Flight Performance & Propulsion (FPP)

Master Weeks 2019

Dr. ir. Gianfranco La Rocca (Track coordinator)
Prof. dr. ir Piero Colonna (Propulsion and Power Chair)
Welcome! on behalf of the PP group!
...and on behalf of the FP group!

Familiar faces?

Prof. dr. ir. L. L. M. (Leo) Veldhuis
Professor
L. L. M. Veldhuis@tudelft.nl

Prof. dr. ing. G. (Georg) Eitelberg
Full Professor (Part-Time)
G.Eitelberg@tudelft.nl

Dr. ir. R. (Roelof) Vos
Assistant Professor
R.Vos@tudelft.nl

Dr. ir. G. (Gianfranco) La Rocca
Assistant Professor
G.LaRocca@tudelft.nl

ir. J.A. (Joris) Melkert
Senior lecturer/educational fellow
J.A.Melkert@tudelft.nl

Dr. F. (Fabrizio) Oliviero
Lecturer
F.Oliviero@tudelft.nl

ir. T. (Tomas) Sinnige
Assistant Professor
T.Sinnige@tudelft.nl
Contents

- Who we are and what we do
- Educational program
- How you can contribute to our research
- Lab facilities
- The ideal FPP student
Who we are and what we do

A unique group of **aircraft designers** and **propulsion specialists** working together to address the future challenges faced by aviation

- 3 Full professors
- 1 Associate professor
- 6 Assistant professors
- 3 Lecturers
- 5 Researchers
- 22 PhD students

- Established in 2013
- Responsible/involved in 18 courses (BSc+MSc)
- About 60 MSc Theses/year
Expertise Flight Performance – a few examples

- Unconventional aircraft design
- Propeller wing interaction
- Flight mechanics of advanced systems
- Hybrid electric propulsion
- Advanced design methodologies
- Scaled flight testing
Expertise Power and Propulsion – a few examples

- Hybrid aircraft engines
- Unconventional turbomachinery
- NICFD experiments
- ORC and scCO2 turbogenerators
- Mini turboprop for UAV
- Clean Combustion for GT
Contents

• Who we are and what we do
• Educational program
• How you can contribute to our research
• Lab facilities
• The ideal FPP student
Educational program

• Overall structure
• Courses (core, profile, elective)
• Internship
• Graduation project
Overall structure

Ideal planning

- **Overall Track structure**
  - Courses
  - Internship
  - Graduation project

- **Courses**
  - Periods 1-3

- **Internship**
  - Period 4

- **Literature study + research methods**
  - Period 5

- **Thesis**
  - Periods 6-8

- **2 years**
Overall structure

Alternative option to cope with late internship

- **Courses**
  - Periods 1-3
  - Period 4: Literature study + research methods
  - Period 5: Internship
  - Periods 6-8: Thesis

2 years
Overall structure

1. Track (FPP, Track 5)
2. Profiles: FP & PP

Profile I
Flight Performance (FP)

Profile II
Power and Propulsion (PP)
## Courses – Flight Performance Profile (FP) Profile I

<table>
<thead>
<tr>
<th>Flight Performance profile (Profile I)</th>
<th>Code</th>
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<td>AE5211</td>
<td>Thesis Flight Performance &amp; Propulsion</td>
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<td><strong>Profile Courses</strong></td>
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Courses - Power and Propulsion profile (PP)
Profile II

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<td>Internal flows</td>
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<td>Combustion for propulsion and power technologies</td>
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<td>Modeling, Simulation and Application of Propulsion and Power Systems</td>
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<td>ME45000</td>
<td>Advanced Heat Transfer</td>
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Overall Track structure
Courses
Internship
Graduation project

Mandatory!
Courses – Electives (preferred & free)

- FP and PP have each a list of preferred electives
- The list of FP preferred electives includes all PP profile courses and vice versa

