AIRCRAFT FAMILIARIZATION

The main components of an aircraft

Fuselage

Main or central structure of heavier-than-air aircraft
☐ provides space for the crew, passengers, cargo, fuel cells, controls, and accessories
☐ structure to which the wings are attached
☐ houses the powerplant in single-engine aircraft

three general types of fuselage construction:

1. Truss type
   ☐ usually steel tubing welded together
   ☐ may also be aluminum fuselage frames riveted or bolted into one piece, with cross-bracing achieved by using solid rods or tubes

2. Monocoque
   ☐ relies largely on the strength of the skin or covering to carry primary stresses
   ☐ uses formers, frame assemblies, and bulkheads to give shape to the fuselage
   ☐ biggest problem is maintaining enough strength while keeping within allowable weight limits

3. Semi-monocoque type
   ☐ all members carry both tension and compression loads
   ☐ constructed primarily of the alloys of aluminum and magnesium
   ☐ longerons: heavy members running fore and aft taking up primary bending loads
     ☐ stringers: short light longitudinal members which supplement the longerons
   ☐ bulkheads: primary vertical structural members which divide the fuselage of the aircraft into compartments or bays
   ☐ frames: fuselage heavy vertical members
   ☐ formers: fuselage light vertical members
Empennage (or tail section)

Tail cone
- streamlines to a tapered end in the aft most part of the fuselage
- construction is usually similar to the fuselage but often built lighter

Fixed surfaces:

- **horizontal stabilizer**: mounted horizontally on the aft fuselage, affording longitudinal stability
  - in straight and level flight, the wing produces a nose-down moment
  - to balance this rotational force, the horizontal tail surface is installed in such a way that it produces a nose load that causes a nose-up moment
- all airplanes are equipped with methods of varying the tail load in flight

- **vertical stabilizer**: (or vertical fin): mounted vertically on the top of the aft fuselage
  - provides directional stability, or the tendency of the aircraft to align with the relative wind

Nacelles or pods

Streamlined enclosures used on multi-engine aircraft primarily to house the engines
- round or spherical in shape
- may be located above, below, or at the leading edge of the wing on multi-engine aircraft

Cowling

The detachable covering on frequently accessed areas such as the engine, accessories, engine mount or firewall area
Landing gear

Supports the aircraft during landing or while it is resting or moving on the ground
- shock struts to absorb the shock of landing and taxiing
- many aircraft have provision for retraction of the landing gear to reduce parasite drag
- may have a nose wheel (tricycle type gear arrangement), or a tail wheel (conventional type gear arrangement)

Wing structure

The part of a heavier-than-air aircraft that produces aerodynamic lift
- it is this lift that holds the aircraft in the air against the force of gravity
- the dihedral of the wings help provide the aircraft with lateral stability
- on fixed-wing aircraft: attached rigidly to the aircraft structure
  - designated left and right, corresponding to the left and right sides of the pilot when seated in the cockpit
- on a helicopter, (a rotor-wing aircraft): mounted on a mast and is rotated by the engine
- cantilever wings: built in such a way so that no external bracing is needed
- on multiple-engine aircraft used to support the engines
- spars: the principal structural members of the wing and run from wing tip to fuselage
- ribs: primary chord-wise members of the wing and give the wing its aerodynamic cross section
Flight control surfaces

Hinged or movable airfoils designed to change the attitude of the aircraft during flight

Two groups:

1. Primary group

   control the aircraft about its three axes
   (1) longitudinal (nose-to-tail)
   (2) lateral (wing-tip to-wing-tip)
   (3) vertical (top-to-bottom)

   aileron: a primary flight control surface mounted on the trailing edge of the wing, near the tip
   □ operates by lateral movement of the control wheel or stick
   □ their displacement causes the airplane to rotate about its longitudinal axis (roll control)

   Flight spoilers: a primary flight control on some aircraft which are used to provide roll control
   □ mounted on top of the wings, they may work with the ailerons or alone

   rudder: primary flight control mounted on the trailing edge of the vertical stabilizer
   □ hinged or movable surface that is moved left or right by the foot-operated pedals in the cockpit
   □ provides movement of the aircraft about the vertical axis (yaw control)

   elevator: primary flight control mounted on the trailing edge of the horizontal stabilizer
   hinged or movable surface that is moved up or down by fore-and-aft movement of the control yoke or stick
   □ provides control of the aircraft about the lateral axis (pitch control)
Flight control surfaces (continued)

