



# Basics of Aeronautical Engineering -2

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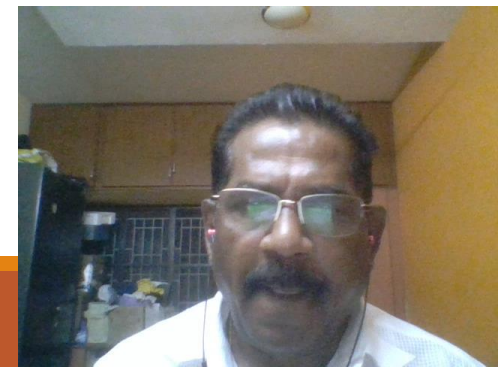
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## UNIT II

## AERODYNAMICS

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Aerodynamic forces on aircraft – Drag types - classification of NACA airfoils, Mach number, center of pressure and aerodynamic center-Component so fan Airplane and their functions-classifications.

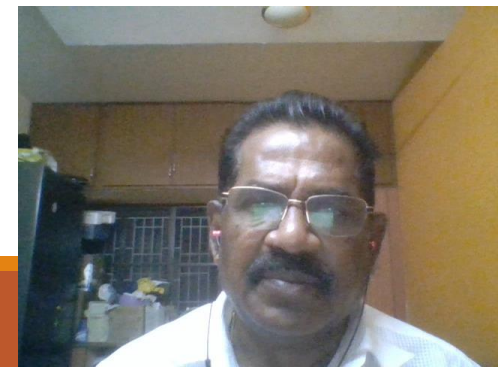




# What is the center of pressure of an aircraft?

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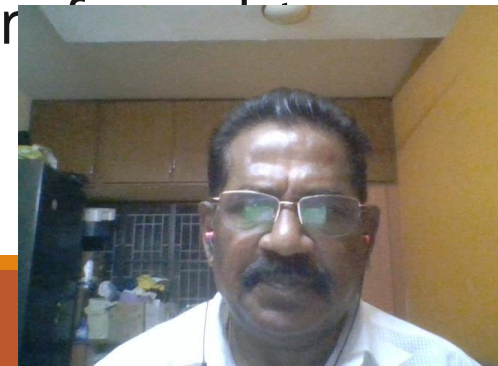
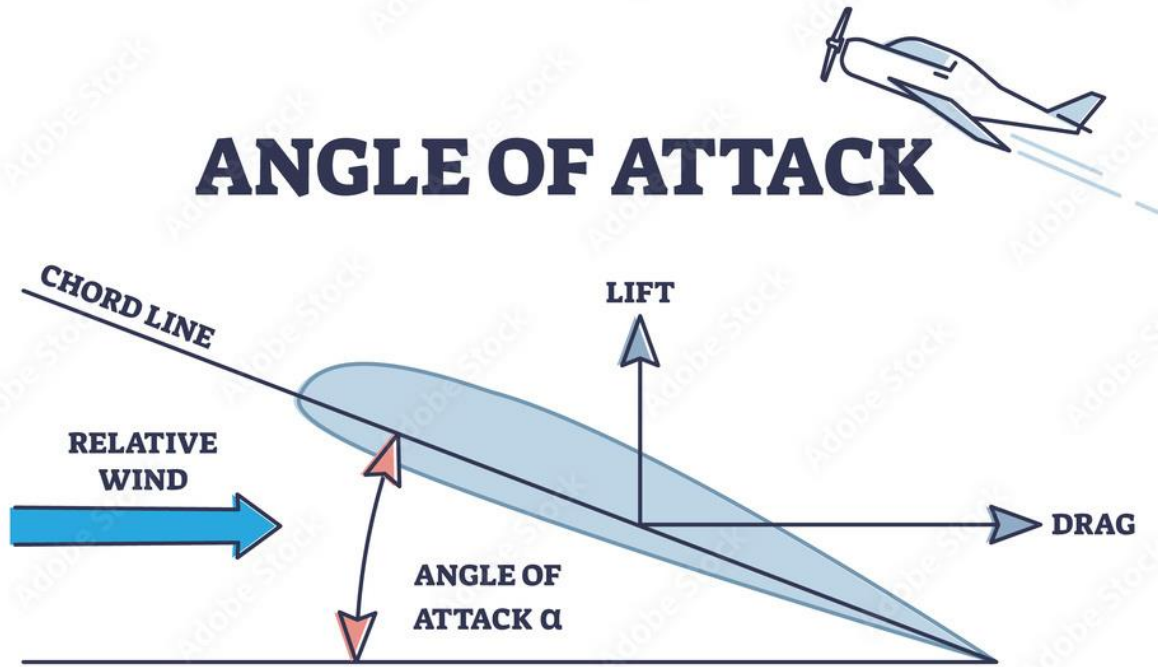
- The center of pressure of an aircraft is the point where all of the aerodynamic pressure field may be represented by a single force vector with no moment.
- A similar idea is the aerodynamic center which is the point on an airfoil where the pitching moment produced by the aerodynamic forces is constant with angle of attack





