

KING FAHD UNIVERSITY

Department of Aerospace Engineering

**An Introduction to Flight Stability
and Control**

Instructor

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Main Topics

- **Meaning of stability and control.**
- **Stability.**
- **Aircraft Anatomy.**
- **Equations of motion.**
- **Longitudinal and lateral modes.**
- **Flying Qualities.**
- **Control.**

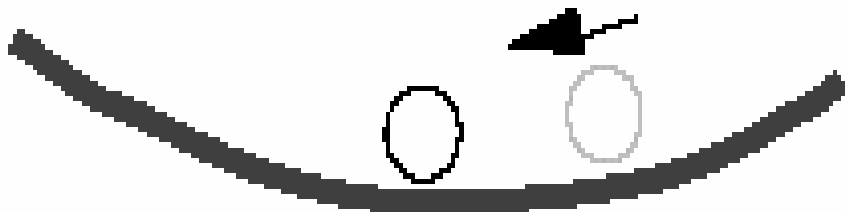
Stability (Static and Dynamic)

- Result of small disturbances from equilibrium which arise at *random* from external loads. It is categorized as *static* or *dynamic*.
- Stability is a *characteristic of the vehicle dynamics* which is independent of the pilot's actions.
- Pilot related.
- Is it stable? Can it do this maneuver? How easy?
- Flying qualities.

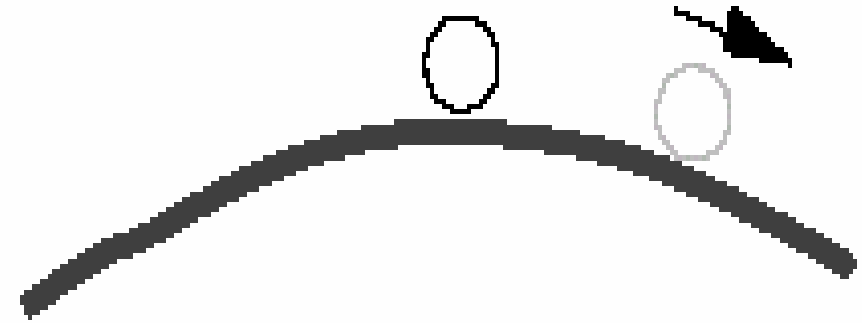
Control

- Response of aircraft to *intentionally* applied forces/moments which causes aircraft to deviate from initial equilibrium condition in a desired fashion.
- Control is affected by *pilot's interaction* with the aircraft.
- Control theories (classical and modern).
- How to make the aircraft stable?
- Improving flying qualities.
- Engineers related (Company secrets).

