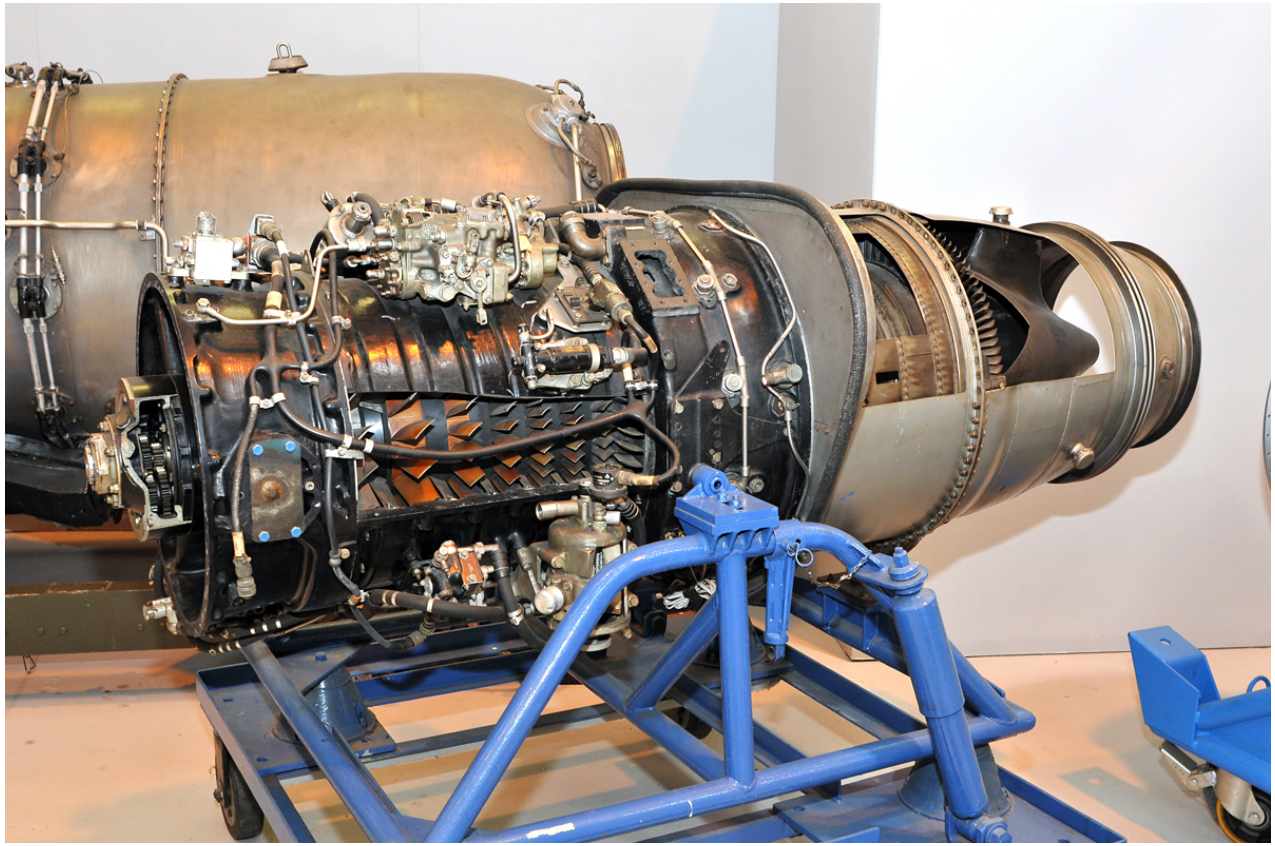
Assignment Description

Conceptual design and operation of the axial compressor of the RR Viper engine

Main Objective

To determine performance of Rolls-Royce turbojet VIPER engine and design the engine axial compressor



[Courtesy of RR]

Performance of Viper Engine on a Sea-Level Test Bed

Engine parameters on a sea-level test bed	
Gross thrust (measured)	15167 N
Air mass flow rate	23.81 kg/s
Fuel mass flow rate	0.4267 kg/s
Total compression ratio	5.5
Sea-level conditions	T0 = 288K, P0 = 1 bar

NB: assume proper values of efficiency for turbomachines, assume that efficiency of combustor and that of the propulsive nozzle is 1

Deliverables

1. Compute engine performance on test-bed assuming choked turbine and propulsive nozzle
   - Is the propulsive nozzle choked?
   - What is the turbine to propulsive nozzle area ratio?
2. Compute engine performance on the sea-level test bed at off-design conditions (TIT=900K)
   - Is the propulsive nozzle choked?
   - What is gross thrust of the engine
3. Compute engine performance in flight-cruise conditions (M=0.78, 35000ft, TIT=1150K)
   - Is the propulsive nozzle choked?
   - What is gross thrust of the engine?
4. Make the conceptual design of the axial compressor

Rules of Engagement of the Assignment

1. This is a group assignment. The ideal number of group members is **3**. Groups of 2 people are in any case allowed.
2. The final product is a **short** report (no more than **5 pages**)
3. The report must contain the following:

