Training Course Outline (Syllabus)

Training Requirements and Endorsements

Fundamentals of Flight

Stalls and Spins

Take-Offs and Landings

Ground Reference Maneuvers

Performance Maneuvers

Under the Hood- Flight by Reference to Instruments

Emergency Procedures

Ground Lessons

Initial Solo Requirements for Student Pilots

Level Turns

Description The most fundamental maneuver whereby the airplane maintains a constant altitude but turns to a new heading (think landmark or waypoint). This is fundamental to accurate navigation, comply with ATC instructions, and cross-country flight.

Objective To develop the techniques required for changing heading and rudder usage.

Elements

- **Perform a "CPAC"**
  - Clear Area
  - Power- 2100 rpm
  - Altitude- 1500 ft agl
  - Clean configuration
- **Configure aircraft for slow cruise** *(____" Hg,_____ RPM)*
- **Lift wing in direction of turn to Clear area and Select outside reference** (point on the horizon corresponding to desired new heading)
- **Gently bank the airplane to 30º** maintain this bank until approaching desired heading,
- **Add Rudder and Aileron Rolling into turn.**
  - **Once Turn established, both aileron and rudder return to neutral**
  - *When ailerons neutral, no adverse yaw, no rudder needed*
  - At bank angles higher than 35 to 40 degrees, see STEEP TURN lesson.
- **Use wings against horizon as reference** of banking angle, verify with attitude indicator
- **Begin roll out 15 degrees (½ the bank angle) prior to reaching turn limit**
- **Use both rudder (enough to offset adverse yaw) and aileron on roll out.**
- **Look for traffic**

***Instructor*:** Explains and then demonstrates technique of level turns, including rudder use.

***Student*:** Explains and then Demonstrates technique of level turns.

Common Errors

- Not lifting wing and looking to clear the area before beginning the turn
- Failure to pick landmark to turn and track before initiating turn
- Failure to cross reference instruments to verify performance
- Application of control movements rather than pressures (Rudder)
- Uncoordinated use of flight controls (rudder to initiate and roll out of bank)
- Fixation on instruments and "ball" instead of outside references

Completion Standards: Student can discuss technique for Level Turns. Student is able to demonstrate appropriate checklist usage with proper configuration of aircraft, dividing attention

between outside references and instrument scan, checking for traffic, apply power and control inputs smoothly with positive aircraft control.

References FAA-H-8083-3C Airplane Flying Handbook

Training Tip: I recommend having students pick landmark 90 degrees off wing and turn to track to the point. This requires lifting wing to look for traffic, then tracking to the object. This is the foundation for flying square traffic patterns (see lesson on rectangular course). Also demonstrate that *rudder is only required to initiate or roll out of a turn*. *Once Turn is established, ailerons will go to neutral* to maintain the desired bank *and rudder input is relaxed*. Rudder is only required when ailerons are displaced (banks of 30^0 or less) in most GA aircraft!

How to use rudder in a turn:

Ailerons cause the aircraft to roll. As the bank is established, the horizontal component of lift pulls the aircraft into the turn. Aileron displacement causes decreased drag on the low wing and increased drag on the high wing. The high wing with more drag pulls the nose away from the turn. This is referred to as "adverse yaw".

> *This can be demonstrated by initiating turns without rudder input. The nose will move opposite the direction of the turn!*

Rudder is required to offset the adverse yaw. As the pilot rolls into the bank, rudder is simultaneously applied to keep the nose rotating on a point (not moving left or right). Once the bank is established, the ailerons are returned to neutral or slightly opposite to counter overbanking tendencies. Since adverse yaw occurs primarily with displacement of the ailerons, rudder is required to be in sync with aileron displacement. Once ailerons are neutralized, rudder pressure is relaxed. Rolling out of the turn also requires synchronized (coordinated) use of rudders and aileron.

Rolling into the turn: The amount of rudder applied can be determined by observation of the nose relative to a ground reference point. Enough rudder is applied to keep the nose fixed on a virtual point until the bank angle is established. Not enough rudder and the nose will move opposite to the turn (slipping turn). Too much rudder and the nose will move into the turn before the bank is established (skidding turn). The goal is to keep the nose on a reference point, so the aircraft appears to "rotate" on the point until the bank is established. Once the bank is established the aircraft will start turning. See figure 1 at the end of the lesson.

