A102 AIRCRAFT SYSTEMS

OBJECTIVE: The objective of this unit is to be able to identify and describe basic aircraft components in relation to their effect on the pilot's operation of the aircraft. Pilots do not need to be able to design and build aircraft to effectively employ the machine; however, a thorough knowledge of the aircraft allows the pilot to synthesize and evaluate sensory data to make good employment decisions. The student should know the location, nomenclature, and basic function of aircraft components and be able to describe the basic operation of aircraft systems.

1. PARTS OF AN AICRAFT

1. Fuselage

- **Definition**:
  - The central body of the airplane that houses passengers, cargo, and controls.
- **Key Features**:
  - Provides structural integrity and attachment points for other components (wings, tail, landing gear).
  - Contains the cockpit, cabin, and avionics.
- **Types**:
  - **Monocoque**: Relies on the outer skin for structural strength.
  - **Semi-Monocoque**: Combines internal frames and skin for strength and flexibility.
- **Function**:
  - Serves as the backbone of the aircraft, supporting all other parts.

2. Wings

- **Definition**:
  - Airfoil-shaped structures that generate lift by creating pressure differential.
- **Key Features**:
  - **Airfoil Design**: Curved on top and flatter on the bottom to produce lift.
  - **Flaps**: Extendable surfaces to increase lift or drag during takeoff and landing.
  - **Ailerons**: Hinged surfaces near the wingtips used to control roll (banking).
- **Types**:
  - **Cantilever Wings**: No external bracing; rely on internal structure for support.
  - **Braced Wings**: Supported by struts or wires.
- **Function**:
  - Generate lift to support the airplane in flight.
  - Provide roll control via ailerons.

3. Tail (Empennage)

- **Definition**:
  - The rear structure that stabilizes and controls the aircraft in flight.
- **Key Features**:
  - **Vertical Stabilizer (Fin)**:
    - Houses the rudder to control yaw (left or right movement).
  - **Horizontal Stabilizer**:
    - Includes the elevator to control pitch (up or down movement).
  - **Trim Tabs**:
    - Adjustable surfaces to relieve control pressure and maintain stable flight.
- **Function**:
  - Maintains stability and directional control.
  - Helps keep the airplane level and aligned with the flight path.

4. Landing Gear
- **Definition**:
  - The undercarriage of the airplane used during takeoff, landing, and taxiing.
- **Key Features**:
  - **Types**:
    - **Tricycle Gear**: Two main wheels and a nose wheel (common in most modern aircraft).
    - **Taildragger**: Two main wheels and a tail wheel.
  - **Shock Absorbers**: Reduce impact forces during landing.
  - **Retractable Gear**: Stows inside the fuselage or wings to reduce drag during flight.
- **Function**:
  - Supports the airplane during ground operations.
  - Absorbs landing forces to prevent structural damage.

5. Powerplant
- **Definition**:
  - The engine and related components that provide thrust and electrical power.
- **Key Features**:
  - **Reciprocating Engine**: Common in small aircraft; uses pistons to generate power.
  - **Turboprop or Jet Engine**: Used in larger or high-performance aircraft.
  - **Cooling System**: Prevents engine overheating (air-cooled or liquid-cooled).
  - **Accessory Systems**:
    - Provide power to avionics, lighting, and hydraulic systems.
- **Function**:
  - Generates power to propel the aircraft and support onboard systems.

6. Propeller
- **Definition**:
  - Rotating blades attached to the engine that convert engine power into thrust.
- **Key Features**:
  - **Fixed-Pitch Propeller**: Blade angle is set and cannot be adjusted.
  - **Variable-Pitch Propeller**: Blade angle can be adjusted to optimize performance at different speeds.
  - **Feathering Capability** (in some models): Reduces drag in the event of engine failure.
- **Function**:
  - Creates thrust by accelerating air backward, pushing the airplane forward.
  - Works in tandem with the engine for efficient propulsion.

How These Components Work Together
1. **Wings generate lift**, countering the force of gravity.
2. **The powerplant and propeller provide thrust**, overcoming drag and propelling the aircraft forward.
3. **The tail ensures stability and control**, helping the pilot maintain the desired flight path.
4. **The fuselage houses controls and payload**, while serving as the structural backbone.
5. **The landing gear facilitates safe ground operations**, enabling takeoff and landing.

2. FLIGHT CONTROL TYPES

Flight controls fall into one of two categories, either primary flight controls or secondary flight controls.

