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**BUILD YOUR OWN GAS TURBINE PERFORMANCE MODEL FROM SCRATCH**

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**AUDIENCE**

Engineers and engineering students interested in design, system simulation and off-design performance prediction and analysis of aircraft propulsion and power systems.

**TUTORIAL DESCRIPTION**

Many (young) engineers are confronted with challenges concerning design and performance prediction of innovative sustainable propulsion and power systems. While there are several comprehensive modelling and simulation tools available for gas turbine engines, there is a need for new functionalities focused on sustainable hybrid systems, either in existing tools or new tools built from scratch. For the user of these tools, the tutorial provides insight in how gas turbine and propulsion system performance models work. For the developer, it provides a guideline to start developing comprehensive modelling tools using PYTHON, which currently is the dominant young engineer’s programming language of choice. The PYTHON source code of a case study will be provided as shareware via GitHub.

**TUTORIAL LEARNING OBJECTIVES**

The aim of the tutorial is to provide a basic understanding of system modelling as applied to predict and analyse propulsion system performance. This involves the identification of key system components, model variables, thermodynamic relationships, parameters and equations, and numerical methods. In addition, software architecture aspects are considered with a focus on object orientation for optimal flexibility to address different system configurations. While the examples and case studies are focused on gas turbine systems, the methodology is equally applicable to more complex hybrid systems.

The participants completing the tutorial will be able to:

* define and describe the basic elements and equations at work in a propulsion and power system model
* understand the potential and limitations of these models for various applications
* avoid the common pitfalls
* understand the basics of object orientation and its benefits for system simulation
* *and last but not least ! : develop a simple gas turbine performance model in PYTHON from scratch*

**CONTENT AND OUTLINE**

1. Introduction
   1. Propulsion and power system performance prediction and analysis
   2. Modelling and simulation tools
   3. Tools required for future propulsion and power system concepts
2. System performance modelling
   1. System models for propulsion and power systems
   2. Equations, variables and parameters
   3. Numerical methods
3. Gas turbine performance system models
   1. Design versus off-design simulation
   2. Component models
      1. Maps and map scaling
   3. Transient/dynamic simulation
4. Hybrid systems
   1. Fuel cells
   2. Batteries
   3. Generators
   4. Electric motors
   5. Electric power converters
5. Software implementation aspects
   1. Structural programming
   2. Object orientation
      1. Benefits for system modelling
      2. Encapsulation, inheritance and polymorphism
6. Case study: jet engine python model
   1. Component models
   2. Turbomachinery maps and scaling
   3. Gas properties model
   4. Defining the equations and state variables
7. Concluding remarks

**REFERENCES**

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