1. Consider the Couette flow of a two-dimensional liquid between two parallel plates placed at a distance D. The top plate is moving at a velocity U_0.

(i) Derive the velocity distribution of the flow $u(y)$;

Consider next the heat transfer from the wall to the liquid in the case where the fluid and wall temperature is T_0 everywhere upstream of $x = L$. The wall temperature alone is raised to $(T_0 + \Delta T)$ downstream of $x = L$. Let δ_T be the thermal boundary layer thickness of the thin liquid region in which the wall heating effect is felt.

(ii) Using scale analysis, find the order of boundary layer thickness δ_T immediately downstream from $x=L$ as a function of D and x

(iii) Determine the variation of δ_T in the liquid film based on an integral analysis, assuming the following temperature profile:

$$\frac{T(x,y)-T_0}{\Delta T} = 1 - \frac{y}{\delta_T}, \quad 0 \le y \le \delta_T \quad \textit{and} \quad T(x,y) = T_0, \quad \delta_T \le y \le D$$

(iv) Up to what distance from the point $x=L$ (upstream/downstream) the integral solution will be valid?