**Lesson 9**

**Flight Instruments and Study Notes**

Read: FTGU pages 32-34, 39-45

1. Pitot Static Instruments

* There are three pressure instruments

- The Altimeter

- The Vertical Speed Indicator (vsi)

- The Air Speed Indicator (asi)

* There are two pressure sources for these instruments:

- Static Pressure

* + Pressure surrounding the aircraft

- Pitot Pressure

* Pressure created by forward motion of the aircraft
* Also called dynamic pressure

The Altimeter

* + Operates on static pressure

Higher pressure 🡪 Lower altitude

* + Aneroid capsules or wafers expand and contract, mechanically moving the needles
* Altimeter Markings

- Small hand reads tens of thousands of feet

- Medium hand reads thousands of feet

- Large hand reads hundreds of feet

* Altimeter Errors

- Pressure Error

- Different pressures exist in different locations

- The altimeter setting compensates for changes in pressure

- Temperature Error

- There is seldom standard temperature with a standard lapse rate

- Mountain Effect Error

- Air is deflected around mountains

- According to Bernoulli's Principle, the pressure in the airflow - drops, which will affect the altimeter reading

The Airspeed Indicator (ASI)

- Reads airspeed (not ground speed)

- Measures the difference between static and pitot pressure

* ASI Markings

- Marked in Knots or MPH

- Red: VNE

- Yellow: Caution Range

Highest point VNE

Lowest point VNO

- Green: Normal Range

Highest point VNO

Lowest point VSL

- White: Flaps Range

Highest point VFE

Lowest point VSO

* Some “V” Speeds

VNE: Never Exceed Speed

VNO: Maximum Structural Cruising Speed or Normal Operating Limit Speed

VSL: Power Off Stalling Speed (clean configuration)

VFE: Maximum Flaps Extended Speed

VSO: Power Off Stalling Speed (flaps and gear down)

VA: Manoeuvring Speed

VB: Maximum Gust Intensity Speed

* ASI Errors

- Density Error

Nonstandard pressure or alt other than 0’ASL

- Position Error

Eddies or the angle the pitot tube meets relative airflow

- Lag Error

Mechanical friction

- Icing Error

Ice covering the intake of the pressure sources

- Water Error

Water in the system

The Vertical Speed Indicator (VSI)

* The VSI is marked in positive and negative feet per minute or knots of vertical speed
* VSI Errors

Lag: The change in altitude must occur before the VSI can register the change

If pitch changes are slow, the lag will be less intense than if the pitch changes are sudden

1. Asymmetric Thrust

* Caused by the descending blade of the propeller having a greater angle of attack than the ascending blade

- High angles of attack and high power settings

* Use right rudder to compensate

1. Precession

* The propeller acts as a gyroscope
* Rigidity in Space

- A gyro will rotate in the same plane and resist change

* Precession
* If forced to change, there is a tendency to rotate 90 degrees to the original axis and rotate parallel to the applied force
* Overcome these tendencies using control inputs as required

1. Slipstream

* Air pushed backwards by the propeller has a corkscrew pattern

- This applies force to one side of the vertical stabilizer

* Offsetting the fin, and rudder input compensates

1. Climbing

* Climbing changes how forces are applied to the airplane
* Best Angle of Climb
  + Best gain for *distance* (by flying VX)
* Best Rate of Climb
  + Best gain for *time* (by flying VY)
* Normal Climb
  + Better engine cooling, control, and visibility over the nose

1. Gliding

* Gliding also changes how forces act on the airplane
* Gliding for Range
  + Best distance covered for altitude (by flying best L/D)
* Gliding for Endurance
* Best time airborne for altitude (by flying min-sink)

Confirmation:

1. What are the pitot static instruments?

Answer: Airspeed Indicator, Vertical speed indicator, Altimeter

1. What is another name for pitot pressure?

Answer: Dynamic pressure

1. Which instrument uses pitot pressure?

Answer: Airspeed indicator

1. What is the difference between VX and VY?

Answer: Vx = Best Angle of Climb (Best gain of altitude in a given distance)

Vy = Best Rate of Climb (Best gain of altitude in least time)

1. How does a glider maintain airspeed?

Answer: A forward component of lift