Rolling out of a turn, rudder is applied to keep the aircraft nose fixed on a virtual point where the aircraft nose rotates on the point without shifting left or right until aircraft has rolled out of the turn. There are two exercises to help a pilot learn to coordinate the rudders and ailerons.

Dutch Rolls: Trim for level flight. Pick a ground reference at the tip of the nose or spinner.

> **Roll briskly into a 30^0 bank** to the right adding rudder to keep nose on the ground reference. *Do not let the aircraft start turning*.

As 30^0 bank is reached**, briskly bank opposite to 30^0 left**. *Use rudder to keep the nose on the point.*

Continue this exercise for several repetitions, alternating left and right bank with no pauses. Do not let the aircraft start a turn.

Alternating 90^0 turns. Trim for level flight. Pick ground references at 90^0 points. Using intersections or "section" lines works well.

Initiate a coordinated bank of 40^0, turn 90^0 to the ground reference. Use rudder as described above.

Upon reaching the ground reference, initiate a 40^0 turn back to the initial heading. On the roll to the opposite direction, use rudder to hold nose on reference point until opposite bank is established. The ailerons and rudder are then relaxed.

Slipping turn: Insufficient rudder applied, the aircraft's nose trails behind or even shifts away from the intended direction of the turn.

Skidding turn: too much rudder, nose moves ahead in turn.

Coordination: applying and removing rudder simultaneously with aileron displacement (to keep aircraft nose pointing into the relative wind). This minimizes drag but more importantly reduces yaw forces to prevent spin events. A spin only occurs during stalls with yaw.

See figure 1. The three images on the next page demonstrate rudder use as the bank is initiated but **BEFORE** the aircraft starts turning. After the aircraft starts turning, both ailerons and rudder are relaxed back to neutral (except for steep turns, see lesson plan on steep turns)


Slipping Turn = Insufficient Rudder
Nose Yaws
away from turn
before bank
established
Ground Reference
Coordinated Turn
Nose Rotates
on ground reference
as bank established
Ground Reference
Skidding Turn = Too much rudder
Nose Yaws into turn
before bank established
Ground Reference

. Figure 1

Aircraft Systems

Objective To teach the student the basics of aircraft systems.

Elements

- Primary flight controls: elevator, ailerons, rudder
- Secondary Flight Controls: Flaps, leading edge devices, spoilers, trim
- Power plant
- Oil
- Avionics

Schedule

Discussion 0:45

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM).
Model aircraft

Instructor Actions

Discuss the components of primary flight controls:

Primary Flight Controls:

Primary control surface	Airplane movement	Axis of rotation	Type of stability
aileron	**roll**	longitudinal	lateral
elevator	**pitch**	lateral	longitudinal
rudder	**yaw**	vertical	directional

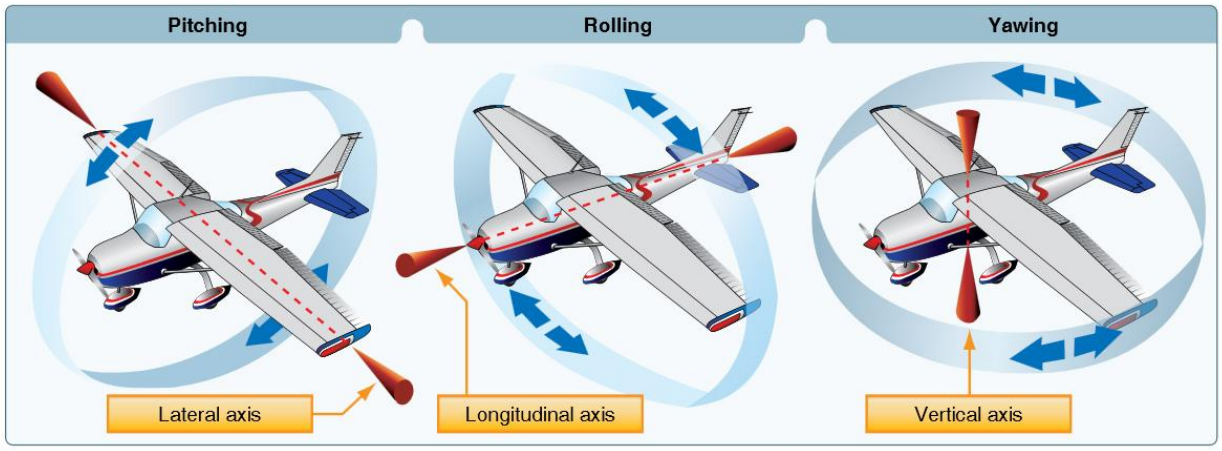
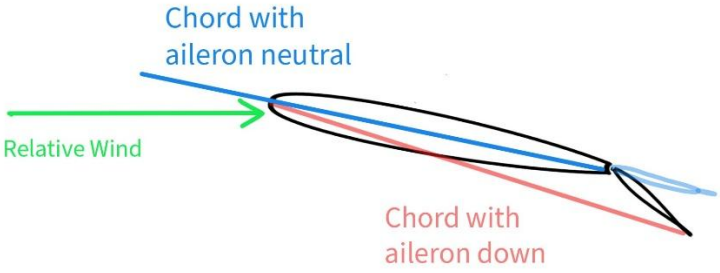


