Principles Of Flight

Lift And Weight

- Newton's third law: "Every action has an equal and opposite reaction"
- Air is a substance.
- Every object has weight.
- Bernoulli's Principle - the faster air moves the lower its pressure (less dense).
- Air moving through a constricted space speeds up.
- The top surface of a wing is more curved than the bottom - air moving over it speeds up.
- The wings are angled upward relative to airflow, so air is forced downwards, also producing lift.
- The top surface of a wing produces most lift at the point where it curves the most.
- Lift always acts at 90° to the airflow.
- The "Centre of Pressure" is the point at which all forces balance.
- Higher airspeed produces more lift.
- Angle of attack is the angle of the aircraft's wing relative to oncoming air.
- Higher angle of attack produces more lift, up to about 15°, where lift reduces.
- More dense air gives more lift.
- Wing shape affects lift.
- In straight and level flight, Lift = Weight. When climbing Lift > Weight, when descending Weight > Lift.

Thrust And Drag

- Thrust is generated by pushing air backward, either using a jet engine or a propeller.
- Drag is 'air resistance' - the force of air pushing on an aircraft.
- Drag is caused by the shape of an aircraft. The larger an object is the more drag it creates.
- The fineness ratio is a shape's height compared to its length. Something that is about 4 times as long as it is high will move through air quite easily.
- Doubling thrust increases drag by 4.
- To maintain straight and level flight Thrust = Drag. When speeding up Thrust > Drag, when slowing down Drag > Thrust.

Stability And Control

- Aircraft move around 3 axies -
    - Lateral - wing tip to wing tip
    - Longitudinal - nose to tail
    - Normal - top to bottom through the centre
- Aircraft can move in three ways -
    - Roll - around the longitudinal axis
    - Pitch - around the lateral axis
    - Yaw - around the normal axis
- Stability is the tendency of an aircraft to fly straight and level on its own.
- Stability in pitching is provided by the tailplane.
- Stability in rolling is provided by the wings, due to their dihedral angle.
- Stability in yawing is provided by the tail fin.
- You need a balance - too much stability is as bad as too little.
- The aircraft has three main control surfaces -
    - Ailerons - provide roll by moving the control column left or right.
    - Elevators - provide pitch by moving the control column forward or backward.
    - Rudder - provides yaw by moving the rudder pedals.
- Direction of movement is always relative to the pilot.
- Trim tabs are smaller ‘flaps’ on each control surface, they allow the pilot to adjust how effective the surface is.
- Flaps on the trailing edge of wings, and affect how much lift the wing produces.
- Flaps allow greater control at slow speeds.
- Slats also improve handling at low speeds. They are movable parts on the leading edge of a wing. They prevent turbulence over the top surface of a wing.

Stalling

- Angles of attack above about 15° start to produce very little lift.
- This is caused by turbulent airflow over the top surface of a wing.
- The speed at which a given aircraft will stall varies according to -
    - Weight - higher weight increases stalling speed.
    - Power - the higher the engine power the lower the stall speed.
    - Flaps - lowered flaps reduce stall speed.
    - Ice - build up of ice on the wings increases stalling speed.
    - Damaged Wings - increased stalling speed.
    - Maneuvers - various maneuvers affect stall speed in various ways.

Gliding

- Gliders have no thrust - they are pulled downward by gravity.
- The three forces that act on a glider are lift, weight and drag.
- The steeper a glider is pitched down the faster it goes.
- The flatter the glide angle the further a glider will travel relative to the ground.

- Gliding into the wind allows you to travel further.
- A glider with an airspeed of 35kts travelling into a 35kt wind will appear to descend over one spot on the ground.
- Airbrakes are panels that slide out of the top and bottom surface of the wings and cause the wings to produce less lift.

The Helicopter

- Helicopters produce lift by spinning their rotors, which act in the same way as wings.
- The pitch of the rotor blades can be adjusted by the pilot. This affects how much lift they produce.
- To make a helicopter move forwards each rotor blade has its pitch increased as it moves around the rear of the rotor disc.
- The same method can be used to move in any horizontal direction.
- To move up and down the pitch of all the blades is altered together. Increasing the pitch causes the helicopter to climb, reducing it causes it to descend.
- Torque Reaction is the tendency of the helicopter to spin the opposite way to the way the rotors spin.
- The tail rotor pushes air sideways to counteract this.
- Adjusting the pitch of the tail rotor blades allows the helicopter to yaw.
- A helicopter pilot has the following controls -
    - Collective - is a lever that controls the pitch of all rotor blades together. This is attached to a cam arrangement that opens the throttle when the lever is moved up.
    - Cyclic - is a stick that controls the pitch of individual blades for horizontal movement.
    - Throttle - a twist grip on the collective lever that controls the engine speed.
    - Tail Rotor control - pedals that cause the aircraft to yaw.