The aircraft angle of attack (AOA) is defined as the angle of the oncoming wind relative to the aircraft's reference line. In other words, the angle that the oncoming air makes with the center of the fuselage or a designed average point on the wing is referred to as the aircraft AOA.

## ANGLE OF ATTACK





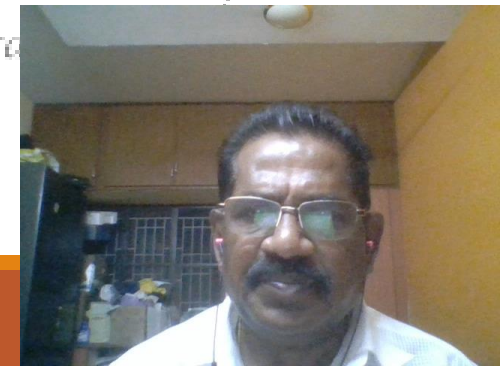
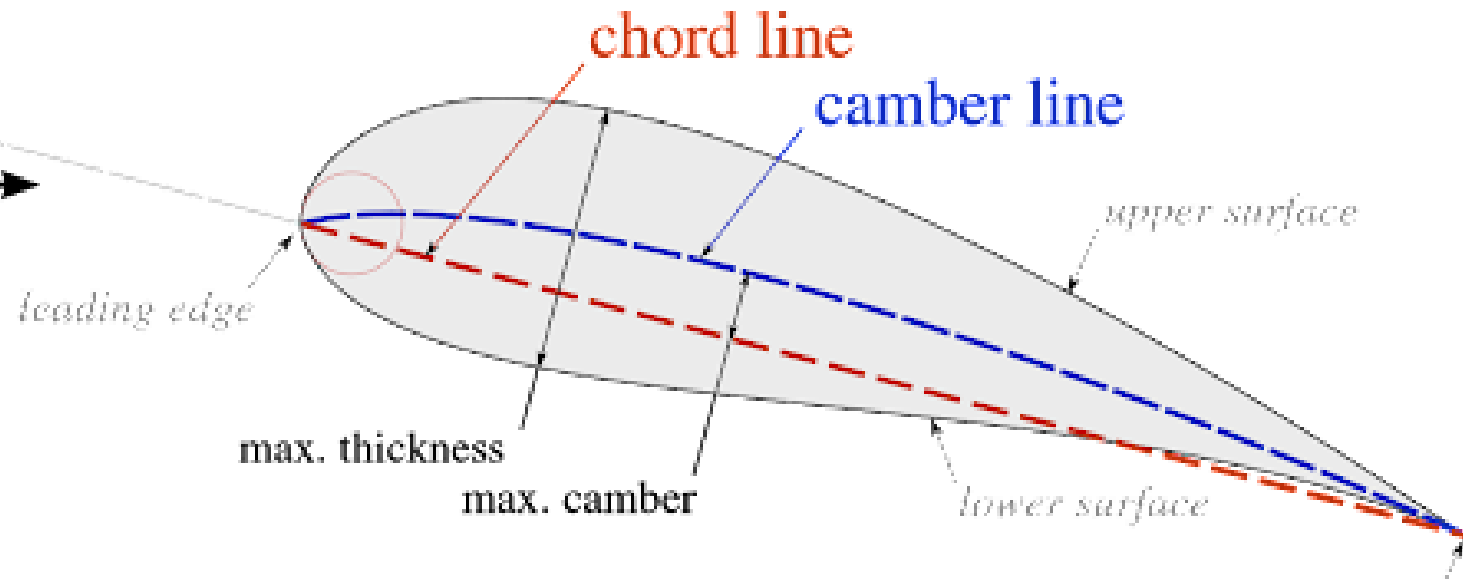
# Aerofoil

