Ab-initio Flight Training

Introduction

The content on the following screens assumes that you are reading the theoretical and practical books from the Aviation Theory Centre (www.flyingbooks.com.au) or similar organisation. The notes contained in this presentation are designed to emphasise the essential aspects of your briefing but cannot be expected to replace a structured 'home' course. Furthermore, **any** directive you receive from your instructor supercedes anything in these notes.

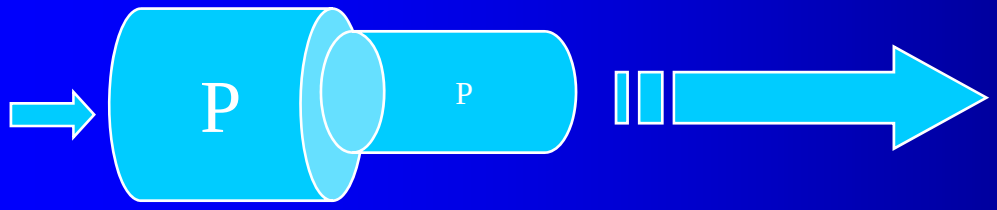
As a guide for the first five lessons you will receive instruction in pre-flighting the aeroplane and will need to become familiar with the purpose of all checks (preflight & run-up), the phonetic alphabet, taxing etiquette and rules as well as right of way air rules.

Topics – the first seven

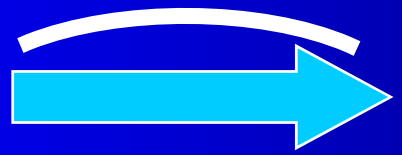
- Basic Aerodynamics
- Effects of Controls
- Straight and Level Flight
- Turns
- Climbing and Descending
- Takeoffs
- Introduction to Landing

Basic Aerodynamics

Daniel Bernoulli (1700-1782) investigated fluid and (in particular) air flow; air being a fluid. The speed of air entering a wider pipe diminishes but the pressure increases. The opposite occurs when air enters a smaller pipe (or throat) [air speed increases and pressure decreases] and the carburetor principle is based upon this relationship.



Imagine two molecules of air at the beginning of the aerofoil separating and then joining at the end of the aerofoil both at the same time.



The molecule which travels the greater distance, over the top of the aerofoil MUST travel faster. The air traveling faster (over the top) compared with the air that traveling beneath has a lower pressure (think of the pipe). The difference in pressure multiplied by the area of (both) wings lifts the aeroplane. That is, the force occurs from under the wing – the hight pressure side. Issac Newton's 3rd Law is responsible for inverted flight but that is another topic.

Effects of Controls

Compared to other modes of transport flight is unique because it is the only event which is 3D. Some would say sailing is 3D also but the distance one can travel in pitch is clearly limited compared with flight. Motion, therefore can occur about all three axis of an aeroplane.

The three axis of an aeroplane amount to a vertical between the pilots and co-pilots seat, another line along (or through) the fuselage and a third line along (or through) the main wings.

Looking at an aeroplane in elevation the vertical line through the centre of gravity (CG) is known as the NORMAL axis. The word ‘normal’ is a well known shorthand for perpendicular when discussing items relating to physics.

Primary Controls

The **axis through** the fuselage is called the longitudinal axis. By imagining the aeroplane pivoting about this axis we can see that the aeroplane will roll

The axis through the main wings is called the lateral axis. By imagining the aeroplane pivoting about this axis we can see that the aeroplane will pitch (up and down) like a boat on a choppy sea.

The rudder controls the aeroplane about the normal axis. The aileron controls roll and the elevator controls pitch. These controls that manipulate the primary axis are known as the PRIMARY CONTROLS

Secondary Controls

It may seem a bit obvious and you will have fun experiencing the effects but “too much” primary control creates secondary effects.

Too much Rudder and the aeroplane will Roll (and the nose can drop – guaranteed with sufficient rudder)

Too much aileron and the aeroplane will turn, i.e. yaw (due to a difference in drag of the wings) against the direction of the roll.

Too much elevator (up) and air speed will diminish.