Static Stability



(a) Statically Stable

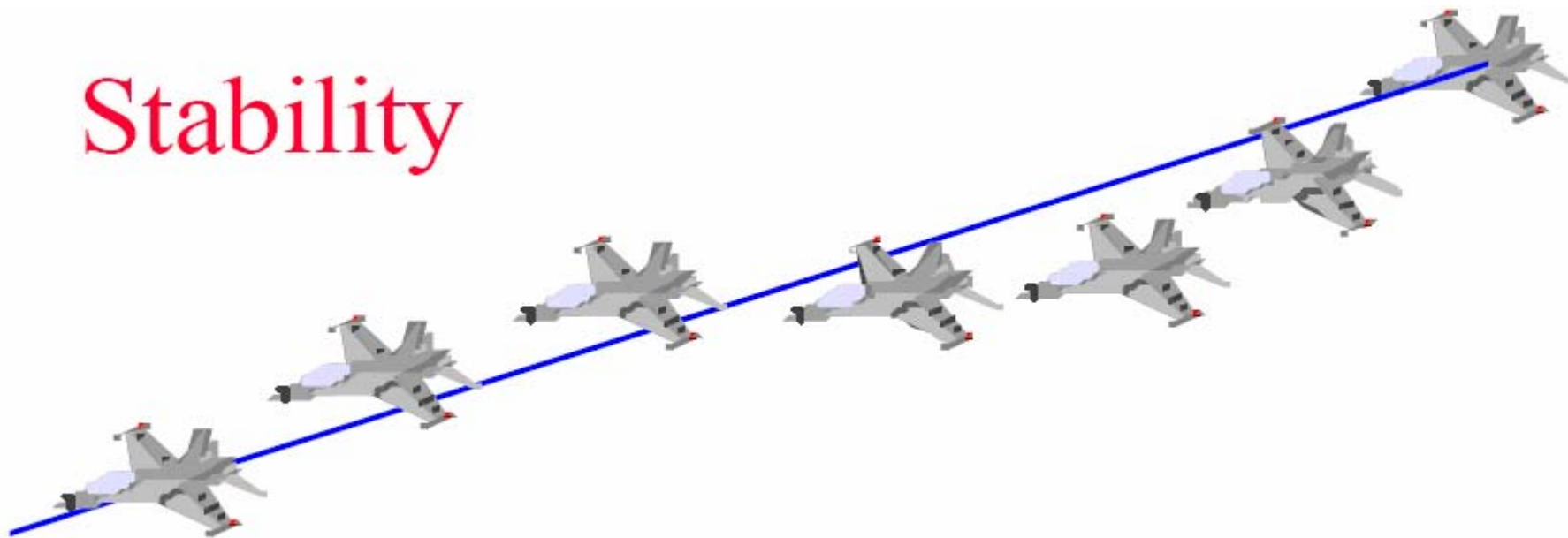


(b) Statically Unstable



