Introduction to fixed wing UAVs:

* Unmanned aerial vehicles have seen increased use in military and civilian applications and consist of fixed wing and multi-rotor categories
* UAVs operate without an on-board pilot and are ideal for tasks that would otherwise put a pilot in harms way (surveillance, damage assessment, surveying natural disasters. . .)
* Fixed wing UAVs ideal for carrying larger payloads in comparison to multi-rotors UAVs
* Small hand launched UAVs
  + Back of a soldier
  + Inexpensive
  + Short range and lower altitude surveillance and damage assessment
  + Battery powered
  + Do not require runway for landing or tack-off
* Large fixed wing UAVs
  + Fly at higher altitudes
  + More expensive in comparison to small hand launched UAVs
  + Carry larger payload
    - Weapons
    - Sensor packages (cameras)
  + Gas powered
  + Require runway to take-off and land
* UAVs are part of an Unmanned Aerial System consisting of:
  + Aircraft itself
  + Autopilot
  + Ground station
  + Two way radio for telemetry
  + Small hand launched UAV
  + transmitter for direct control
* Ground stations are used for constructing missions, configuring, and communicating with UAV
* Missions are built from tasks such as:
  + Point-to-point navigation
  + Loitering
* Flown at constant altitude, 2d paths generated and sent to UAV connecting tasks with primitives
  + Straight line
  + Circular arcs
* Paths are relayed to an autopilot with a two way radio which also collects information on the state of the UAV
* Autopilots receive high level path commands and is responsible for minimizing the tracking error with respect to the reference path
* The autopilot adjusts the state of the aircraft by sending signals to the actuators:
  + Rolling
  + Pitching
  + Yawing
  + Thrust
* An autopilots functions can generally be categorized under one of three categories:
  + Guidance
  + Navigation
  + Control
* Navigation is responsible for measuring, filtering, and estimating the aircrafts state (position, attitude) which closes the feedback loop for guidance and control systems
  + Accelerometers, gyroscopes, barometers, compass 🡪 IMU (attitude)
  + GPS (position)
  + Sensors measurements are not perfect and are subject to noise and sample at different rates
  + Common filter used for combining measurements at different rates and filtering out noise is the kalman filter (probabilistic)
* Control systems are responsible minimizing the difference in state of the vehicle with respect to a reference input
  + Reference input is provided by guidance system
  + Can be a heading, velocity, altitude
  + Any state
* Guidance systems turn high level paths generated at the ground station into reference inputs the control system can use
* Leads into sections on different types of guidance
  + PF
  + Vector field histogram
  + Lyapunov VF
  + Gradient Vector Field