angle of attack

$\alpha$

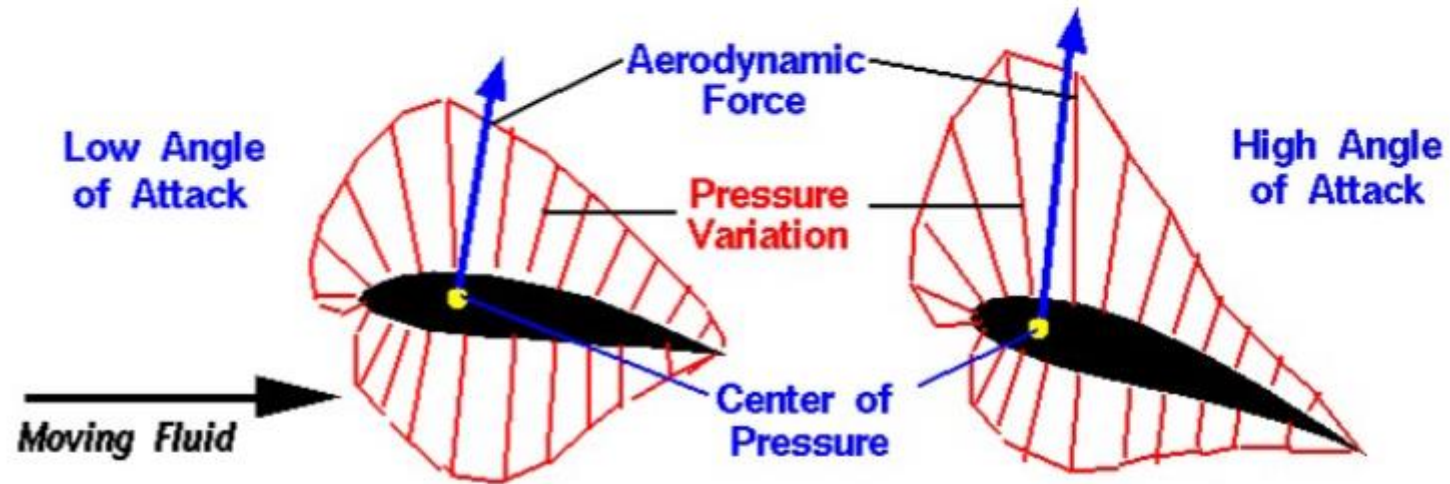


relative wind





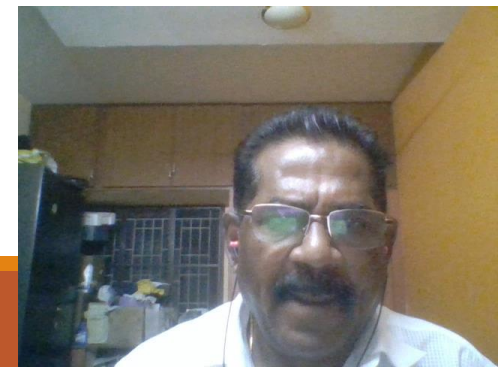
# Center of Pressure



Center of Pressure is the average location of the pressure.  
Pressure varies around the surface of an object.  $P = P(x)$

