



Project ICAROS Report Code	FR-SE-2016-DEC-07
Title	<i>Flight mechanics</i>
Start/End Date	<i>15-DEC2016/ 16-DEC-2016</i>
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Number and age of students	<i>24 students / 16-18 years old</i>
Description of activities	<p><i>During this session, our students in first year of MEI (industrial equipments maintenance) discover flight mechanics.</i></p> <p><i>First, students review forces involved in the hover flight and dynamic flight of the quadcopter.</i></p> <p><i>Then helicopter torque effect is introduced as well as the device to overcome it : anti-torque tail rotor. We ask them to analyse the origin of this effect on a quadcopter and to find the way to offset.</i></p>
Learning outcomes	<p><i>During this teaching sequence the exam skills practised by the students are :</i></p> <ul style="list-style-type: none"><i>• Appropriating</i><i>• Analysing</i><i>• Communicating</i> <p><i><u>The different abilities associated to the degree framework are :</u></i></p> <p><i>HS1.1 listing the mechanical actions applied on a solid. Drawing and characterizing a mechanical action by a force. Experimentally checking the equilibrium condition of the solid submitted to two or three forces.</i></p> <p><i>HS1.3 Using the torque formula. listing the torques applied on a solid .</i></p>

Flight mechanics

Hovering

The rotation of the blades generates a force that acts against the weight of the craft. That force which is called the lift is the combination of the force of each motor F_1, F_2, F_3, F_4 .

When this force is greater than the weight of the craft, it allows climbing in altitude.

$$Lift = F_1 + F_2 + F_3 + F_4$$

Dynamic flight

The tilt of the craft leads up to a vertical component F_v that counteracts the weight and an horizontal component, the thrust, that lets the quadcopter travel within the air.

Drag is a mechanical force that opposes the motion of the craft through the air.

$$Lift = F_v + Thrust$$

Torque effect on a helicopter

The force applied by the motor to turn the blades generates a torque that tends to rotate the helicopter in the opposite direction.

The craft has an antitorque tail rotor on an horizontal axis that prevents the helicopter from spinning due to the effect of the main rotor.

Example of antitorque <https://www.youtube.com/watch?v=...>

Torque effect on a quadcopter

In the diagram below, describe the dynamic behaviour of the quadcopter.

Suggest a change to cancel out the torque effect.

Photos or other relevant material

Couple induit dans un quadcoptère

Dans la configuration ci-dessous, décrire le comportement dynamique du quadcoptère.

Proposer une modification susceptible d'annuler le couple induit.

Il y a un couple induit qui fait tourner le drone dans l'autre sens.

Seul des moteurs opposés tournent dans le même sens.