Figure 5-18. *Axes of an airplane.*

Control Surfaces work by changing the AOA on the airfoil. For example, downward deflection of an aileron increases the AOA (changes chord line to relative wind) on the wing increasing lift and drag. Upward displacement of the aileron decreases the AOA which decreases both lift and drag. Elevators and Rudders change the AOA on their stabilizers which produces the pitch and yaw effect described below.



Ailerons:

- o Control roll about longitudinal axis
- o **Adverse yaw** can be counter acted with rudder use, or special aileron designs: differential ailerons, Frise-type ailerons, ailerons coupled to the rudder

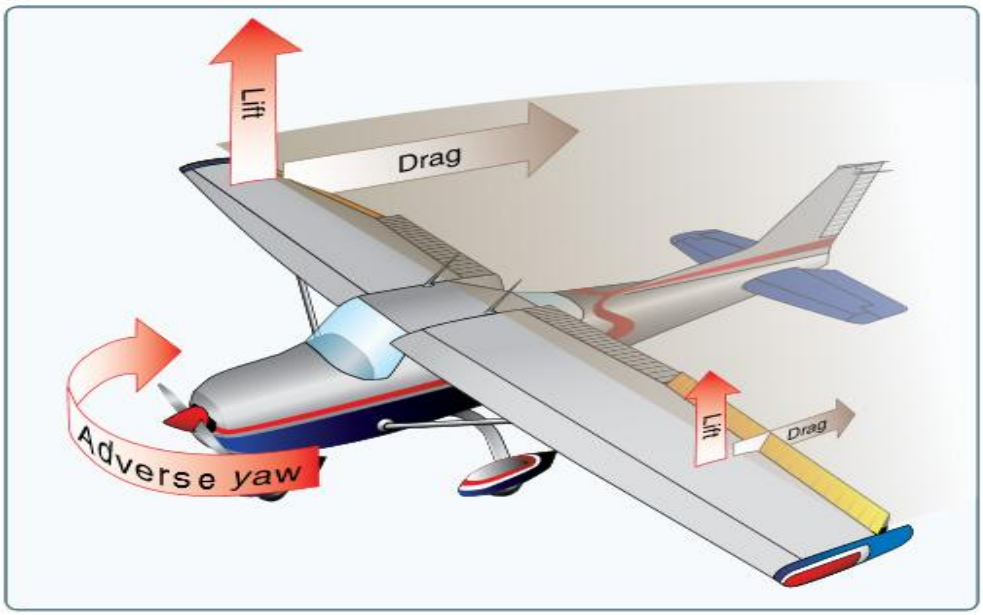
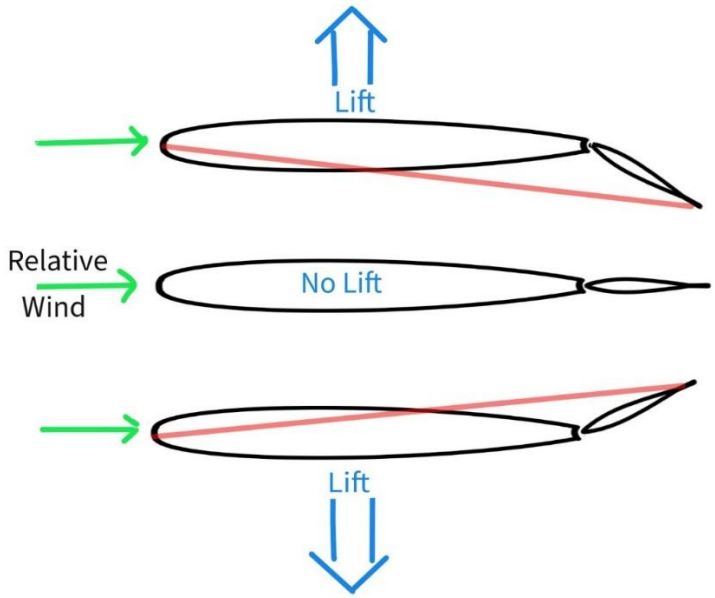