Summary of your first flying lesson

- Preflight the aeroplane – learn a consistent pattern of external checks.
- Your checklist is your friend inside the aeroplane. Each stage of flight has its own set of checks.
- You will learn to taxi the aeroplane, initially, and then you'll head for the runway and ultimately for the training area to learn about Effects of Controls.
- Your instructor will discuss "trimming" the elevator and carb heat during the practical lesson.

Straight and Level Flight

There may be some overlap between the first lesson and this lesson. The purpose of this lesson is to fly at a constant altitude while looking at the horizon and only momentarily at the altimeter. Then the exercise will be repeated at various power settings. The lower the power setting the more pitch the aeroplane requires (why?) and the more demanding the exercise.

During this lesson you will hear a lot about “attitude” which is a fancy name for the aeroplane in pitch – and not about your worldly sentiments.

The phrase : Power - Attitude –Trim will become instinctive in this and subsequent lessons.

Maintaining the aeroplane in trim makes it very much easier to fly.

When you get a moment – do maintain a listening watch for other aeroplanes as well as scanning the sky for them !!

Turns

During this lesson two more instruments will be introduced to you. You will already be familiar with the ASI and the Altimeter and in this lesson the artificial horizon (AH) and the turn coordinator will be utilised. However, for most (95%) of the time you will be looking outside.

We know that aileron controls roll and rudder controls yaw so its not surprising that we need both (inputs) to make a nice (balanced) turn

Level turns should be kept to a maximum of 30 degrees.

If there is time, your instructor may demonstrate the compass overshooting on turns through northerly headings and undershooting through southerly headings.

Climbing and Descending

This is quite a demanding lesson. The purpose is to assemble your skills to date and apply them to causing the aeroplane to climb and descend in an orderly (controlled) manner which typically means at a constant air speed.

If we climb or descend at a constant air speed then the forces on the aeroplane must be in equilibrium (if no acceleration is occurring). At relatively low altitudes (less than 15,000 feet) this implies a constant angle to the horizontal for a given air speed. Change the angle and we change the speed.

Ensure that you know the best ANGLE of climb speed, the best RATE of climb speed and the glide speed (or minimum drag speed) – these speeds will be demonstrated

Revision – putting it all together

This lesson is a confidence builder. The purpose is to combine all that you have learnt in respect of straight & level, turns, climbs etc. You will be undertaking combinations – i.e. climbing and descending turns with power and (in the case of descent) without power.

The major ‘tip’ is to maintain balance of the “balance ball”; step on the ball (to select rudder) If the ball is to the right then feed the aeroplane more right rudder.

Preview of Lessons Following

By now you will have made a few radio calls and possibly seen an area forecast (ARFOR) or a terminal area forecast (TAF) or both. The next two lessons prepare you for circuit training where all of what you have learnt plus the next two lessons has the ultimate objective of enabling you to fly solo in the circuit.

Over the next few lessons you will be expected to become proficient with the procedures at the aerodrome you are training at – MBZ or GAAP or CTA

Rules – takeoff and land INTO the wind (why)

- Give way to any aircraft on Final (and possibly base)
- listen out irrespective of the aerodrome
- Read ENR 1.1 /5.5 and /11.5 (on separation)

Preview continued

The Takeoff (next lesson) is intimately related to what you learned in climbing the aeroplane (REMEMBER Vy and Vx – best RATE and ANGLE - respectively)

Similarly for powered descents and Landing – again (REMEMBER Vy and Vx) which are not too different (a little slower) than the max. glide speed.

TAFs –learn to interpret aerodrome forecasts. Remember that wind direction is given in degrees TRUE and Radio/ATIS reports in degrees MAGNETIC.

Now, buy a copy of the CASA VFR Flight Guide and revise the sections in these slides.

Takeoffs

You will recall that Rudder controls yaw. There is also the asymmetric propeller blade phenomenon which “pulls” the aeroplane to the left. On high performance ‘CSU’ singles this effect is very noticeable. It is not uncommon to have to apply ½ right rudder in the early takeoff stages just to keep the aeroplane straight in a high powered single. (why is less rudder required at takeoff speed ?)