$$cp = \frac{\int x p(x) dx}{\int p(x) dx}$$

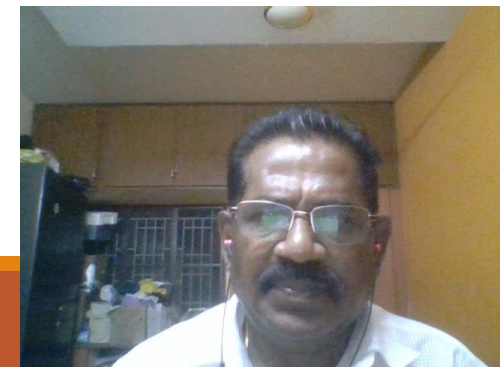
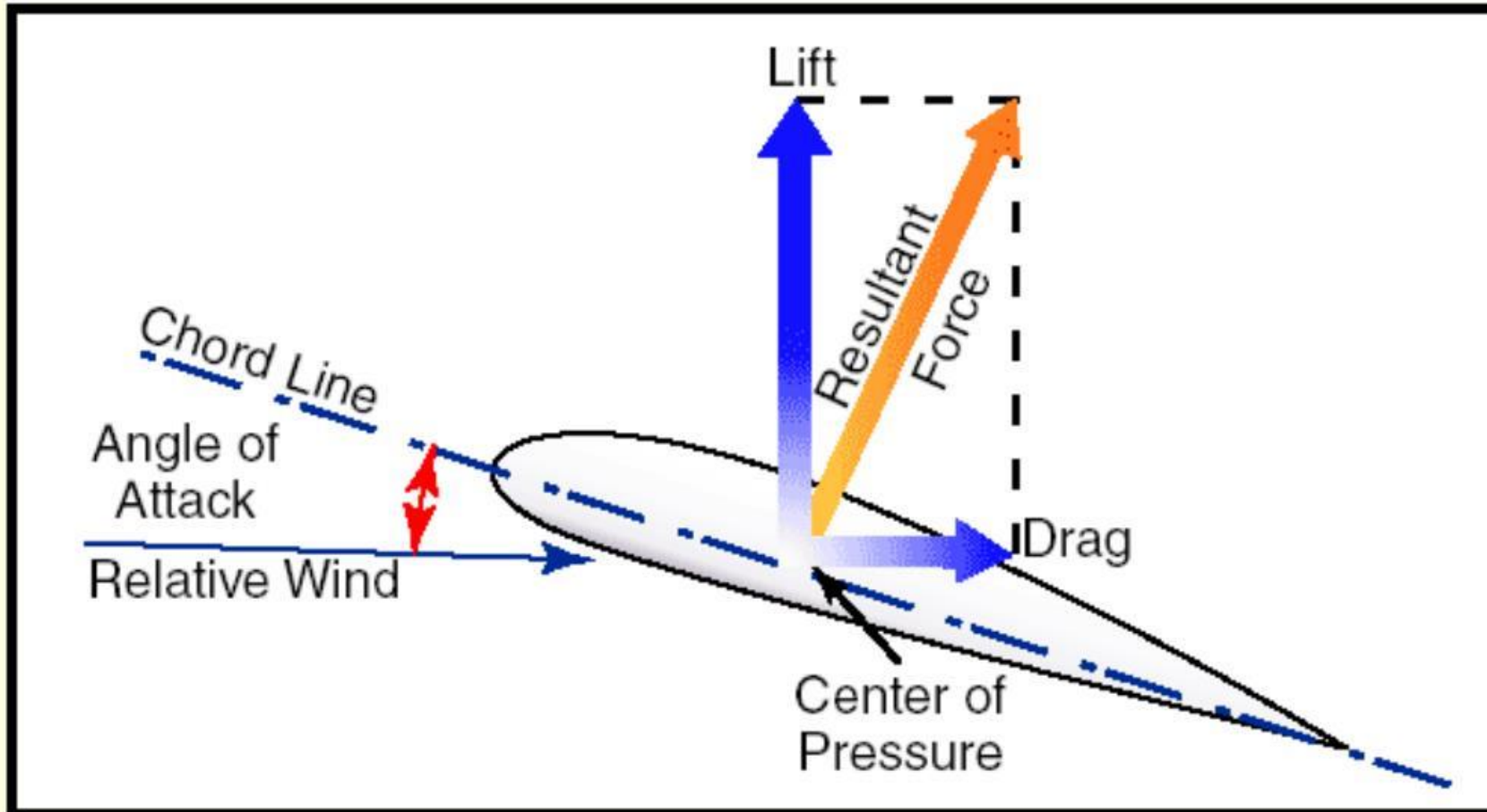
Aerodynamic force acts through the center of pressure.  
Center of pressure moves with angle of attack.