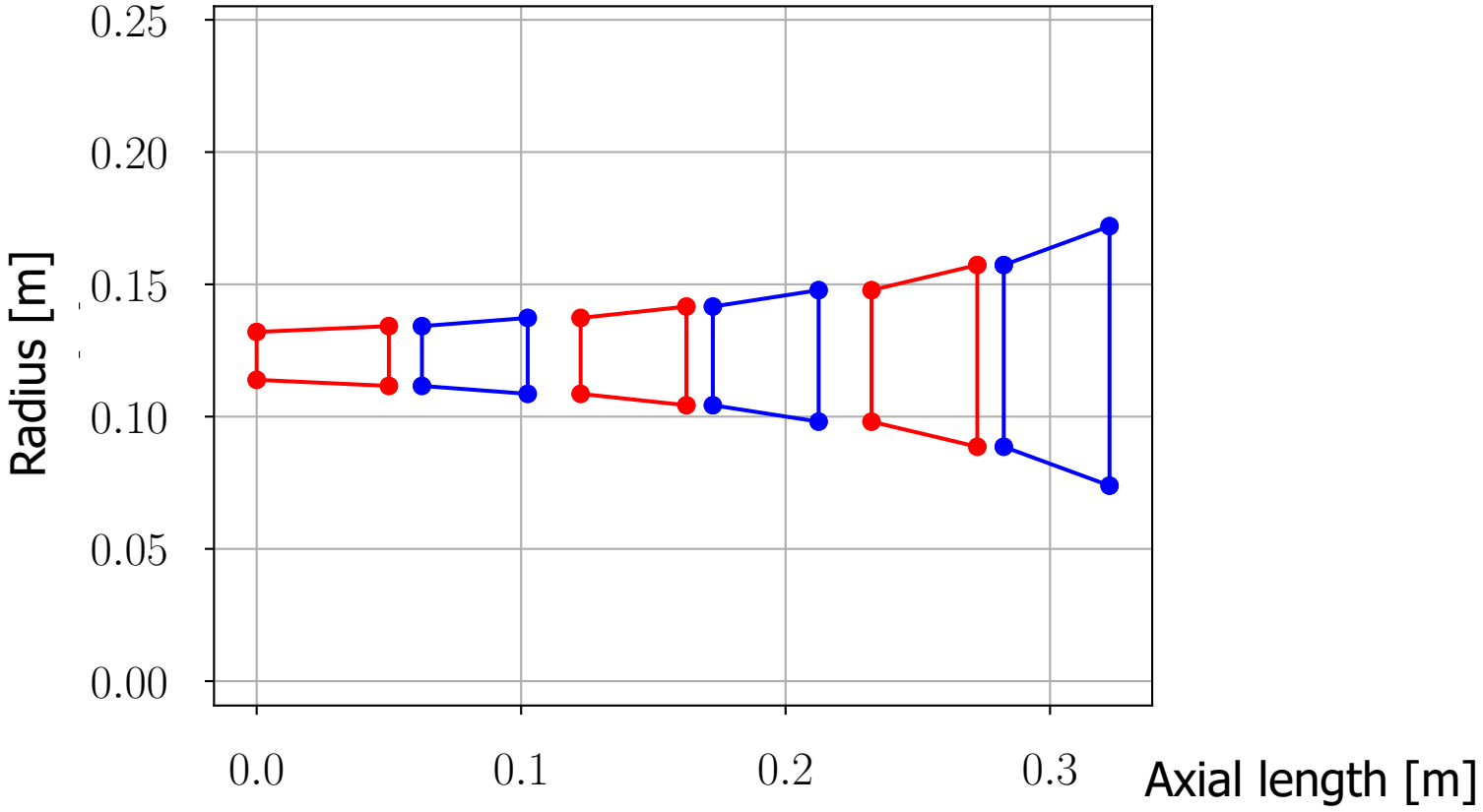
   - Deliverables 1-3: engine operating conditions, mass flow through engine, and answer to questions in slide 4
   - Deliverable 4: problem statement, assumptions (e.g. perfect gas, adiabatic machine, etc.), explanation of design choices and design procedure, results: meridional gas-path, velocity triangles, *h-s* diagram, aero-thermal flow properties along gas path in dimensionless form, e.g., $\frac{P}{P_{t0}}, \frac{P_t}{P_{t0}}, \frac{T_t}{T_{t0}}, \beta_{stage}$
   - Conclusions: what are the main take-aways? Present them shortly and in the form of max 3/4 bullet points.

Rules of Engagement for the Assignment

4. The due date for the delivery is **30/10/2022 (midnight)**. The pdf, along with the mathematical/numerical calculations (source code or Excel sheet), must be submitted via Brightspace. **Please make a single .zip folder** containing the report in pdf format (any other format will not be accepted) and your calculation sheets (e.g. a single Excel sheets or Matlab/Python scripts).

5. After the delivery, the lecturers can randomly ask a group to give a presentation to explain the results of the assignment. In case a group member shows little awareness of the project contents, this will be considered as a failure for the entire group.

Example of Meridional Gas-Path



Example of Aero-Thermal Flow Properties along Gas Path