You will be taught pre-takeoff (engine) checks prior to entering a runway.

Drill – Heels on the floor and look at the end of the runway and keep in mind that you will probably have to apply some right rudder. Apply full power smoothly. Most training aeroplanes fly themselves off the ground but lift-off at about 65 kts should be easy. Maintain attitude, particularly Vy, AND runway heading until at LEAST 500 feet AGL. Aileron input should not be necessary (unless in a crosswind – which is a bit advanced at this stage)

The Circuit Vocabulary

You will need to become familiar with the following terminology

- Takeoff or runway roll
- Upwind – the tracking of runway heading and undertaken in the initial climb
- Crosswind (the continued climb) having turned 90 degrees from runway heading
- Downwind – with the wind and (obviously) opposite to upwind
- Base – the descending leg to the runway which is at 90 degrees
- Final – descending approach lined-up with the runway
- Circuit Height – typically 1000 feet AGL
- Overfly Height – typically 1500 feet AGL

Introduction to Landing

Your instructor will give you a pre-landing check list to MEMORISE ! This check will be repeated by you on EACH downwind segment of a circuit.

The two most important aspects of a landing are approach (nice profile as the aeroplane descends) AND speed – not above 80kts and about 70kts across the “keys”. Control these two aspects and the only other thing to think about is the flare.

As the aeroplane becomes very near to the ground look at the END of the Runway – AND -

Fly level

Power off - smoothly

Hold off - i.e. pull the stick back to maintain level flt (to the other end of the strip)

- **RELAX :** if approach, speed and flare are correct the aeroplane will land itself !

Typical Problems with Landings

Balloons – when too much back pressure is applied and the Angle of Attack causes the aeroplane to climb

Bounces - caused by

- Failure to round out
- Touching down too fast
- Excessive back pressure causing the aeroplane to drop onto the runway – including flaring too high

Your instructor will provide advice on recovery from these conditions as well as “go-rounds”

Your solo circuit is not far away !

Stalls

A stall is a quite complicated aerodynamic effect but in simple terms it occurs when an aeroplane ceases to hold itself in the air and behaves like a brick. In particular the stall occurs when the lift coefficient diminishes or when Bernoulli abandons the aeroplane.

A stall can occur at any speed and typically when the relative airflow is at 16 degrees to the cord (of the wing). It is also a function of weight – more noticeable in heavy twins.

As you “pull-back” in the practical exercise the lift is increasing because of the increasing angle of Attack but so is the DRAG and more so than the lift. Ultimately the airflow across the top of the wing cavities (actually it is more than turbulent) and all lift is “lost”. The aeroplane drops (not surprisingly) and sometimes drops a wing (so beware !).

Recovery is WINGS LEVEL with RUDDER – push forward and apply power – Use ONLY your FEET if a wing drops (otherwise you’ll make it worse)

Forced Landings

Aeroplane engines are usually very reliable so the likelihood of an engine failure is slight. Nevertheless there are some basic rules.

Your instructor will explain the mnemonic FMIIT - Fuel,Mixture,Ignition,Instruments,Throttle. If the engine looses significant power the first objective is to maintain height and this is achieved by maintaining, and trimming for, maximum glide speed (about 75 kts in a 152, 172 or PA28)

Next, pick a field preferably into wind and close to civilisation and do some trouble checks if time.

Briefing of passengers and radio calls (Maydays) are all very well but the objective of a forced landing is to walk away from it – NOTHING MORE. Therefore FLY the Aeroplane at ALL costs.

Tight Turns

- As the angle of bank increases more lift (upward force) is required to keep the aeroplane at a constant altitude. Mathematically the relationship is $F \sim \text{secant}(\text{angle-of-bank})^{-1}$
- At 45degrees 1.41 = $\text{secant}(45)^{-1}$ or the lift required is 41% more than level flight.
- More lift is achieved by a greater A.O.Attack (pulling back) and more power. The radius of turn also increases with air speed. (why?)
- Pick a grot-speck on the windshield and line it up with the horizon. Roll the aeroplane to 45 degrees on the AH and hold it for 360 degrees. As you roll out release the elevator and reduce power (slightly) – ITS FUN !

