Project 6 – Design of a military turbofan

6.1 Context and objectives

The aim of this project is to study practical as well as theoretical limits that apply to the engine designer's work.

You are working for an aircraft engine manufacturer which is developing an afterburning turbofan engine to power a combat airplane. The engine is to meet stringent thrust and fuel consumption requirements.

Based on calculations as well as your best judgment,

- Draw the layout of an engine that is able to meet the requirements;
- Calculate the maximum thrust, SFC, thermal and propulsive efficiencies of the engine running dry;
- Calculate the same parameters when the engine is running with afterburner.

Your mark will be based on the clarity of your work and the validity of your calculations. You may use any tool you wish (e.g. software, books), but you are required to quote all of your sources.

Groups handing in written reports must hand in one single printed or PDF (A4-size) document, no longer than 8 pages.

Groups making an oral presentation must aim for less than 15 minutes (all members participating), and then answer questions from the class. Please hand in your slides as a print-out or PDF file.

6.2 Overall requirements

The aircraft geometry limits the maximum mass flow delivered to the engine to 60 kg s^{-1}.

The two main design requirements are

1. To have a high overall efficiency during dry operation;
2. To provide a maximum wet thrust of 70 kN.

6.3 Engine components

The pressure to reduce manufacturing costs and development time leads you to chose existing, "off-the-shelf" components for the engine core:

- Overall compression total pressure ratio: $OPR = 30$
- Fan total pressure ratio: $FPR = 5$
- Turbine entry temperature: $TET = 1500\,\mathrm{K}$
- Turbine entry speed: $C_{TE} = 200\,\mathrm{m\,s^{-1}}$

For the sake of simplicity, all of the engine components can be assumed to be ideal.

The engine will run on standard fuel with heat capacity $c_{fuel} = 33\,\mathrm{MJ\,kg^{-1}}$.

6.4 Ambient conditions

The reference values for atmospheric flight conditions are:

- Mach number: $M = 0.6$
- Pressure: 0.26 bar
- Temperature: −50 °C