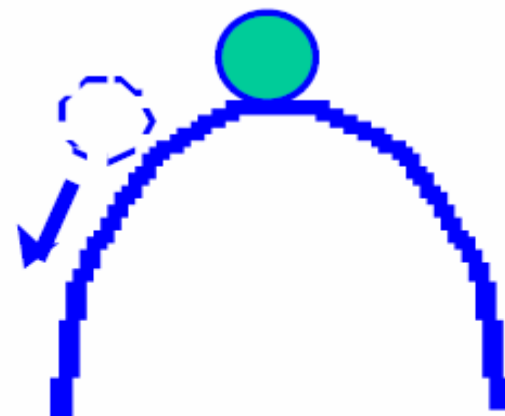
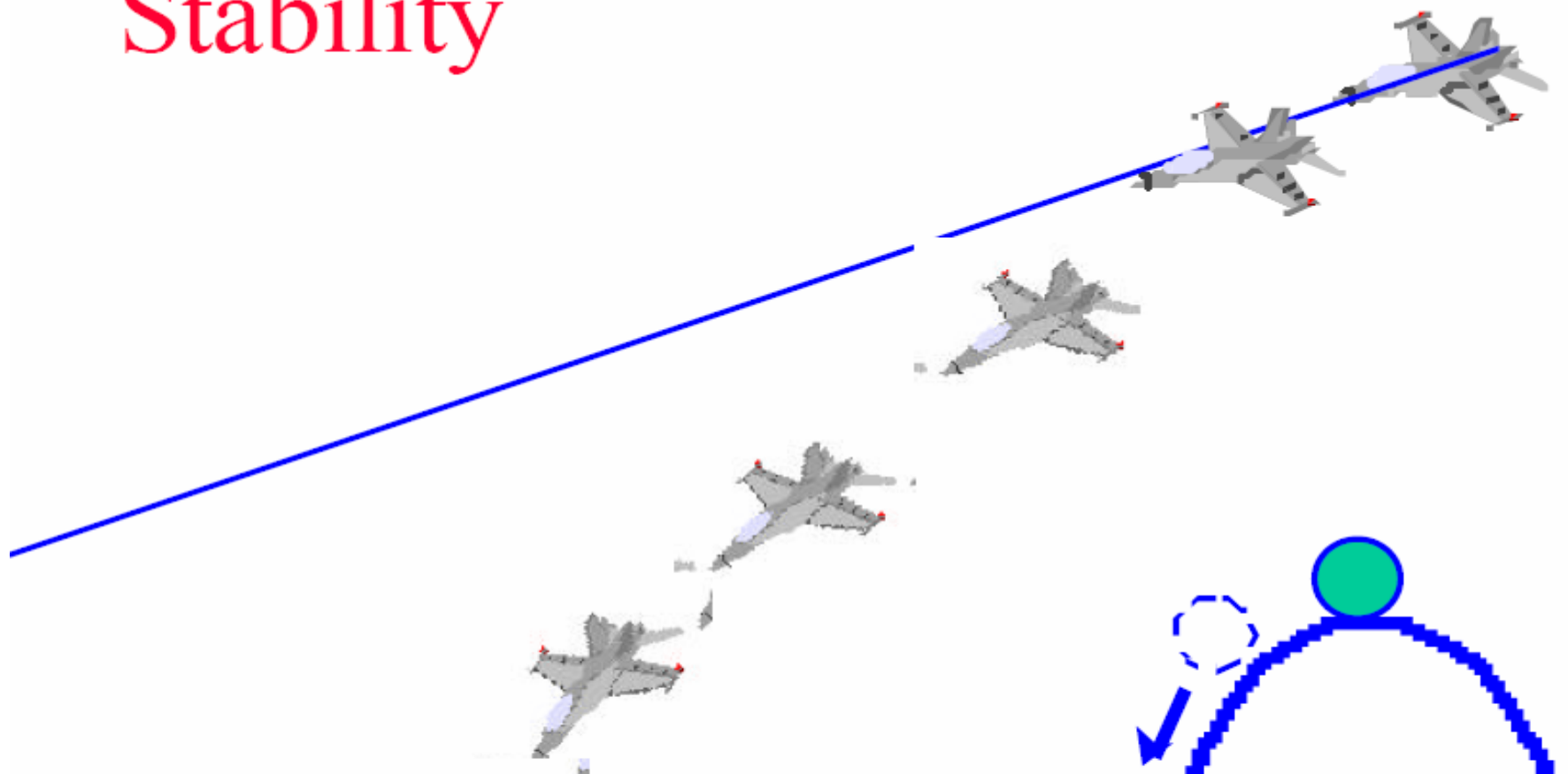
(c) Neutrally Stable

