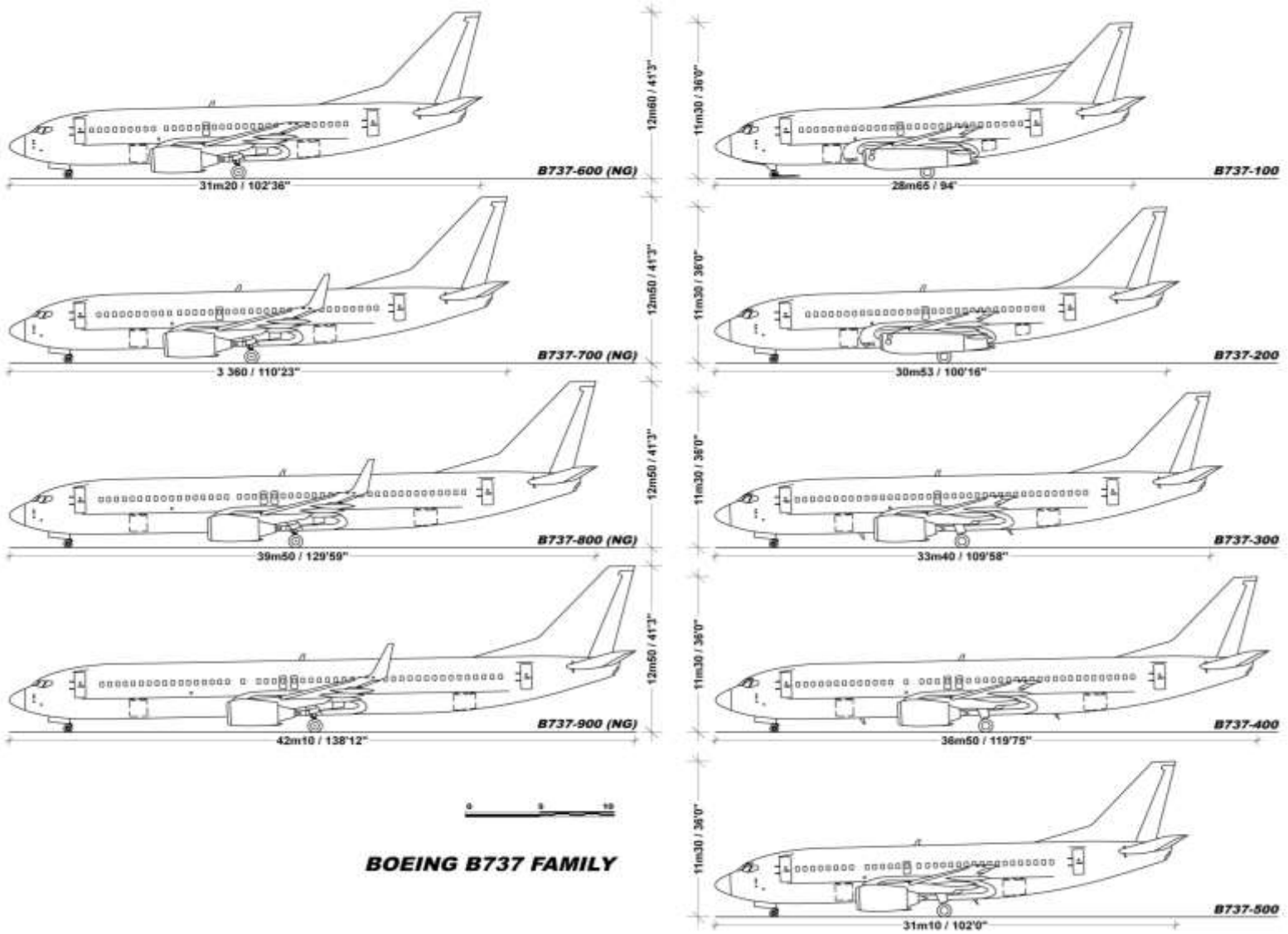
AE4238: Aero Engine Technology Assignment -1