# Center of Pressure

The resultant aerodynamic force acts at the Center of Pressure (c.p.), about which the moment is zero.





# Center of Pressure

- Center of Pressure of airfoil shifts with:
  - Camber (ie, flaps!)
  - Change of AoA
- Result:
  - Control pressures and trim will change with AoA and flap extension

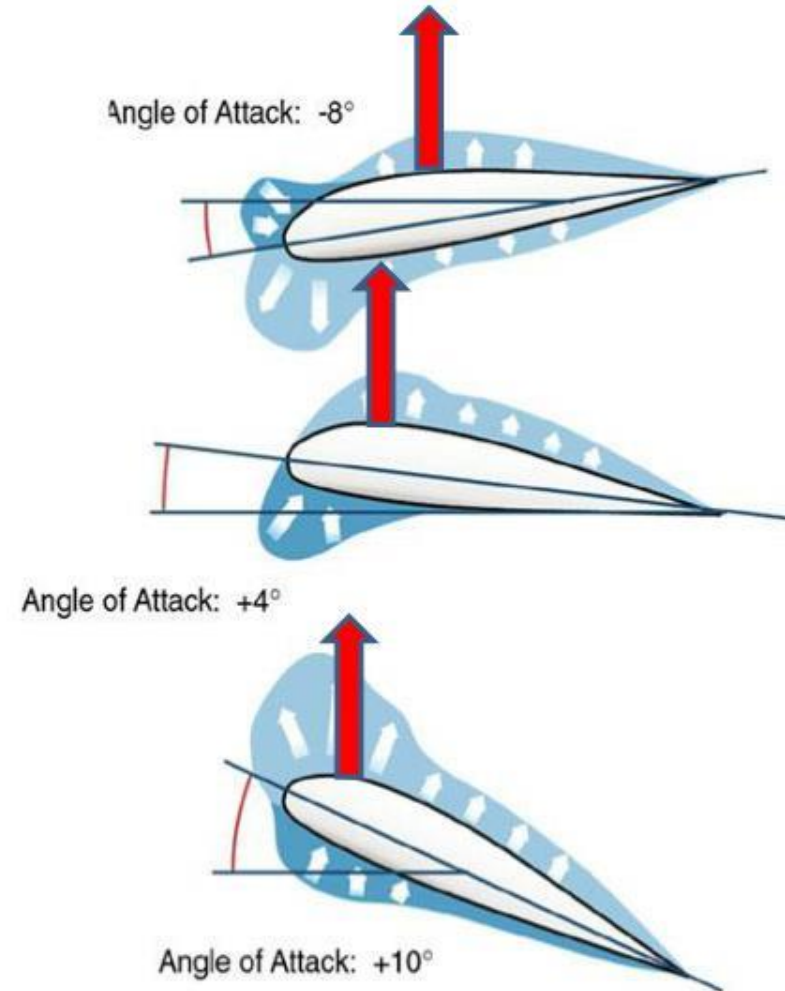
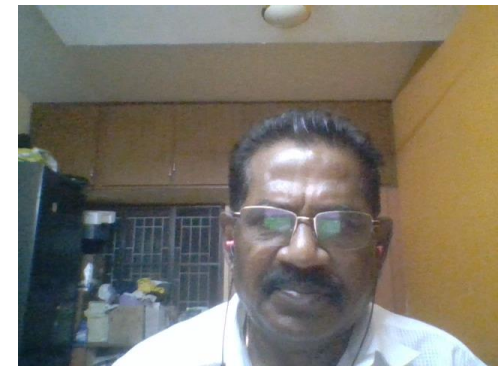