Stability



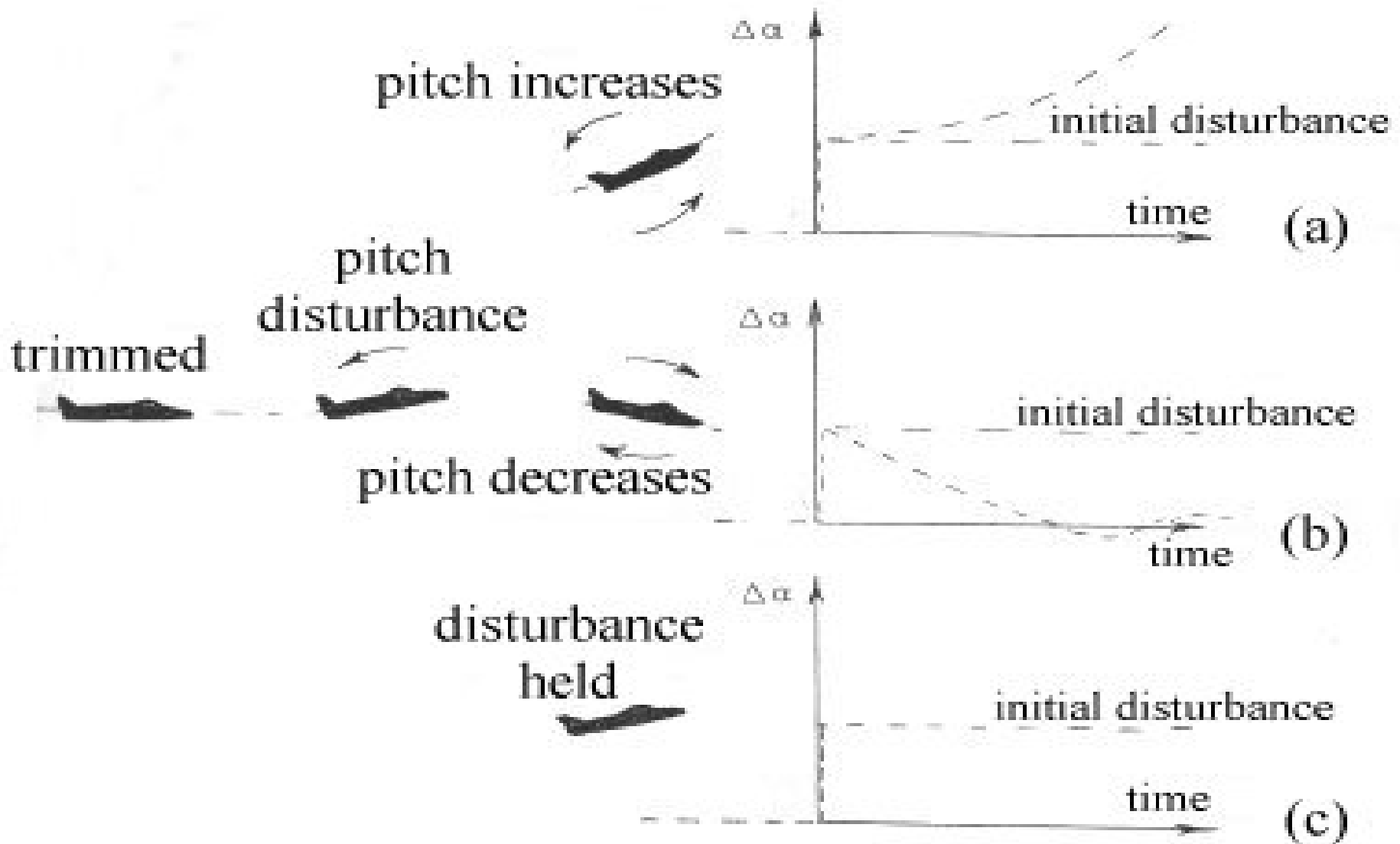
stable

Stability



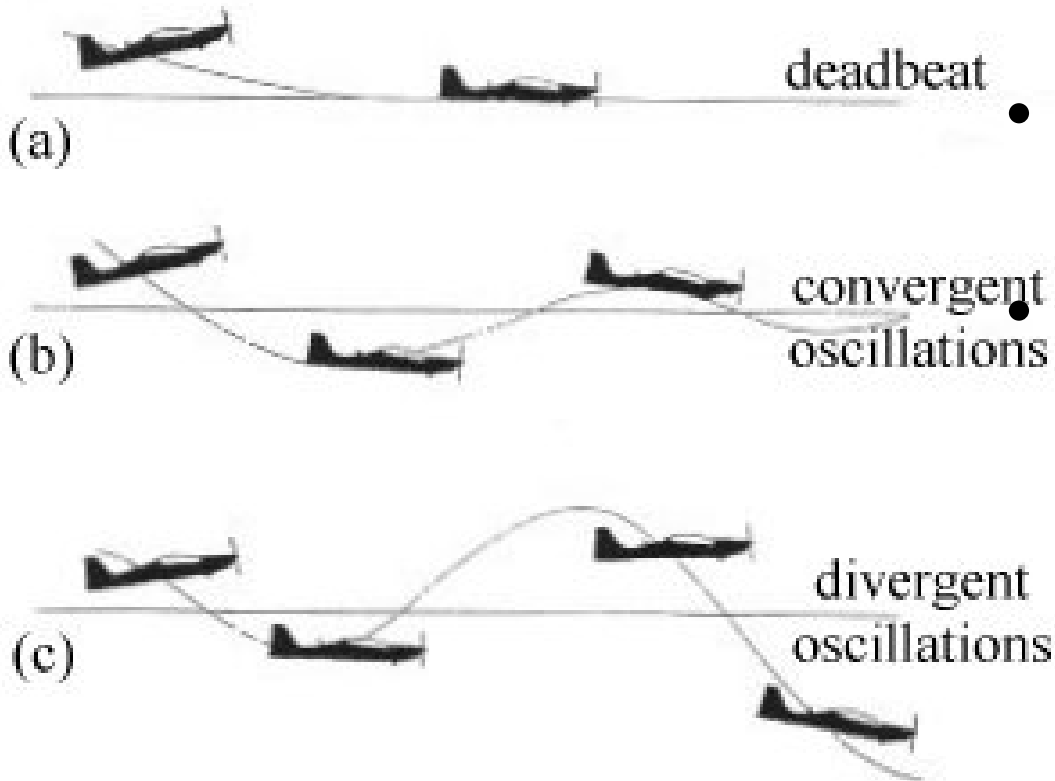
unstable

Longitudinal Static Stability



Dynamic Stability

- For dynamic stability, motions have to be *convergent* or *damped out*. (The vehicle will return to its original equilibrium condition after some interval of time).



- If divergent then dynamic instability exists.

