XII.A-D. Basic Attitude Instrument Flight

References: FAA-H-8083-3; FAA-8083-3-15

Objectives	The student should develop knowledge of the elements related to attitude flight and have the ability to smoothly and steadily control the aircraft without the use of outside references. The student will be able to perform this as required in the PTS.
Key Elements	1. Pitch + Power = Performance 2. Trim 3. Crosscheck 4. Adjust
Elements	1. Control and Performance 2. Procedural Steps 3. Establish 4. Trim 5. Crosscheck 6. Adjust 7. Straight-and-Level Flight 8. Constant Airspeed Climbs 9. Constant Airspeed Descents 10. Turns to Headings 11. Common Errors
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can smoothly and steadily control the airplane by reference to the instruments only. He or she will be able to establish and maintain a thorough crosscheck and make the required adjustments to the flight attitude.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

As you're flying along you can see that the weather ahead looks like it might be getting worse. You think you can 'scud run' the rest of the way but lo and behold you unexpectedly enter a cloud and need to get out safely.

Overview

Review Objectives and Elements/Key ideas

What

Attitude instrument flying may be defined as the control of an aircraft's spatial position by using instruments rather than outside visual references.

Why

In the instance that you mistakenly fly into adverse weather it is important to be comfortable flying the airplane without outside references

How:

1. **Control and Performance**
   - A. Aircraft performance is achieved by controlling the aircraft attitude and power (AOA and thrust to drag) to produce the desired performance
     - i. Pitch + Power = Performance
   - B. The three general categories of instruments are control, performance, and navigation instruments
     - i. Control - Display immediate attitude and power indications and are permit precise adjustments
       - a. Control is determined by reference to the attitude indicator and power indicators
     - ii. Performance - Indicate the aircraft's actual performance
       - a. Performance is determined by reference to the Altimeter, airspeed indicator, VSI, heading indicator, and turn coordinator
     - iii. Navigation - Indicate the position in relation to a selected navigation facility or fix
       - a. Determined by course indicators, range indicators, glide-slope indicators and bearing points
2. **Procedural Steps**
   - A. *Establish* - an attitude/power setting on the control instruments resulting in the desired performance
     - i. Known or computed attitude changes and approximate power settings will help reduce workload
   - B. *Trim* - until control pressures are neutralized.
     - i. Trimming is essential for smooth, precise control and allows attention to be diverted elsewhere
   - C. *Crosscheck* - the performance instruments to determine if the desired performance is being obtained
     - i. Involves seeing and interpreting
     - ii. If a deviation is noted, determine the magnitude and direction of correction necessary
   - D. *Adjust* - the attitude or power setting on the control instruments as necessary
3. **Establish**
   - A. The control instruments are used to set up the necessary pitch and bank attitudes
     - i. Aircraft attitude control is accomplished by properly using the attitude indicator
       - a. Provides an immediate, direct, and corresponding indication of any change in pitch or bank
   - B. Pitch Control
     - i. Changes are made by changing the pitch attitude by precise amounts in relation to the horizon

a. Changes are measured in degrees or bar widths
b. The amount of deviation from that desired will determine the magnitude of correction

C. Bank Control
i. Changes are made by changing the bank attitude by precise amounts in relation to the bank scale
a. Normally use a bank angle that does not exceed 30°

D. Power Control
i. Made by throttle adjustments and reference to the power indicators
a. Little attention is necessary to ensure the power setting remains constant
ii. From experience, you know how far to move the throttles to change the power a given amount
a. Make power changes primarily by throttle movement and then crosscheck the indicators
- DON'T FIXATE on the indicators while setting the power

4. Trim

A. Trim the plane out for hands off flights
i. Trim frequently, and in small amounts
ii. Momentarily let go of the stick to check the trim, if the aircraft does not maintain attitude, re-trim

5. Crosscheck

A. The continuous and logical observation of instruments for attitude and performance information
i. The pilot maintains an attitude by reference to instruments that will give the desired performance

B. It is impossible to establish an attitude and have performance remain constant for a long period of time
i. It is therefore necessary to constantly check the instruments and make appropriate changes