The Boeing 737 family



B737-100

PW-JT 8D
Boeing 737

Boeing B-737 Max

CFM LEAP-1B

P&W JT8D & Leap 1B during cruise

Parameters		JT 8D	Leap-1B
Bypass Ratio	-	1.62	8.6
Core Mass Flow Rate, corrected kg/s		90.2	50
Fan Pressure Ratio		1.9	1.5
HPC Pressure Ratio		3.5	10
Turbine Inlet Temperature	°K	1150	1450
Overall Pressure Ratio		17	40
Fan, LPC & HPC Isentropic Efficiency		0.85	0.92
LPT and HPT Isentropic Efficiency		0.88	0.92
Combustor Efficiency		0.985	0.995
NR. OF STAGES IN COMPRESSOR / TURBINE		2+6+7 / 1+3	1+3+10 / 2+5
DIAMETER	m	1.25	1.75

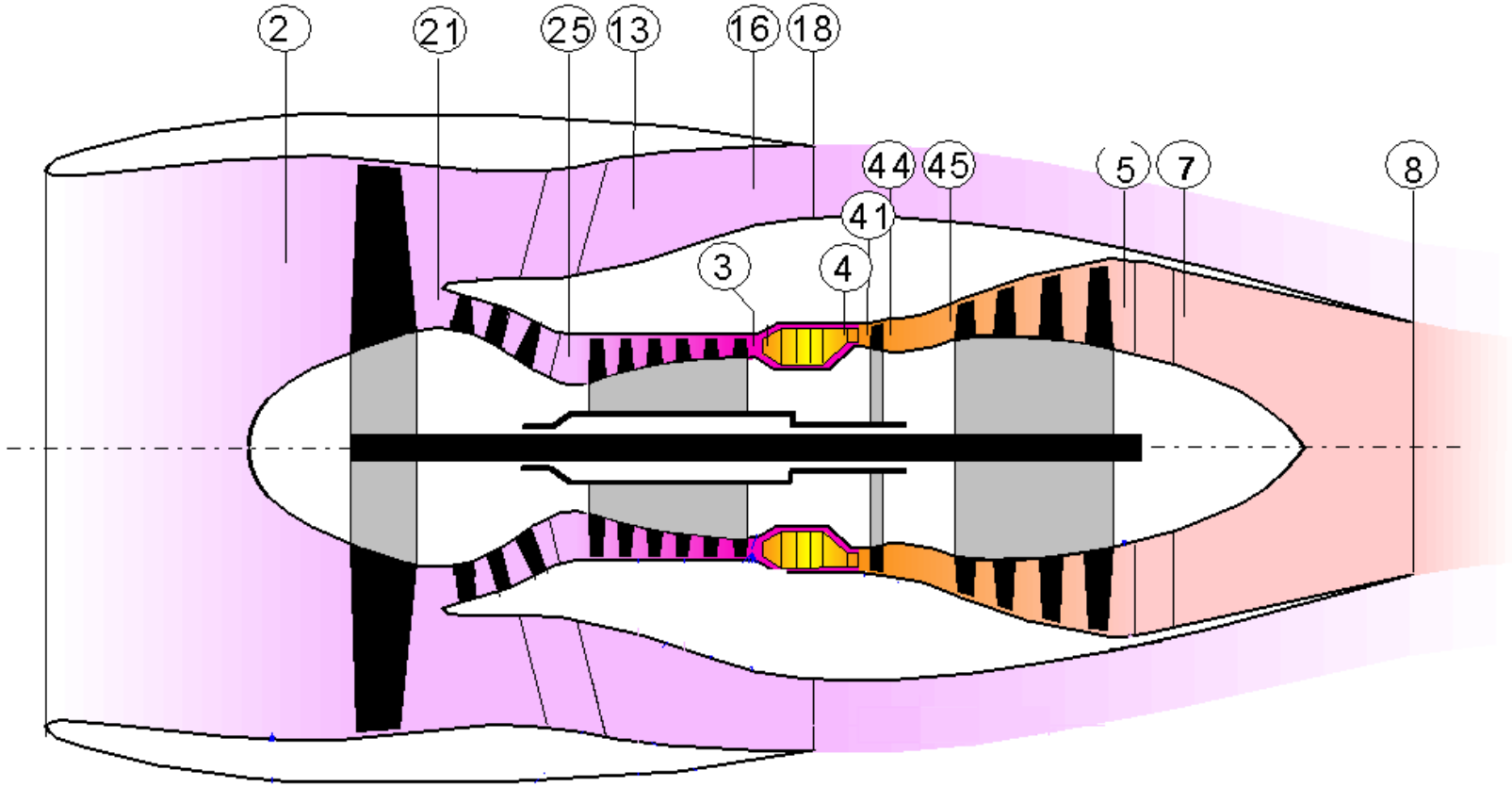
Assignment-1

General characteristics

Type: two spool turbofan Engine
Nozzle= Convergent
Intake Isentropic Efficiency = 0.99
Mechanical efficiency = 0.99
combustor pressure ratio = 0.96
Nozzle efficiency = 0.99

Ambient Temp. = 220 K
Altitude = 10668m
Mach number =0.78
Ambient Press. = 23842 Pa
Gas constant= 287 J/kg K
Fuel calorific value (LHV) = 43MJ
CP air = 1000; *kappa air* = 1.4
CPgas = 1150; *kappa gas* = 1.33

Turbofan Nomenclature



Various Efficiency

chem. energy

$$\eta_{comb} = \frac{\dot{m} \cdot c_p \Delta T_{comb}}{\dot{m}_f LHV_f}$$

heat

$$\eta_{thdy} = \frac{P_{gg}}{\dot{m} \cdot c_p \Delta T_{comb}}$$

gas power

$$\eta_{jet.gener.} = \frac{\Sigma \left\{ \tfrac{1}{2} \dot{m} \left(v_j^2 - v_o^2 \right) \right\}}{P_{gg}}$$

kin. energy

