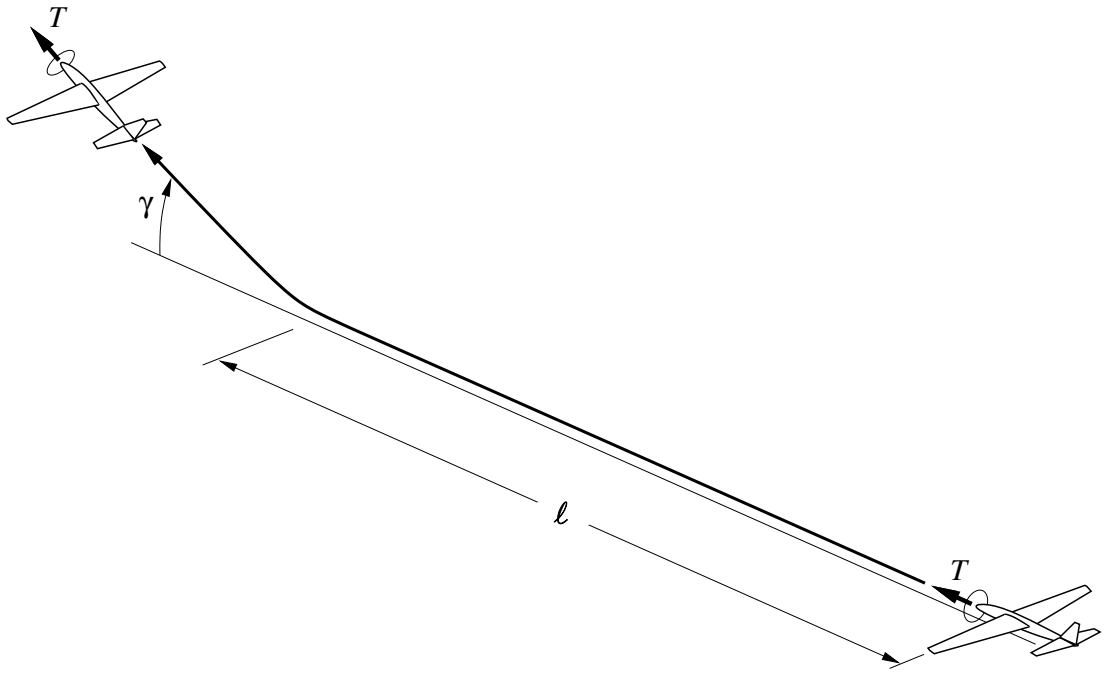
Aerospace Systems Engineering (ASE) Field Exam 2018

During the oral portion of the field exam, students will respond to questions on the ASE core content and also their chosen ASE elective topic.

1. This problem will examine some theoretical limits on the takeoff performance of a Short Takeoff or Landing (STOL) aircraft.



   (a) Determine the upper limit on the dynamic pressure q available for lift, as a function of the takeoff run distance ℓ, the aircraft's thrust/weight ratio $\tau \equiv T/W$ and rolling resistance coefficient μ, and any number of physical parameters.

   (b) Determine the minimum takeoff distance ℓ required to achieve liftoff, as a function of the available takeoff lift coefficient $C_{L_{TO}}$, the wing loading W/S, and any of the parameters in the previous question.

   (c) The initial climbout of an STOL aircraft typically occurs at a high C_L, in which case the induced drag dominates and we can assume $D \simeq D_i$. Using this approximation, estimate the maximum achievable steady climb angle γ as a function of the span b, the span efficiency e, and any of the previous parameters.

   (d) Using your relations, identify the important aircraft parameters required to achieve a successful takeoff which meets some minimum distance requirement, $\ell \leq \ell_{\min}$.

   (e) The above analysis assumed some specified thrust value T. In reality, the available thrust depends on any number of physical and operating parameters. Explain how the analysis might be improved if the propulsor is
   i) a rocket
   ii) a turboprop
   iii) an electric prop.

   (f) The aspect ratio choice for a conventional transport aircraft is typically driven by a tradeoff between structural weight and induced drag, and one definition of the optimum aspect ratio is the one which gives a minimum fuel burn in cruise.

   Explain what competing tradeoffs will determine the optimum aspect ratio for an STOL aircraft whose primary requirement is short-takeoff performance (and not cruise fuel burn).