C. Different Crosschecks
i. Select Radial Crosscheck
a. Based off the attitude indicator
- Eyes never travel directly between the flight instruments, but move by way of the attitude indicator

b. Begin with the attitude indicator, scan an instrument and return to the attitude indicator before moving to another
c. Most popular – commonly referred to as the Hub and Spoke method
- The attitude indicator is the hub and the primary reference for all maneuvers
- Move from the hub (attitude indicator) out a spoke (performance instrument) back to the hub and repeat

ii. Inverted V Crosscheck
a. Moving your eyes from the attitude indicator to the turn coordinator, up to the attitude indicator, to the VSI, and back to the attitude indicator

iii. Rectangular Crosscheck
a. Move your eyes across the top three instruments and drop down to scan the bottom three
b. This gives equal weight to each instrument, regardless of its importance to the maneuver
c. But, this method lengthens the time for your eyes to return to a maneuver's critical instrument

D. Crosscheck and Bank
i. After establishing, check the heading indicator and turn coordinator to ensure the airplane is performing as desired

E. Crosscheck and Pitch
i. After establishing, check the Altimeter, VSI and airspeed indicator to ensure the airplane is performing as desired

F. Crosscheck Errors
i. CE - Fixation
a. Staring at a single instrument (attitude indicator is the most common)
b. This occurs for a variety of reasons and eliminates the crosscheck of other pertinent instruments

ii. CE - Omission
   a. Omitting an instrument from the crosscheck
   b. May be caused by failure to anticipate major instrument indications following attitude changes
iii. CE - Emphasis (VSI - chasing is common or emphasizing pitch or bank instruments)
   a. Putting emphasis on a single instrument, instead of the necessary combination of instruments
   b. You may naturally tend to rely on the instrument most understood

G. Instrument Interpretation
   a. Understanding each instrument's construction and operating principles and applying this
   b. Tendency to chase the VSI thinking it's an instantaneous reading (but it's a lag instrument**)**
ii. As the performance capabilities of the aircraft are learned, the instrument indications will be interpreted appropriately in terms of the attitude of the aircraft
   a. If the pitch is to be determined, the airspeed indicator, altimeter, VSI and attitude indicator provide the necessary information
   b. If the bank attitude is to be determined, the heading indicator, turn coordinator, and attitude indicator must be interpreted
iii. For each maneuver, you will learn what performance to expect and the combination of instruments to interpret to control the aircraft

6. Adjust

A. Make the adjustments necessary in relation to the attitude indicator then go through the process again
   i. The amount of deviation from the desired performance will determine the magnitude of correction
      a. Restrict the attitude indicator's pitch displacement to 1 bar or ½ bar width up or down
      b. Use a bank angle that approximates the degrees to turn, not to exceed 30°
B. Incorrect interpretation of instruments and improper controls to correct (EX: rudder to fix heading)

7. Straight-and-Level Flight

Pitch + Power = Desired Performance
Nose on Horizon + Cruise Power = Straight and Level

Pitch		Bank	
A/I	On Horizon	A/I	Wings Level
Alt	Constant	DG	Constant
VSI	0	Compass	Constant
Airspeed	Constant Cruise AS	T/C	Level/Coordinated

A. Establish **-** Use the attitude indicator to establish a wings level, nose on the horizon attitude adjusting power as needed
B. Trim - Trim to relieve the control pressures
C. Crosscheck
D. Adjust - Correct any performance errors as necessary and re-trim the airplane, then crosscheck again

8. Constant Airspeed Climbs

Pitch + Power = Desired Performance
10° Nose Up + Full Power = Constant Airspeed Climb

Pitch		Bank	
A/I	10° Nose Up	A/I	Wings Level
Alt	Climbing	DG	Constant
VSI	Positive Climb	Compass	Constant
Airspeed	Constant Climb AS	T/C	Level/Coordinated

A. Establish - Raise the nose of the aircraft to the approximate pitch attitude for the desired climb speed
   i. As the airspeed approaches the desired climb speed, set the power to the climb setting (full)
B. Trim -Trim to relieve the control pressures
C. Crosscheck

