**ESCOLA TÈCNICA SUPERIOR D'ENGINYERIES INDUSTRIAL I AERONÀUTICA DE TERRASSA**

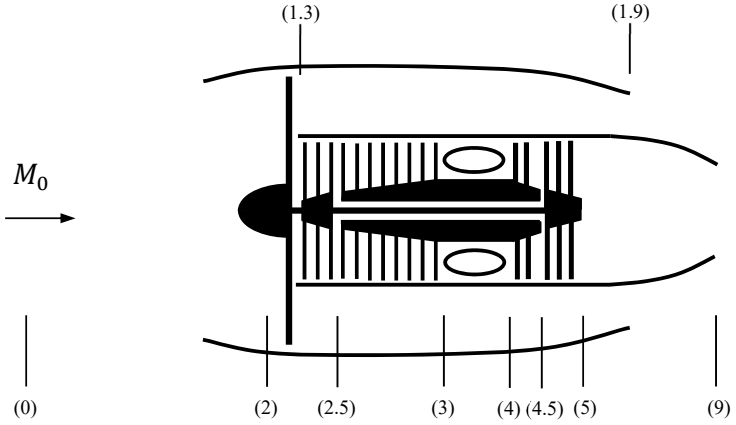
Grau en Enginyeria en
Tecnologies Aeroespacials
Propulsió, curs 2019 – 2020

# PROJECT

Team-Work (maximum 4 people)
Deadline: May 21st 2020

## Description

Consider a too-spool turbofan with convergent nozzles, as depicted in the figure below, and the operational condition of cruise at $M_0 = 0.85$ and 11000 m.




The following component efficiencies will be assumed:

| $\pi_d$ | $\eta_f$ | $\eta_{LPC}$ | $\eta_{HPC}$ | $\pi_b$ | $\eta_b$ | $\eta_{HPT}$ | $\eta_{LPT}$ | $\eta_{mH}$ | $\eta_{mL}$ |
|---|---|---|---|---|---|---|---|---|---|
| 0.98 | 0.89 | 0.88 | 0.86 | 0.96 | 0.99 | 0.91 | 0.92 | 0.993 | 0.997 |

Assuming a turbine inlet temperature $T_{t4} = 1450\ K$, and the air, gas and fuel properties $\gamma_c = 1.4$, $\gamma_t = 1.3$, $R_g = 287$ J/(kg K), $h = 43$ MJ/kg, the following is requested:

1. Find a set of parameters $\alpha$, $\pi_f$, $\pi_{LPC}$, $\pi_{HPC}$ that give reasonably good values of both the specific thrust $F/\dot{m}$ and specific impulse $I_{sp}$.
2. Analyze and plot the sensibility of $F/\dot{m}$ and $I_{sp}$ to small variations of each parameter in a range about its nominal value, keeping constant the rest of them.
3. According to the results of question 2), select a new set of values for $\alpha$, $\pi_f$, $\pi_{LPC}$, $\pi_{HPC}$, and compute the gain of $F/\dot{m}$ and $I_{sp}$.
4. Compute the gain of $I_{sp}$ that would be obtained if any of the nozzles (or both) is modified in order to achieve both exhaust flows matched to ambient pressure.
5. If all the parameters are kept constant, except for the fan pressure ratio $\pi_f$, that is free to vary in a certain range, compute the propulsive efficiency $\eta_p$ and the exhaust velocities of each flow $u_9$ and $u_{19}$ as a function of $\pi_f$, considering both nozzles matched to ambient pressure, as done in question 4).