Cases (a) & (b) here are longitudinally dynamically stable, case (c) is longitudinally dynamically unstable (all are statically stable).

Statically stable, dynamically stable moments tend to return airplane to equilibrium - oscillations decay



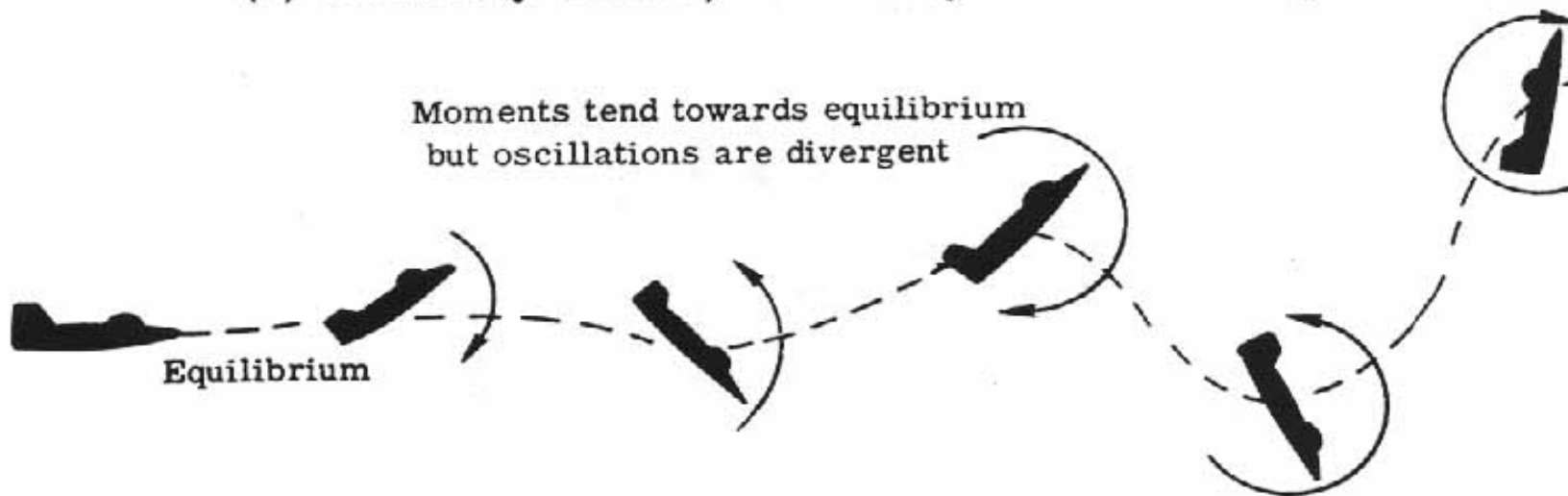
(a) Statically and dynamically stable.

Moments tend to return airplane to equilibrium but oscillations do not decay



(b) Statically stable; neutral dynamic stability.