2. Secondary group

trim tabs and spring tabs:
☐ attached to the trailing edges of the primary flight controls
☐ enable pilot to trim out any unbalanced condition which may exist during flight, without exerting any pressure on the primary controls

flaps: auxiliary flight control built into the trailing edge (or leading edge) of the wings
☐ extended (lowered), to change the airfoil shape of the wing to increase both its lift and drag
☐ reduces landing speed
☐ reduces the length of the take-off run
☐ reduces in-flight air speed

ground spoilers: lift decreasing devices that extend up on hinges from the tops of the wings
☐ used only when the aircraft is on the ground to greatly reduce the wings lift during landing to aid in slowing the aircraft
☐ on some aircraft the flight spoilers are used this way also

slats: on some aircraft a portion of the wing leading edge mounted on tracks so it can extend downward and create a duct to direct high-energy air down over the surface of the wing and help prevent stalling at slower airspeeds
Basic concepts of aerodynamics

Bernoulli’s principle

The Swiss mathematician and physicist Daniel Bernoulli has given us a principle that explains the relationship between potential and kinetic energy in a fluid.

The pressure of a fluid (liquid or gas) decreases at points where the velocity of the fluid increases.

☐ a tube with a decrease in diameter in the middle of it demonstrates this concept and is called a "venturi tube"

☐ as a fluid in motion passes over the restriction in the center of the tube, its velocity must increase for it to get out of the way of new fluid coming in ☐ as it increases in velocity passing over the restriction, it decreases in pressure creating a low pressure area in the center of the tube

☐ if a hole is drilled in the restriction, it will act as a siphon and draw in any fluid introduced into it from outside the tube

☐ the venturi tube principle is used in a number of systems on the aircraft such as the carburetor, instrument pressure, and cabin pressurization

Just as Bernoulli’s principle is used in liquid and gas systems of the aircraft to provide a low pressure area where it is needed, it is also the principle by which it is possible for an aircraft to fly.

☐ an airfoil is really nothing more the bottom 1/2 of a venturi

☐ air moving over the top of the wing speeds up and creates a low pressure area, and the air moving across the bottom is moving slower creating a high pressure area

☐ the wing produces lift because of pressure difference; and the greater this difference, the more lift developed

Newton's third law of motion

Newton's third law of motion states: for every action there is an equal and opposite reaction
this also plays a role, along with Bernoulli’s principle, in the development of lift

when there is an angle between the wing and the direction of the airstream, the air is forced to change direction

- angle of incidence: fixed angle of the wing in relationship to the longitudinal axis (set by the manufacturer)
- angle of attack: variable angle of the wing controlled by the pilot in flight by the elevator about the lateral axis (pitch control)

if the wing is tilted upward against the airstream, the air flowing under the wing is forced downward

- the wing therefore applies a downward force to the air, and the air applies an equal and opposite upward force to the wing
- this is lift

in summary, aerodynamic lift is produced on an airfoil by the pressure difference across the airfoil

- the aircraft wing is designed to produce lift resulting from relatively:
  - positive air pressure below the wing’s surface (Newton’s third law of motion), and
  - negative air pressure above the wing’s surface (Bernoulli’s principle)
Aircraft instrument systems

Instrumentation: the science of measurement
Some examples:
☐ speed    ☐ direction    ☐ temperature
☐ distance    ☐ RPM
☐ altitude    ☐ pressure

Four groups of instruments:

1. **Flight instruments:**
   - ☐ located on main instrument panel for instant reference by the flight crew
   - ☐ aid in controlling the in-flight attitude
   - ☐ operated by atmospheric, impact, differential, or static pressure, or by a gyroscope
   - some examples:
     - ☐ airspeed indicator    ☐ attitude indicator
     - ☐ vertical speed indicator    ☐ altimeter
     - ☐ turn and slip indicator

2. **Engine instruments:**
   - used by the flight crew to monitor engine operation and performance,
   - ☐ also to alert them to a degrading engine condition before it becomes an engine failure
   - ☐ designed to measure the quantity and pressures of engine liquids and gases, RPM, and temperature
   - some examples:
     - ☐ tachometer    ☐ oil temperature gage
     - ☐ fuel quantity gage    ☐ fuel and oil pressure

3. **Navigation instruments:**
   - provide information that enables the pilot to guide the aircraft accurately along definite courses
   - ☐ directional gyro    ☐ clock
   - ☐ turn coordinator    ☐ compasses
4. Auxiliary instruments:
some examples:
☐ outside air temperature
☐ system pressure indicator
☐ fuel quantity