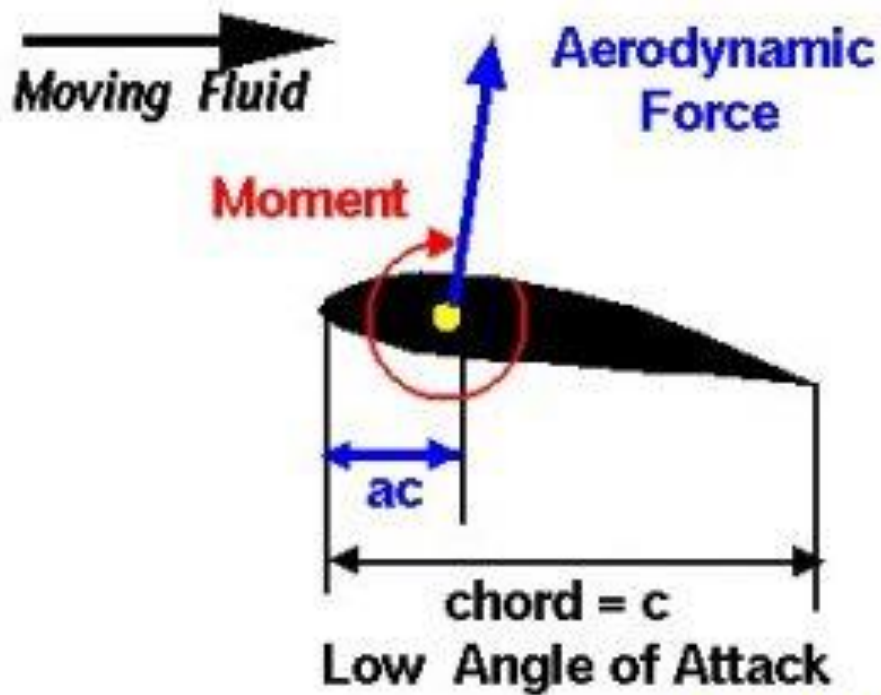


FIG 03-06







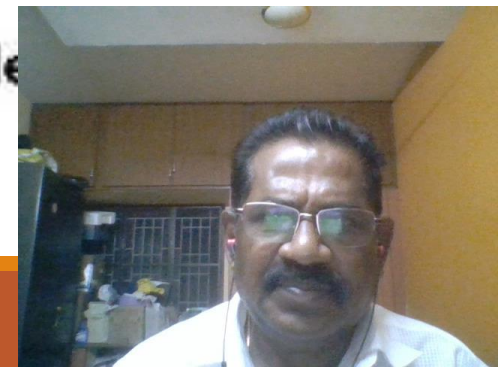
### Aerodynamic Center

For low speed, thin airfoils (flat plate):

$$ac = \frac{c}{4}$$

Moment about the aerodynamic center is constant with angle

**Aerodynamic center does not move with angle.**





# Revision

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Center of Pressure on an aircraft

Angle of Attack

Aerofoil parts

