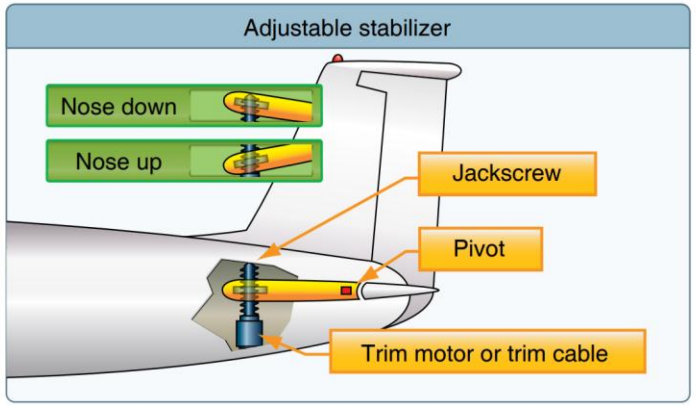
- **Elevator Trim**
  - Relieves control pressure
  - Manually operated via <u>Control wheel</u> or <u>Electric</u>

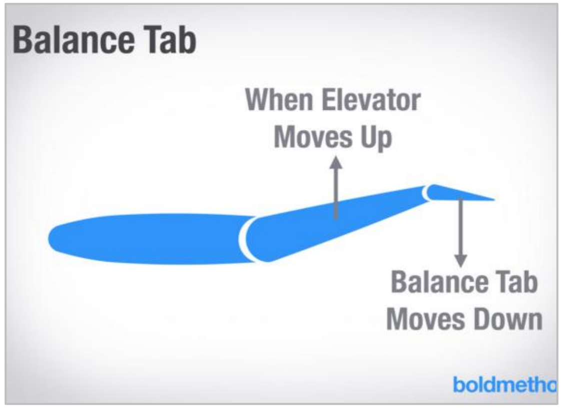
- **Types of Trim Tabs**
  - <u>Servo Tab</u> ➔ moves <u>opposite</u> to elevator, <u>helps deflect elevator</u>
  - <u>Antiservo Tab</u> ➔ moves same direction, <u>reduces sensitivity</u>
  - <u>Balance Tab</u> ➔ same as “servo”, but <u>coupled w/ elevator</u>
  - <u>Ground Adjustable Tab</u> ➔ metal tab that can be bent manually
  - <u>Adjustable Stabilizer</u> ➔ whole stabilizer moves)