Figure 6-5. *Adverse yaw is caused by higher drag on the outside wing that is producing more lift.*

Rudder, Elevator and trim tabs. The horizontal and vertical stabilizers are typically symmetric airfoils which have a symmetric pressure distribution with zero lift at zero degrees of angle of attack. When the elevator or rudder are displaced, the cord line changes and these airfoils will produce lift in either direction efficiently. Cambered airfoils can produce lift in either direction but require significant AOA below zero to produce negative lift. It is common misconception the displacement of the control surface impacts and thus "deflects" the airstream to produces the required pitch or yaw moments. *The force generated by impact of the free air stream against a displaced control surface is very small compared to the lift force generated through AOA created by the same control surface.*



Elevator: Controls pitch about lateral axis. The Main purpose is to pitch up and pitch down relative to the pilot. For example, in a steep turn, the elevator will "pitch" the aircraft further into the turn.Pulling aft on the elevator generally increases the load and angle of attack in upright (positive G) flight

Stabilator: Some aircraft (e.g. Pipers) use a stabilator with an anti-servo tab. The entire horizontal stabilizer moves to induce pitch changes. The Anti-servo tab moves the opposite direction of the stabilator to decrease control stick forces for the pilot. The anti-servo tab can be adjusted in the cabin and function as a trim tab.

Rudder: Controls the airplane about its vertical axis – **yaw** (nose going left/right). The primary purpose is to offset adverse turning tendencies (adverse yaw in turns and left turning tendencies on take-off, climbs), cross wind landings, and taxiing.

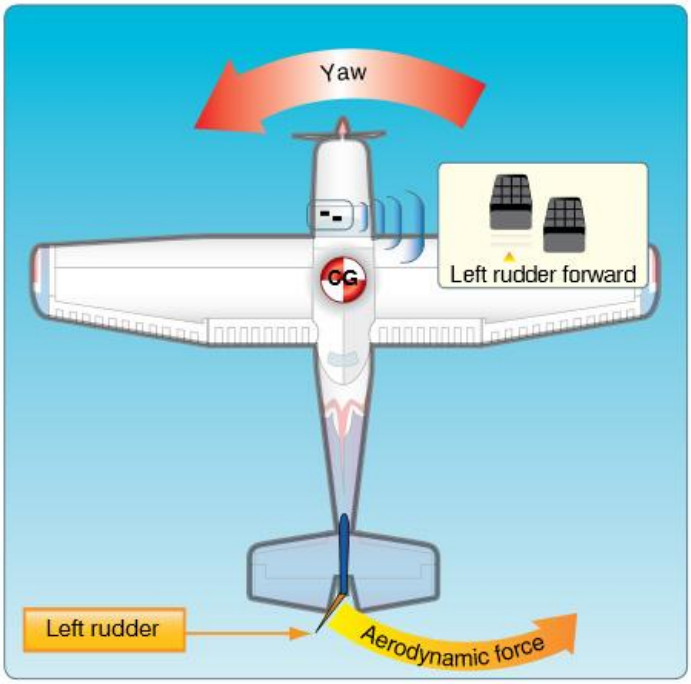


Figure 6-15. *The effect of left rudder pressure.*

Secondary Controls:

- **Trim:** Used to relieve control pressures, Trim tabs, ground adjustable tabs

  Trim tabs affect the elevator, rudder and ailerons in the same fashion. However, the trim tabs move opposite as the desired primary control surface direction. In the diagram below, the local negative AOA moves the elevator down till it reaches equilibrium with other aerodynamic forces or reaches zero local AOA. The Elevator displaced downward causes the AOA to increase in the horizontal stabilizer moving the tail up and the nose down (*aircraft rotates around CG*).