Moments tend towards equilibrium but oscillations are divergent

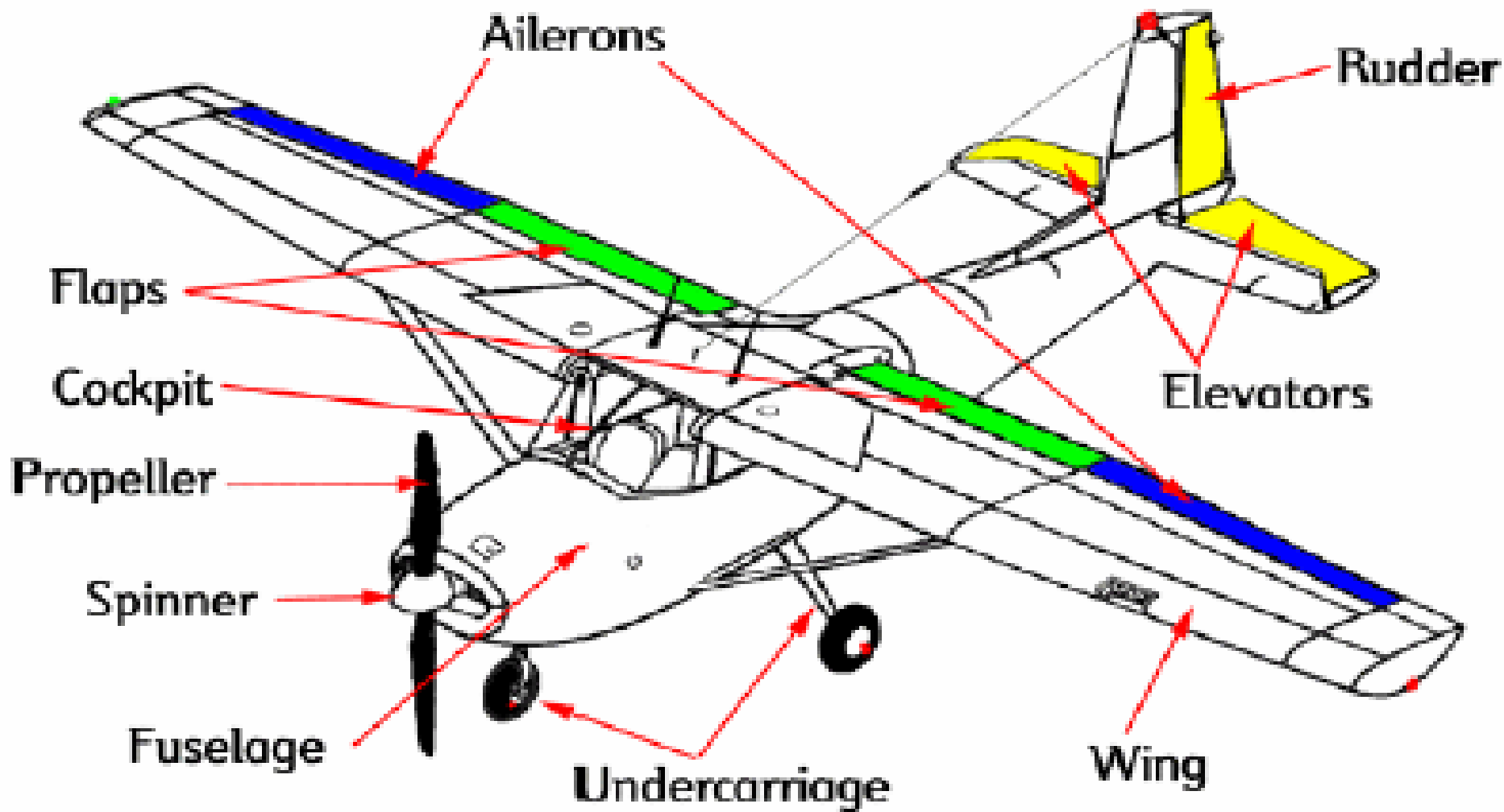