### Flight Performance profile (Profile I)

#### Preferred Elective courses

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<td>Experimental Simulations</td>
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<td>AE4120</td>
<td>Viscous Flows</td>
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<td>AE4135</td>
<td>Rotor / wake Aerodynamics</td>
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<td>AE4136</td>
<td>CFD 2: Discretization Techniques</td>
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<td>AE4139</td>
<td>CFD 3: Large Eddy Simulation</td>
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<td>AE4138-18</td>
<td>CFD 4: Uncertainty Quantification</td>
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<tr>
<td>AE4140</td>
<td>Gas Dynamics</td>
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<td>AE4180</td>
<td>Flow Measurement Techniques</td>
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<td>AE4206</td>
<td>Turbomachinery</td>
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<td>AE4260A</td>
<td>Fundamentals of Aeroacoustics</td>
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<tr>
<td>AE4260B</td>
<td>Experimental Applications of Aeroacoustics</td>
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<td>AE4261</td>
<td>Internal Flows</td>
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<td>AE4262</td>
<td>Combustion for the Analysis of Nuclear Reactors</td>
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<tr>
<td>AE4263</td>
<td>Modeling: Flow and Heat Transfer and Propulsion</td>
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<td>Automatic Control System Design</td>
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<tr>
<td>AE4301P</td>
<td>Exercise Automatic Flight Control System Design</td>
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<td>AE4314</td>
<td>Rotorcraft Mechanics and Design</td>
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<td>AE4314P</td>
<td>Helicopter Performance, Stability and Control</td>
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<td>Advanced Dynamics</td>
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<td>AE4411</td>
<td>Aircraft noise and emissions</td>
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<tr>
<td>AE4462-17</td>
<td>Aircraft Emissions and Climate Effects</td>
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<td>AE4463-17</td>
<td>Advanced Aircraft Noise Modeling and Measurement</td>
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<td>AE4465M03</td>
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<td>ET4117</td>
<td>Electrical Machines and Drives</td>
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<td>ME46060</td>
<td>Engineering Optimization; Concepts and Applications</td>
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<td>ME46500</td>
<td>Advanced Heat Transfer</td>
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### Power & Propulsion profile (Profile II)

#### Preferred Elective courses

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<td>ME43310</td>
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</table>
Courses – summary

Flight Performance (FP)
- 5 ECTS
- Track 5
- Profile FP

Power&Propulsion (PP)
- 86 ECTS
- Track 5
- Profile PP

Elective
- Preferred electives
  - Specific FP
  - Profile PP

Elective
- Preferred electives
  - Specific PP
  - Profile FP

Free electives

Overall Track structure:
- 5 ECTS
- 86 ECTS
- Total ≥ 120 ECTS

FP: ≥ 15 ECTS
PP: ≥ 11 ECTS

Prescribed

Your choice*

Courses
Internship
Graduation project
Special courses: AE4ASM517 Aircraft

- Build a real, to be certified Van’s RV12 aircraft
- Everything, from planning to certification, done by students
- Team of ~15 students,
Courses - Where to find detailed information?

Course descriptions:
- www.studyguide.tudelft.nl

Tip:
- Check on our website the suggested preparation for period 1 courses
Internship

“Learn and explore” to acquire different skills than those taught at university

| 80% abroad: 45% EU + 35% non-EU | 18 ECTS – 12 weeks full time | Cultural shock of the real work environment |
Graduation project

- (Research methodologies)
- Literature study (12 ECTS)
- Thesis (42 ECTS)  
  \[= \text{54 ECTS}\]
FPP graduation projects are diverse in nature to satisfy the ambitions and fit the skills of different students

- All provide a good balance of basic science and applied technology
- Some are more conceptual design oriented
- Some are more computational and simulation based
- Some focus on the system to be designed
- Some focus on the enabling design methods
- Some require an experimental approach
- Most of them are a combination of the above
Contents

• Who we are and what we do
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• **How you can contribute to our research**
• Lab facilities
• The ideal FPP student
Thesis research topics examples

Airframe - Propulsion integration

Objective
Development of design and analysis capability for novel propulsion system integration

- Hybrid electric propulsion
- New generation propellers
- Interaction with wing and/or fuselage
- Effects of non-uniform inflow (incl. BLI)
- Distributed propulsion
- Integration in AC design framework
- Integration in experimental settings

Methods
CFD, KBE, Experimental (wind tunnel, propulsion lab, scaled flight lab)
Thesis research topics examples