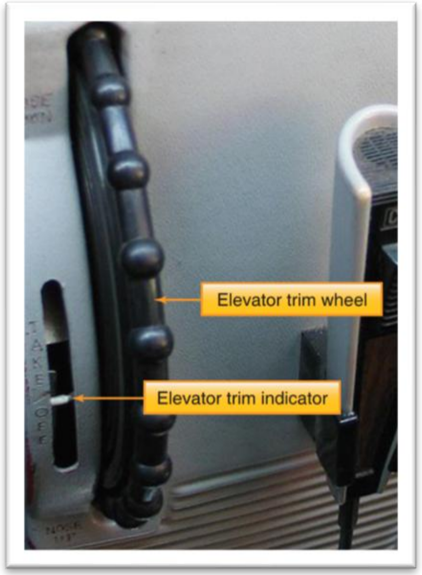






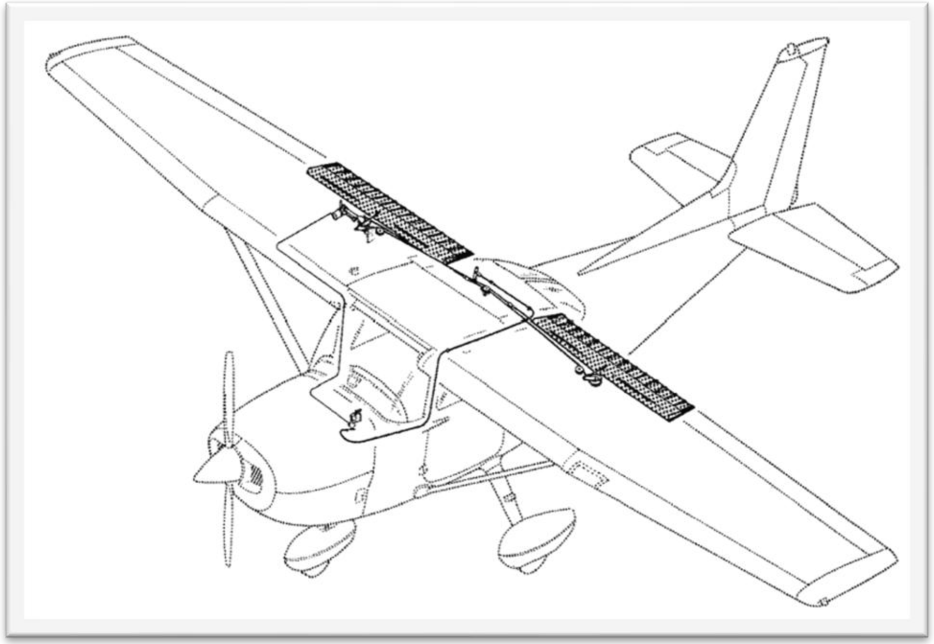






6. Flaps

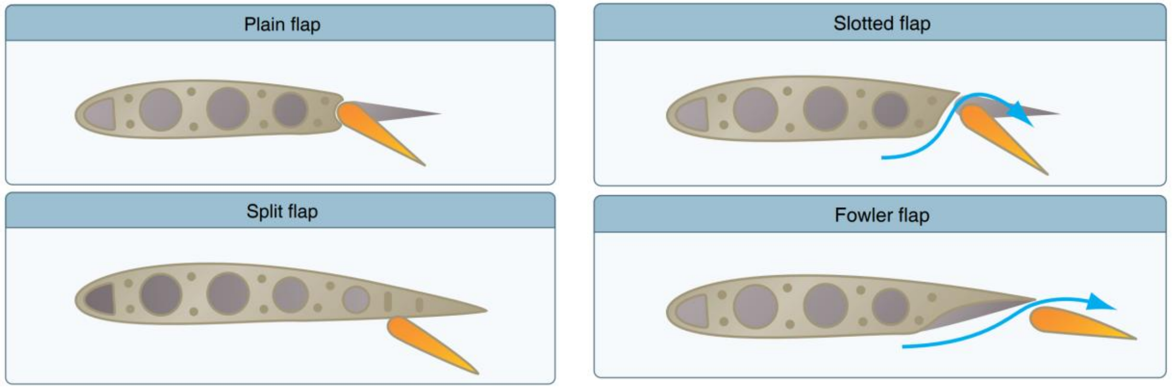
- Increase lift and drag by changing the airfoil's shape
- **Benefits**
  - Shorter takeoff and landing distances
  - Improved climb capabilities, slower and/or steeper approaches
  - Lower stall speed
- **Types of Flaps**
  - Plain ➔ Simplest type, increase lift and drag
  - Split ➔ Deflect from lower surface, slightly higher lift than plain
  - Slotted ➔ High energy airflow delays separation, higher lift than split
  - Fowler ➔ Type of slotted flap, slides out on tracks increasing area of the wing and providing the highest lift



Cessna 172S

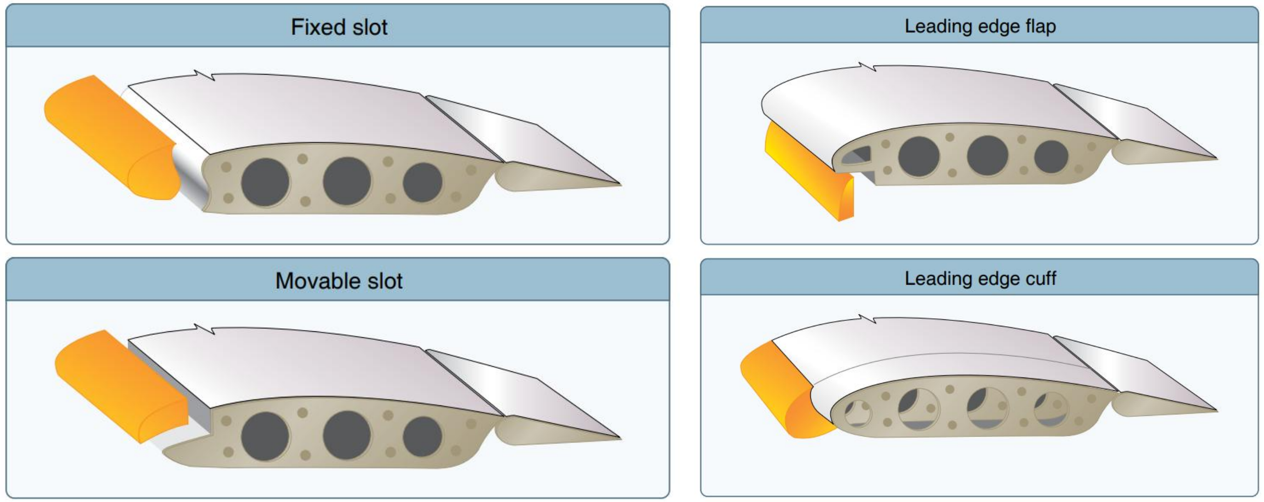
✓ *Electrically actuated (right wing) – 10A circuit*