D. Adjust - Correct any performance errors as necessary and re-trim the airplane, then crosscheck again
    a. Adjust the pitch attitude to maintain the desired climb airspeed (1 bar or ½ bar width movements)
E. Leveling Off
    i. Lead the altitude by 10% of the vertical speed (EX: 500 fpm climb is lead by 50')
    ii. Use the same procedure to level off the plane
        a. Establish - Reduce power and apply smooth steady elevator pressure toward a level attitude
        b. Crosscheck - VSI, Altimeter and attitude indicator should show level flight
        c. Then Trim the airplane and maintain straight and level flight
F. Turning Climbs
    i. In the case of the turn, apply the same procedures as above, and establish the desired bank angle in the desired direction on the attitude indicator
        a. Monitor the performance of the turn on the heading indicator and turn coordinator
        b. Small adjustments to pitch and power may be necessary to maintain airspeed with the additional bank
        c. The instrument crosscheck will have to be accelerated as there is more information to take in
            - Monitor the climb, airspeed, heading change, and plan ahead for the level-off and the roll-out from the turn (they may not happen simultaneously)

9. Constant Airspeed Descents

Pitch + Power = Desired Performance
3° Nose Down + Descent Power = Constant Airspeed Descent

Pitch		Bank	
A/I	3° Nose Down	A/I	Wings Level
Alt	Descending	DG	Constant
VSI	Negative Climb	Compass	Constant
Airspeed	Constant Descent AS	T/C	Level/Coordinated

A. Establish - Reduce power to a predetermined setting for the descent and maintain straight and level flight as airspeed decreases
    i. As the airspeed approaches the desired level, lower the nose with the attitude indicator to maintain a constant speed
B. Trim - Trim to relieve the control pressures
C. Crosscheck
D. Adjust - Correct any performance errors as necessary and re-trim the airplane, then crosscheck again
    i. Adjust the pitch attitude to maintain the desired climb airspeed
E. Leveling Off
    i. Lead the altitude by 10% of the vertical speed (EX: 500 fpm climb is lead by 50')
    ii. Use the same procedure to level off the plane
        a. Establish - Introduce power and apply smooth steady elevator pressure toward a level attitude
        b. Crosscheck - VSI, Altimeter and attitude indicator should show level flight
        c. Then trim the airplane and maintain straight and level flight
F. Turning Descents
    i. In the case of the turn, apply the same procedures as above, and establish the desired bank angle in the desired direction on the attitude indicator
        a. Monitor the performance of the turn on the heading indicator and turn coordinator
        b. Small adjustments to pitch and power may be necessary to maintain airspeed with the additional bank
        c. The instrument crosscheck will have to be accelerated as there is more information to take in

- Monitor the descent, airspeed, heading change, and plan ahead for the level-off and the roll-out from the turn (they may not happen simultaneously)

10. Turns to Headings

Pitch + Power = Desired Performance
Wings Banked/Nose Slightly High + Cruise Power = Turn to Heading

Pitch		Bank	
A/I	Nose Slightly High	A/I	Wings Banked
Alt	Constant	DG	Turning to Heading
VSI	0	Compass	Turning to Heading
Airspeed	Constant Cruise AS	T/C	Banked/Coordinated

A. Prior to entering, determine which direction the turn should be made and the angle of bank required
   i. Use an angle of bank equal to the number of degrees to turn, not to exceed 30°
B. Establish - coordinated aileron and rudder pressure to establish the desired bank angle on the attitude indicator
   i. If standard rate, use the turn coordinator to check
   ii. Adjust pitch as necessary (probably increase) to maintain level flight
C. Trim - Trim the airplane
D. Crosscheck
E. Adjust - Correct any performance errors as necessary and go through the process again
F. Rolling Out
   i. Apply coordinated rudder and aileron pressure to level the wings on the attitude indicator
      a. Depending on the amount of turn, rollout about 10° before the desired heading
         - Or use ½ the bank angle or less for small turns
   ii. Adjust the pitch to maintain level flight

11. Common Errors

A. Discuss the common errors below, and ways to mitigate these errors

Common Errors:

- "Fixation," "Omission," and "Emphasis" errors during instrument cross-check
- Improper instrument interpretation
- Improper control applications
- Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections
- Improper entry or level-off procedure (specific to Constant Airspeed Climbs)
- Improper entry or roll-out procedure (specific to Turns to Headings)
- Faulty trim procedure

Conclusion:

Brief review of the main points

In visual flight, you control aircraft attitude in relation to the natural horizon by using certain reference points on the aircraft. In instrument flight, you control aircraft attitude by reference to the flight instruments. A proper interpretation of the flight instruments will give you essentially the same information that outside references provide in visual flight.

PTS Requirements:

Straight-and-Level Flight

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of straight-and-level flight, solely by reference to instruments by describing:
   a. Instrument cross-check, instrument interpretation, and aircraft control.
   b. Instruments used for pitch, bank, and power control, and how those instruments are used to maintain altitude, heading, and airspeed.
   c. Trim procedure.
2. Exhibits instructional knowledge of common errors related to straight-and-level flight solely by reference to instruments by describing:
   a. "Fixation," "omission," and "emphasis" errors during instrument cross-check.
   b. Improper instrument interpretation.
   c. Improper control applications.
   d. Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections.
   e. Faulty trim procedure.
3. Demonstrates and simultaneously explains straight-and-level flight, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight-and-level flight, solely by reference to instruments.

Constant Airspeed Climbs

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of straight and turning, constant airspeed climbs, solely by reference to instruments by describing:
   a. Instrument cross-check, instrument interpretation, and aircraft control.
   b. Instruments used for pitch, bank, and power control during entry, during the climb, and during level-off, and how those instruments are used to maintain climb heading and airspeed.
   c. Trim procedure.
2. Exhibits instructional knowledge of common errors related to straight and turning, constant airspeed climbs solely by reference to instruments by describing:
   a. "Fixation," "omission," and "emphasis" errors during instrument cross-check.
   b. Improper instrument interpretation.
   c. Improper control applications.
   d. Failure to establish proper pitch, bank, or power adjustments during heading, and airspeed corrections.
   e. Improper entry or level-off procedure.
   f. Faulty trim procedure.
3. Demonstrates and simultaneously explains a straight and turning, constant airspeed climb, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight and turning, constant airspeed climbs, solely by reference to instruments.

Constant Airspeed Descents

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of straight and turning, constant airspeed descents, solely by reference to instruments by describing:
   a. Instrument cross-check, instrument interpretation, and aircraft control.
   b. Instruments used for pitch, bank, and power control during entry, during the descent, and during level-off, and how those instruments are used to maintain descent heading and airspeed.
   c. Trim procedure.

2. Exhibits instructional knowledge of common errors related to straight and turning, constant airspeed descents, solely by reference to instruments by describing:
   a. "Fixation," "omission," and "emphasis" errors during instrument cross-check.
   b. Improper instrument interpretation.
   c. Improper control applications.
   d. Failure to establish proper pitch, bank, or power adjustments during heading and airspeed corrections.
   e. Faulty trim procedure.
3. Demonstrates and simultaneously explains a straight and turning, constant airspeed descent, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight and turning, constant airspeed descents, solely by reference to instruments.

Turns to Headings

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of turns to headings, solely by reference to instruments by describing:
   a. Instrument cross-check, instrument interpretation, and aircraft control.
   b. Instruments used for pitch, bank, and power control during turn entry, during the turn, and during the turn roll-out, and how those instruments are used.
   c. Trim procedure.
2. Exhibits instructional knowledge of common errors related to turns to headings, solely by reference to instruments by describing:
   a. "Fixation," "omission," and "emphasis" errors during instrument cross-check.
   b. Improper instrument interpretation.
   c. Improper control applications.
   d. Failure to establish proper pitch, bank, and power adjustments during altitude, bank, and airspeed corrections.
   e. Improper entry or roll-out procedure.
   f. Faulty trim procedure.
3. Demonstrates and simultaneously explains a turn to a heading, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to turns to headings, solely by reference to instruments.