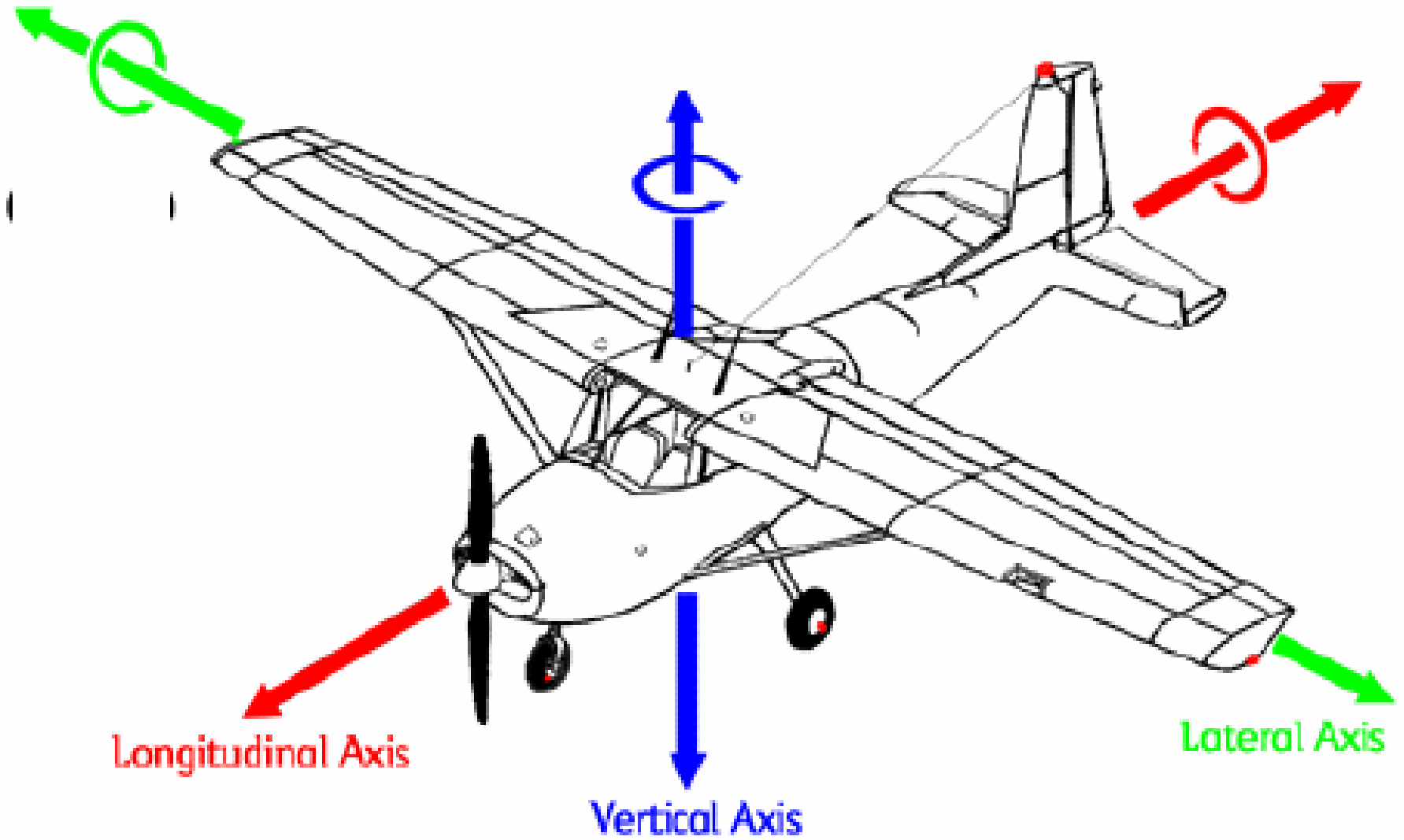
(c) Statically stable; dynamically unstable.