Primary Flight Controls

- Ailerons (roll the aircraft left or right)
- Elevator (pitch the aircraft up or down)
- Rudder (yaw the aircraft left or right)

The ailerons and elevator are connected to the aircraft's "stick" or "yoke", while the rudder is controlled through rudder pedals located in the footwell.

Secondary Flight Controls:

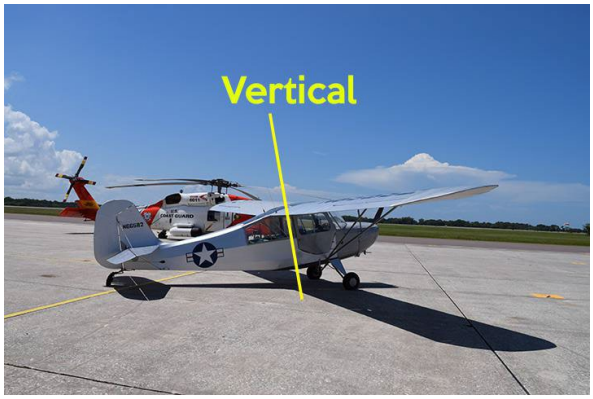
- Flaps
- Trim

Flaps increase the amount of lift the wing is capable of producing, allowing the aircraft to be flown at slower speeds which can be beneficial for takeoff and landing. Trim, on the other hand, is similar to cruise control in your car. It is often referred to as the "cheap man's autopilot", and allows you to maintain a set altitude by alleviating control pressures. For example, once you level off and set your desired power setting, you may be holding the yoke slightly forward or slightly back to maintain your current altitude. Adjusting trim allows you to release that pressure while keeping the airplane at the same altitude.

Axis of Movement:

The airplane moves about three axes, and all of these axes meet at one central point which is the CENTER OF GRAVITY.

- Longitudinal axis (long axis from nose to tail, ailerons roll the airplane around this axis)
- Lateral axis (this axis goes wingtip to wingtip, the airplane pitches about this axis controlled by the elevator)
- Vertical axis (a vertical line from the bottom up, the airplane yaws about this axis controlled by the rudder).



3. AIRCRAFT ENGINE:

a. The powerplant includes the engine and propeller systems that produce thrust.
b. There are various types of engines, including reciprocating, turboprop, turbojet, and turbofan engines.
   - Reciprocating Engines: Use a series of pistons to convert chemical energy into mechanical energy through combustion. Typically operate on a four-stroke cycle (intake, compression, power, exhaust).
   - Turboprop Engines: Utilize a gas turbine engine connected to a propeller through a reduction gearbox, offering high efficiency for low-to-medium speeds.
   - Turbojet: Compress, ignite, and expel air at high speeds for thrust, suitable for high-speed aircraft.
   - Turbofan Engines: A hybrid of turbojet and propeller designs, providing a balance of efficiency and speed. Include bypass air to reduce noise and increase efficiency.
   - Propeller Systems: Fixed-pitch and constant-speed types control thrust by adjusting blade pitch and engine RPM
c. https://youtu.be/gIdXLMVP6VU

4. LANDING GEAR:

a. Supports the aircraft during takeoff, landing, and taxiing.
   - Types: Fixed or retractable.
   - Braking Systems: Hydraulic disc brakes with anti-skid features.
b. https://youtu.be/skv6CgCY3vM

5. FUEL SYSTEM:

a. The fuel system stores and delivers fuel to the engines. Key components include:
   - Fuel Tanks: Integral or bladder-type, often located in wings.
   - Fuel Pumps: Electric and engine-driven pumps ensure a continuous fuel supply.
   - Fuel Filters: Remove contaminants to protect the engine.
b. https://youtu.be/rya4YFDpsPs

6. HYDRAULIC SYSTEM:

a. Operates systems requiring significant force, such as landing gear, brakes, and flight controls.
b. Hydraulic Pumps: Can be engine-driven or electric.
c. Actuators: Convert hydraulic pressure into mechanical movement.
d. Reservoir: Stores hydraulic fluid.
e. https://youtu.be/M1UddxRAjbc

7. ELECTRICAL SYSTEM:

a. Supplies power to the aircraft's instruments, lighting, and avionics. Main components include:
   - Battery: Provides DC power for starting and emergencies.
   - Alternator/Generator: Powers systems during flight and recharges the battery.
   - Circuit Breakers and Buses: Distribute and protect electrical circuits.
b. https://youtu.be/d5sXmNplQHw