**Aircraft design support frameworks**

**Objectives:**
Development of computational systems to
- Support the synthesis of conventional and novel aircraft configurations
- Accelerate the use of (high fidelity) simulations in design
- Enable multidisciplinary design analysis and optimization (MDAO)
- Reduce cost of engineering
- Support collaborative design

**Methods:**
KBE, MDO, general purpose programming
Thesis research topics examples

*Flight mechanics of complex systems*

**Objectives**
Flying qualities investigation of novel fixed wing aircraft configurations
- Automatic generation of flight mechanics simulation models to support multidisciplinary design optimization
- Development of control allocation strategies for redundant movable surfaces
- Dynamic scaled flight testing

**Methods**
Multibody dynamics, multi physics simulation, MDO, experimental
Thesis research topics examples

*Hybrid aircraft engines for multi-fuel aircraft*

- LNG/LH2 Main Combustor
- Kerosene/Biofuel Secondary Flameless Combustor
- Bleed cooling by LH2
- Counter rotating shrouded fans
- Higher Specific Thrust
- Low Installation Penalty
Thesis research topics examples

Aircraft environmental control systems (ECS)

- **Today**: air cycle system → light, but low efficiency
- **Tomorrow**: inverse Rankine cycle system (vapor compression)
- High-speed centrifugal compressor (>200 krpm!)
- Need for several special HX’s
- Applications: small jets, helicopters, future long-haul aircraft

air cycle machine on a Boeing 737
Thesis research topics examples

**ORC and scCO2 turbogenerators**

- Waste-heat recovery for mobile applications
- Unconventional turbomachinery
- CFD analysis of supersonic flows of dense vapors
- Automated shape optimization
Contents

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FPP lab facilities

The Clean Combustion Lab &
the Laser Diagnostic and Remote Sensing Lab

Propulsion lab

Wind tunnels
(in cooperation with Aero)

Aircraft Manufacturing Lab
(in cooperation with Aerospace Structures and Material)

Scaled Flight Testing Lab
FPP lab facilities

Propulsion lab
Wind tunnels
(in cooperation with Aero)

Aircraft Manufacturing Lab
(in cooperation with Aerospace Structures and Material)

Scaled Flight Testing Lab

The ORCHID test rig
FPP lab facilities

Propulsion lab

Wind tunnels
(in cooperation with Aero)

Aircraft Manufacturing Lab
(in cooperation with Aerospace Structures and Material)

Scaled Flight Testing Lab
FPP lab facilities

Propulsion lab

Wind tunnels
(in cooperation with Aero)

Aircraft Manufacturing Lab
(in cooperation with Aerospace Structures and Material)

Scaled Flight Testing Lab
FPP lab facilities

- Propulsion lab
- Wind tunnels (in cooperation with Aero)
- Aircraft Manufacturing Lab (in cooperation with Aerospace Structures and Material)
- Scaled Flight Testing Lab
Contents

• Who we are and what we do
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The ideal FPP student

*Suitable profile*

- Passion for aircraft design and/or propulsion and/or their integration
- Will to make an impact on future sustainable aviation
- Multidisciplinary mind
- Able to go deep without losing the big picture
- Solid understanding of flight physics and thermodynamics
- Solid background in mathematics
- Good programming skills
- Proactive and able to work independently
- Interest in experimental work (optional)
Questions? Interest?

Come and visit our stand on Friday!

**Master Weeks March 2019**

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<th>Wednesday 06/03</th>
<th>Thursday 07/03</th>
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<td>Aerodynamics Wind Energy</td>
<td>Control Operations</td>
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**15/03 Master Drink**

17:30 - 20:00 // AE Faculty Main Hall

*Do not forget to register for the Master Drink via bit.ly/masterweeks*

**DON'T FORGET TO REGISTER!!**
Points of contact

FPP Master Track Coordinator
Dr. ir. Gianfranco La Rocca
G.LaRocca@tudelft.nl
+31 (0) 15 278 5384
Office: LR7.21

Profile Coordinator Power and Propulsion
Dr. ir. Arvind Gangoli Rao
A.GangoliRao@tudelft.nl
+31 (0) 15 278 3833
Office: LR7.13

FPP website: fpp.lr.tudelft.nl  Brightspace: Track 5 FPP