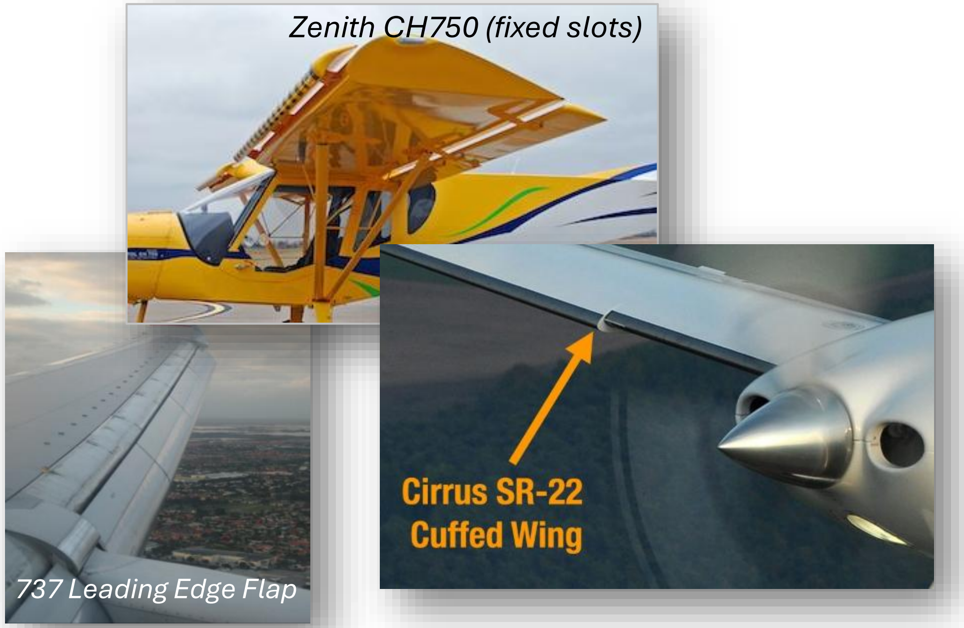
✓ *3 positions: 10º, 20º, 30º*



7. Leading Edge Devices

- Used increase wing's performance – can reduce "nose down" caused by Flaps
- **Types:**
    - Fixed Slot ➔ Directs airflow the upper wing surface, delaying separation at higher AoA
    - Movable Slot ➔ Similar to fixed slot, but it is only actioned when AoA increases (slats move forward)
    - Leading Edge Flap ➔ Similar to trail edge flap, increase camber (and lift). Reduce "nose down" caused by flaps
    - Leading Edge Cuff ➔ Lowers stall speed. Similar to Leading Edge Flap, but it is fixed





8. Spoilers

- **High-drag devices:** deploy from the wings, reducing lift and increasing drag
- **Uses**
  - Reduce Airspeed
    - ✓ *In flight, particularly during approach, or on the ground)*
  - Decreases ground roll during landing:
    - ✓ *Disrupting lift (breaks more effective) and increasing drag (aerodynamic brakes)*
  - Increase Descent Rates:
    - ✓ *Disrupting lift (higher descent rates without increasing speed)*
  - Roll Control and offsetting adverse yaw:
    - ✓ *Spoiler on the high wing is deployed adding drag*

Questions?