

Problem Set #C: Engine Component Analysis

- Homework solutions should be neat and logically presented, see format requirements at <http://seitzman.gatech.edu/classes/ae4451/homeworkformat.html>.
- If appropriate, include a **sketch** of the flow/system, and indicate clearly your choice of **control surface**.
- Always indicate any **assumptions** you make. If you use any results or equations from the class notes or text in your solutions, please note and **reference** them (but you better be sure they are applicable to the problem at hand).
- Try to **solve** the problem **algebraically** first. If possible, only use numbers/values in the final steps of each solution.

1. Aircraft Engine Inlet Design

You have been tasked with the preliminary design of the engine inlet for a turbojet engine. You have been given two flight conditions and the required air mass flow rate through the engine at each flight condition.

Flight Condition	Flight speed (m/s)	Ambient p (atm)	Ambient T (C)	Air Mass Flowrate (kg/s)
Takeoff MaxPower	0	0.970	20.0	89.32
High Alt. MaxAccel	273	0.269	-46.1	38.12

Determine the corrected mass flow rate at each of these flight conditions. Also provide a reasonable estimate of the proper front plane (entrance) and back plane (exit) cross-sectional areas for the engine's inlet (i.e., diffuser) assuming a maximum allowable Mach number of 0.79 at the front plane and 0.50 at the back plane.

2. Compressor Stage Performance

Consider the 1st stage of the axial LPC for an aircraft engine. At an operating condition where the stagnation temperature and pressure entering the compressor are 305 K and 77.6 kPa, and the inlet axial air velocity is 142 m/s, 46.8 kg/s of air enters the stage with a swirl angle of 40.1°. At this condition, the stage's flow coefficient is 0.547 and its loading coefficient is 0.431. Furthermore, the mean radius of the rotor is 0.314 m.

What are the rotational speed (in rpm) of the stage's rotor and the power (in kW) required to turn the rotor?

For a stage efficiency of 90.67%, what are the stagnation pressure and stagnation temperature exiting the stage?