Flight Lesson: Slow Flight

Objectives:

1. exhibit knowledge of the elements related to maneuvering during slow flight
2. be able to perform the four fundamentals during slow flight with minimal assistance from the instructor

Justification:

1. develops a pilot's sense of feel and ability to use he controls correctly.
2. improves proficiency in performing maneuvers in which a low airspeed is required (landings, takeoff, climbs, etc)
3. helps develop control while transitioning the airplane
   (1) plane is transitioned from fastest speed to slowest, and flaps from 0° to full.
4. demonstrates many characteristics of airplanes and aerodynamics
5. maneuver is required in the private pilot check ride.

Schedule:

Activity	Est. Time
Ground	0.75
Preflight/Taxi	0.25
Flight	1.25
Debrief	0.25
Total	2.50

Recommended Readings:

PHAK	Chapter 4: 4-19 to 4-21
AFH	Chapter 4: 4-1 to 4-2

Elements Ground:

- Slow Flight Overview
  - MCA
- Components of Slow Flight
  - induced drag
  - left turning tendencies
  - slow flight turns
  - pitch and power
  - overbanking tendency
  - control effectiveness
- procedure

Elements Air:

- slow flight in straight and level
- slow flight in turns
- slow flight in climbs and descents
- slow flight in combinations

Completion Standards:

1. Understands principles and elements of slow flight
2. ability to perform the four fundamentals in slow flight with minimal assistance from instructor

Common Errors:

- does not maintain altitude
- does not maintain correct airspeed
- does not apply enough right rudder

Presentation Ground:

Slow Flight Overview

1. *:flight at minimum controllable airspeed with maintaining altitude and heading*
   (1) Minimum Controllable Airspeed (MCA)
      i. *:airspeed at which any increase in AoA, load factor, or reduction in power will cause an immediate stall.*[1]

PTS Standards			
initial altitude	> 1500' AGL	**initial airspeed**	Vmc
Δ altitude	±100'	**Δ airspeed**	+10/-0 kts
heading	±10°	**bank angle**	±10°

Components of Slow Flight

1. induced drag
   (1) *:drag created by the production of lift*
   (2) drag vs airspeed graph
   (3) relatively high power setting, at 2100 RPM to fly less that 50 kts.
2. left turning tendencies
   (1) p-factor (propeller factor) *:at high AoA an ascending blade has a lower resultant velocity than the descending blade, thus creating less thrust. On a clockwise rotating propeller, this results in more thrust being produced right of the longitudinal centerline, thus producing left yaw tendency.*
      i. *good example is helicopter blades with a horizontal wind component*
   (2) spiraling slipstream *:airflow of a propeller driven aircraft tends to spiral around the aircraft, and strike the left side of the vertical fin, thus producing left yaw tendency.*
   (3) torque reaction *:in a clockwise rotating propeller, the aircraft wants to roll to the left due to the counter reaction of the propeller rotating to the right (Newton's Third Law).*
      i. On the ground it can be even more pronounced because left tire will get more load, and thus greater friction and drag.
   (4) gyroscopic precession :a gyroscope reacts 90° ahead of, and in the same direction of the applied force
      i. A propeller acts as a gyroscopic, thus any pitch change will result in a yaw, and any yaw change will result in a pitch.
      ii. tail wheel aircraft will tend to yaw to the left as the tail rises
   (5) These left turning tendencies are compensated for via aircraft design, but not completely. They are especially prominent at lower airspeed and high power/AoA.
      i. rudder tabs bent to the left will counteract spiraling slipstream by pushing the rudder to the right, and thus counteract the left yaw tendency
         (i) alternatively, some aircraft adjust the entire vertical stabilizer to the left
      ii. a horizontally canted engine turned to the right will counteract left yaw by offsetting the thrustline to the right.
      iii. left wing may be designed to have higher angle of incidence to counteract left roll tendency.

[1] *FAA-H-8083-3A - 4-1*

3. higher drag in turns
   (1) In any turn, more power is required to maintain both airspeed and altitude.
   (2) IN slow flight it is more prominent since induced drag is so high to begin with.
4. higher AoA when turning
   (1) Since we are slow close to stalling already, the additional AoA required in a turn may cause stall warning to come on.
   (2) This is normal, but it is also when we will not exceed standard rate turns in slow flight.
5. Pitch and Power control
   (1) During slow flight, airspeed is controlled by pitch (because the airspeed is already critically low), and altitude is controlled by power.
   (2) remember, pitch controls what is most important for the situation, power controls the other.
   (3) This is similar to upwind, and final of the traffic pattern.
6. Overbanking tendency
   (1) due to the slow airspeed, the radius of turn during slow flight is very small
   (2) because of this, the outside wing is moving at a much faster airspeed than the inside wing
   (3) this produces a tendency for the aircraft to over bank into a turn
   (4) to correct, hold opposite aileron, and rudder.
7. Control effectiveness
   (1) since the aircraft is moving relatively slow, the airflow over the control surfaces is also slow.
   (2) this leads to a lack of effectiveness of the controls.

Procedure

1. Entry
   (1) clearing turns
   (2) CGGLUMPS
      (1)**C**arb Heat - off
      (2)**G**as - both
      (3)**G**auges - check
      (4)**L**ights - on
      (5)**U**ndercarriage - check (up if retractable)
      (6)**M**ixture - rich
      (7)**P**ower - set 1800 RPM
      (8)**S**eat belts - on
   (3) maintain altitude to slow aircraft
   (4) at appropriate speed add flaps 10°, 20°, then full
   (5) at MCA, add power as needed to maintain altitude (approximately 2000 RPM)
2. Recover
   (1) full power
   (2) flaps 20°, 10°, 0°
   (3) back to straight and level, adjust power appropriately.
3. Pitch Notes
   (1) 1.1 - 1.4, pitch controls altitude

(2) 1.5, pitch controls airspeed
(3) 2.1 - 2.3, pitch controls altitude
(4) Since airspeed is most important during slow flight, pitch controls it.
(5) power controls the other (altitude)
(6) This is a visual maneuver, BUT watch the airspeed indicator, and altimeter to stay level and at the correct airspeed.

4. Turns
   (1) turns at slow flight should not exceed standard rate of turn (3˚/sec).
      i. this is due to the small radius of turn, and high AoA already being flown
      ii. over banking tendency can become uncontrollable, and stall the airplane.

Presentation Air:

1. straight and level
2. turns
3. climbs
4. descents