$$\eta_{prop} = \frac{\Sigma \left\{ \dot{m} \left(v_j - v_o \right) \right\} v_o}{\Sigma \left\{ \tfrac{1}{2} \dot{m} \left(v_j^2 - v_o^2 \right) \right\}}$$

Thrust

Please note that these efficiencies are valid for an unchoked nozzle

$$\eta_{thermal} = \frac{\Sigma \left\{ \tfrac{1}{2} \dot{m} \left(v_j^2 - v_o^2 \right) \right\}}{\dot{m}_f LHV_f}$$

$$\eta_{total} = \frac{\Sigma \left\{ \dot{m} \left(v_j - v_o \right) \right\} v_o}{\dot{m}_f LHV_f}$$

Assignment-1

1. Calculate the various efficiency mentioned in the Sankey.
2. Draw a relevant Sankey diagram for the two engines, PW-JT8D and Leap 1B.
3. Write a paragraph or so on how the losses depicted in the Sankey diagram could be reduced.
4. Draw specific conclusions from the exercise above (in bullets).

Instructions

1. Make a report on the assignment.
2. The report should contain at least the following parts
   - Problem description
   - Assumptions
   - Procedure
   - Results & observations
   - Conclusions & outlook
3. The report should be handed in on /before 9th Dec 2024 23:00 CET
4. You can do this assignment in a group of two or as an individual.
5. Please restrict the number of pages to 8 (excluding appendix).
6. Attach your code as an appendix.
7. You can use any programing language of your choice.
8. Use the standard station numbering.
9. Please submit your assignment on Brightspace.
10. In case if we find elements of plagiarism in the assignments, students would be reported to the board of examiners.