

**Problem P1.** (Propulsion)

- a. Consider a turbojet powered aircraft during landing with the throttles set to some fraction of that required to achieve take-off thrust. As the aircraft is rolling down the runway at 60m/s, the engine consumes 150kg/s of air and produces an exhaust jet velocity of 200m/s.

What is the thrust of the engine? (Assume that the exhaust jet is ideally expanded and that the mass flow rate of fuel is small compared to the mass flow rate of the air.)

- b. Now suppose that the pilot engages the thrust reversers which deflect the engine exhaust normal to the direction of travel (say half up and half down) without affecting the operating condition of the engine.

What is the magnitude and direction (i.e. forward or reverse) of the thrust produced by the engine?

- c. With the thrust reversers still engaged, the aircraft comes to a stop on the taxiway. The engine is now consuming 80 kg/s of air and producing an exhaust velocity of 150 m/s.

What is the magnitude and direction (i.e. forward or reverse) of the thrust produced by the engine?

- d. You are asked to design some of the vanes used in the thrust reverser. Estimate the vertical forces (y-direction) on the turning vanes as a function of the variables shown. (Assume steady flow and no acceleration of the vehicle.)

