Problem 1.

A turbo-propeller-driven aircraft is flying at V_0 = 150m/s and has a propeller efficiency of η_{pr} = 0.75. The propeller thrust if F_{prop} = 5000N and the airflow rate through the engine is 5kg/s. The nozzle is perfectly expanded and produces 1000 N of gross thrust. Calculate

(a) The shaft power delivered to the propeller in kW
(b) The nozzle exit velocity in m/s (neglect fuel flow rate in comparison to the air flow rate)
(c) In using this, $\eta_p \equiv \dfrac{F \cdot V_0}{\wp_s + \Delta \dot{KE}}$, first show that the contribution of the net kinetic power produced by the engine $\Delta \dot{KE}$ is small compared to the shaft power $\wp_s$ in denominator of this Equation. Second, estimate the propulsive efficiency η_p for the turboprop engine from this equation.

Problem 2.

For the turbofan engine shown, calculate

(a) ram drag D_{ram} in kN
(b) primary nozzle gross thrust F_{g9}, in kN
(c) fan nozzle gross thrust F_{g19}, in kN
(d) the engine net thrust F_n, in kN
(e) the propulsive efficiency η_p (—)

Hint: To calculate the pressure thrust for the primary and fan nozzles, you may calculate the flow areas at A_9 and A_{19} using the mass flow rate information as well as the density that you may calculate from pressure and temperature (via the speed of sound) using perfect gas law.