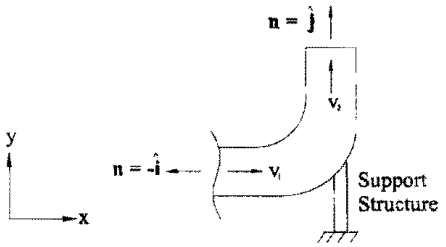
※ 考生請注意：本試題 □可 ☑不可 使用計算機

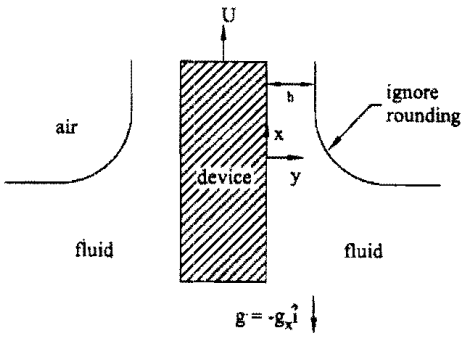
1. Given $v = Ax\hat{i} - Ay\hat{j}$, determine (a) the Eulerian acceleration (10%), (b) the components of strain rate (10%), and (c) the divergence of the velocity field (5%).

2. Given $v = \frac{x}{1+t}\hat{i} + \hat{j}$, find the equation of:
   (a) The streamline through the point (1, 1) at t=0 (8%),
   (b) The path line for a particle released at the point (1, 1) at t=0 (9%), and
   (c) The streak line at t=0 which passes through the point (1, 1) (8%).

3. For a steady incompressible flow of water through the reducing elbow shown to the right, the entrance area A_1 is 30 cm^2 and the exit area A_2 is $\frac{1}{2}A_1$. The mean velocity v_1 entering the elbow is 5 m/s with an inlet pressure of 5 Pa and outlet pressure equal to atmospheric. Find the total force required to hold the bend in place (20%).



4. A biomedical device is thrombogenic and thus must be coated with a thin biocompatible film thickness as shown below. Assume that the fluid adheres to the device (no slip) as the device is pulled through it. Assume a constant film thickness h, and that the fluid behaves as Newtonian and incompressible. By solving Navier-Stokes equations, show that $h = \sqrt{\frac{2\mu U}{\rho g_x}}$ (20%).



5. For a Newtonian fluid, the velocity field of the fully developed laminar flow in a pipe is shown to be $u(r) = \frac{-R^2}{4\mu}\frac{dp}{dz}\left(1 - \frac{r^2}{R^2}\right)$. Determine the flow rate (10%).