To Study Stability and control we need to know :

- Aircraft anatomy especially controls (aileron, rudder, throttle, thrust vectoring, etc.) *What parts do the job?*
- Aircraft equations of motions. *How is it done?*
- Automatic control theory. *How to do it better?*

Aircraft Anatomy





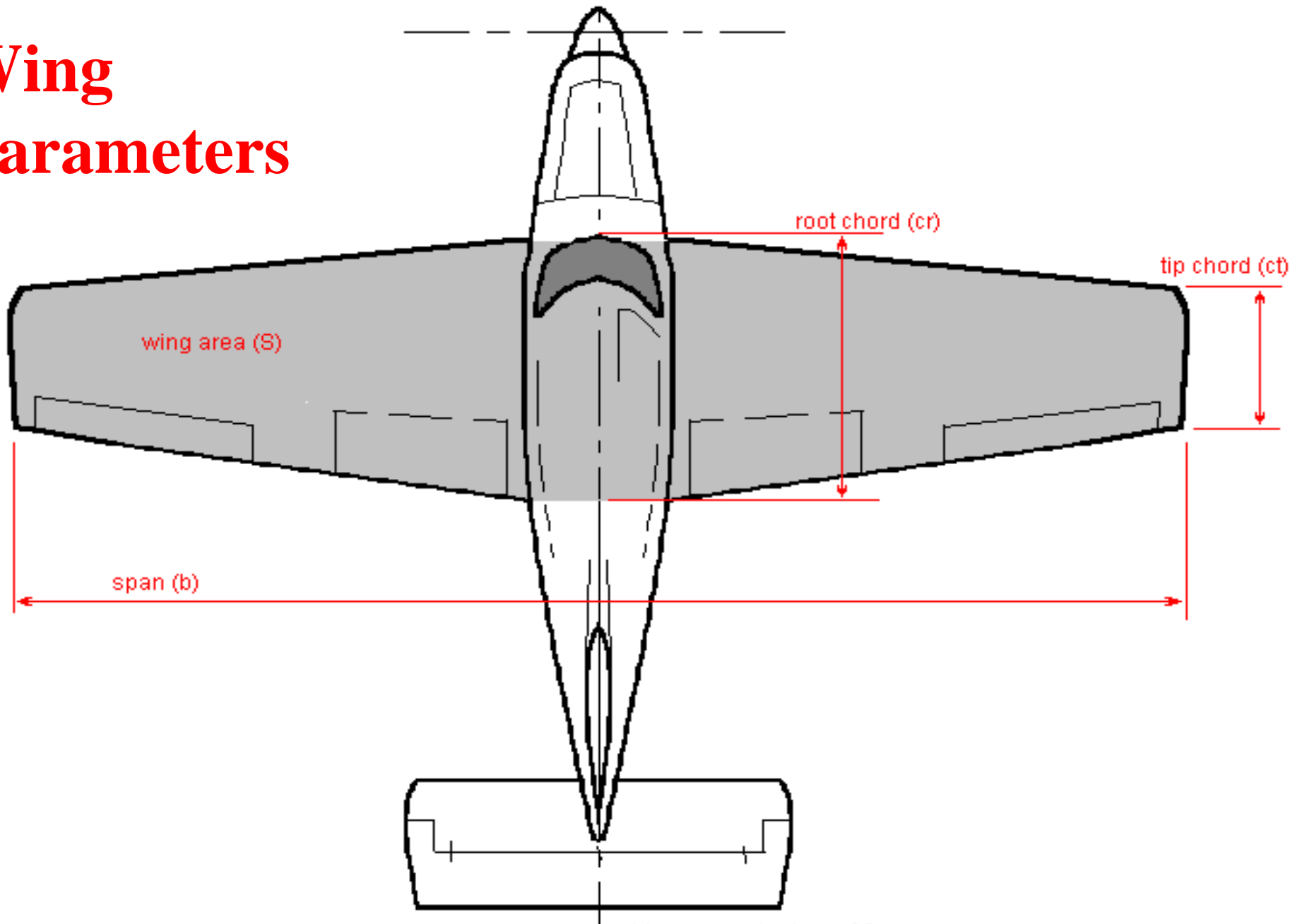


The eagle



The Hornet

Wing Parameters



What about these systems ?

- Open or closed loop?
- regulation or tracking ?
- Identify the control loop elements?



Ready for Questions

