1. A 15 kg block slides down a smooth inclined surface as shown in Figure 1. Determine the terminal velocity of the block if the 0.2 mm gap between the block and the surface contains SAE 30 oil at 60°F ($\mu = 0.375 \quad m^2/N \cdot s$). Assume the velocity distribution in the gap is linear, and the area of the block in contract with the oil is 0. $5\,m^2$. (25%)

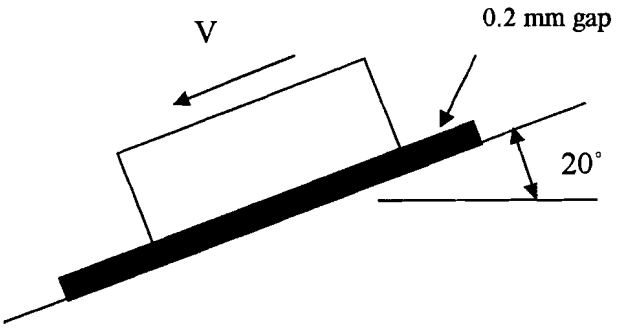

Figure 1.

2. 依下列順序說明自由渦流 (Free Vortex) 與強制渦流 (Force Vortex) (25%)

(1) 說明何者為旋性流？何者為非旋性流？ (7%)

(2) 請繪出兩者之流線與等勢能線。(8%)

(3) 若有兩以極座標表示之速度函數 $V_\theta = \frac{K}{r}$ 及 $V_\theta = \omega r$，K 及 ω 為常數，說明各自為何種 vortex 之速度函數，並寫出各自之流函數(Stream function)及速度勢能函數(Velocity potential function)。(10%)

3. When a sphere of diameter d falls slowly in a highly viscous fluid, the settling velocity, V, is known to be a function of d, the fluid viscosity, μ, and the difference, $\Delta\gamma$, between the specific weight of the sphere and the specific weight of the fluid. Due to a tight budget situation, only one experiment can be performed, and the following data were obtained: $V = 0.42$ ft/s for $d = 0.1$ in., $\mu = 0.03$ lb · s/ft^2, and $\Delta\gamma = 10$ lb/ft^3. If possible, based on this limited amount of data, determine the general equation for the settling velocity. If you do not think it is possible, indicate what additional data would be required. (25%)

4. The velocity potential for a certain inviscid, incompressible flow field is given by the equation

$$\phi = 2x^2y - \frac{2}{3}y^3$$

where ϕ has the units of m^2/s when x and y are in meters. Determine the pressure at the point $x = 2$ m, $y = 2$ m if the pressure at $x = 1$ m, $y = 1$ m is 200 kPa. Elevation changes can be neglected and the fluid is water. (25%)