Semi-Advanced Handling

Depending upon how you are going in your training your instructor may consider some, all or none of the following. In any event you can always become proficient with any item later on. None are strictly necessary for the GFPT.

- Steep descending turns
- Spins
- Slide-slipping in gliding turn
- Short field operations (takeoff and landing)
- Endurance (max time minimum fuel) flying

Precautionary Landings

The example typically given for needing a precautionary landing is running out of daylight which can only occur with bad planning. Remember: be ‘home’ 10 mins before End of (Official) Daylight. Other examples include very sick passengers or very bad weather – the former erring on bad luck and the latter on bad planning.

The essential techniques are to examine the field (orientate the DG to the field) and, when satisfied, fly a proper circuit to land – being assured that you can take off when conditions improve.

Instrument Flight

- The syllabus requires 2 hours of instrument flight and for many students this is very demanding. The purpose is to give you a feel for what it is like in cloud. For a non trained pilot loss of control occurs in an average of 17 seconds – and there is 70 years of history supporting the claim. You are still UNTRAINED at the end of 2 hours. – At all costs stay OUT of cloud
- The AH is your friend and primary instrument. Keep an eye on the turn and slip and step on the slip for wings level. Do not EVER turn more than 15 degrees of bank (why?) and keep an eye on the ASI and altimeter. (If you have time compose your autobiography)

Low Level Flight

Low level flight is flight at minimum legal altitude (500 feet AGL or 1000 feet over built-up areas). Take a look at the Rules (CAR 157, 141)

Required, possibly, for deteoriating weather, bad light or fearful headwinds at higher altitudes

Eyes OUTSIDE but keep the air speed in mind and maintain one hand on the throttle. Beware of windshear and turbulence.

Read the chart at eye level to looking outside; i.e read the chart with eyes sideways (not downways) and generally fly landmark-to-landmark.

Keep endurance in mind and change tanks at regular intervals (to ensure balance of the AFCT and not to run a tank dry)

Crosswind Takeoffs & Landings

- Learn to calculate crosswind component (sine of the variation of wind direction with runway)
- Takeoff – RUDDER for Directional Control and aileron into wind. Less aileron will be required as the aeroplane increases speed (why ?)
- Positive liftoff at about 3-5 kts more than normal and allow the aeroplane to crab into the wind.
- Allow for drift on downwind and base – about 10 degrees to begin with.
- As to final in a crosswind, your instructor will teach crabbing or forward-slipping or both or a combination

But wait : there is MORE

The competent execution of all of the above skills will qualify you for a GFPT. You will be at about the same standard, aeronautically, as someone with their new car license; safe but inexperienced.

It is in your interest to get more confidence (solo) and perhaps take a friend flying (but only in the circuit or training area). Up to 15 hours solo is permitted prior to a recheck. You may wish to have a go at some of the advanced items above during your recheck.

The next step is the PPL which is GFPT + navigation; i.e. about 5 to 7 dual nav. exercises and 2 or 3 solo exercises. Having passed a formal external exam (comprising Navigation, Met & Air Law) and a flight test you may now fly across Australia in (official) daylight and VMC with passengers subject to a medical, recency and all the other aviation regulations pertaining to flights (upon which you will have been examined). In any event get some more confidence solo especially with navigation.

Finishing Off

After you are quite familiar with a fixed pitch and fixed undercarriage aeroplane a CSU and Retractable endorsement will give you access to more powerful (read faster and capable) aeroplanes. The circuits will be more demanding and you will have to learn more corrective techniques (undercarriage failures for example).

After another 35 hours of day time navigating (seldom beneficial before) a Night VFR will give you more freedom and more instrument skills to say nothing of superior navigating skills.

From this skill level you will be a very independent pilot with an excellent grounding to continue with a CPL, a twin endorsement, a PIFR or a CIR. Alternatively, having achieved your current skill level this may satisfy your flying requirements.