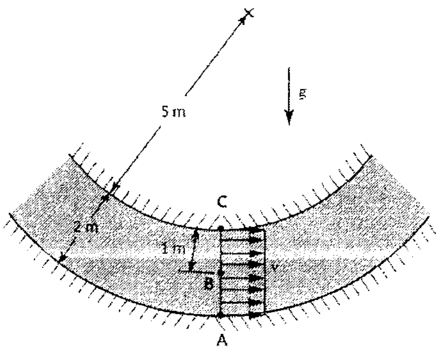
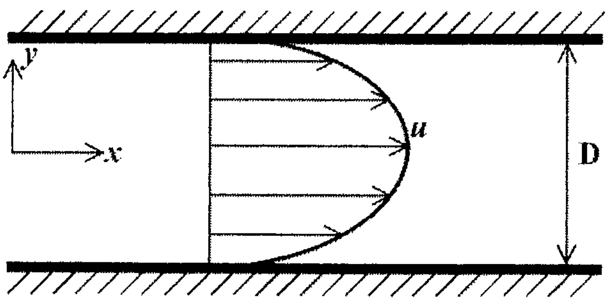
1. Silicone oil, with density of 0.963 g/cm^3, flows around the vertical bend. The streamlines are circular as indicated in the figure below. The flow is assumed as two-dimensional with constant and uniform velocity of 12 m/s. If the pressure is 80 kPa at Point A, determine
   (a) the pressure at Point B. (13%)
   (b) the pressure at Point C. (12%)



2. Consider a fully developed Couette flow: Flow between two infinite parallel plates driven by a pressure gradient $\frac{\partial P}{\partial x}$, as sketched below. Flow is in the x-direction only with a velocity u (no flow in the y and z directions). Both plates are stationary. Buoyancy is neglected.



   (a) Find the basic governing equation for this flow by simplifying the incompressible Navier-Stokes equation in the x-direction as given below. (13%)

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=\rho g_x-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)$$

   (b) Solve the basic equation found in (a) to obtain u as a function of y. (12%)

3. A plane wall of thickness L, thermal conductivity k has its surface at $x = 0$ insulated. Heat is generated within the wall at a rate of

$$q(x) = q_0 \cos\frac{\pi x}{2L} \text{ in unit of W/m}^3,$$

   where q_0 is the heat generation rate per unit volume at $x = 0$.
   (a) Consider that the wall surface at $x = L$ is kept at constant temperature T_L. Develop an expression for the one-dimensional, steady-state temperature distribution in the wall. (10%)
   (b) Further, the wall surface at $x = L$ is attached to a base kept at constant temperature T_B. The thermal contact resistance per unit area between the wall and the base is R''. Develop an expression for T_L. (8%)

注意:背面有試題

4. Consider the plane wall problem above. Assume the wall surface at $x = L$ is directly subject to thermal radiation, and the surroundings are kept at constant temperature T_∞. Develop an expression for T_L. (7%)

5. Please sketch the velocity boundary layer and thermal boundary layer qualitatively of uniform flow over a flat plate from the left to the right hand side for (a) air and (b) water. (6%)

6. Air at temperature of 300 K and velocity of 6.0 m/s flows over a heating surface at temperature of 400 K. The length and width of the plate are 2.0 m and 0.5 m respectively.
   (a) What temperature should you use for evaluating the fluid properties? (2%)
   (b) Is it a laminar flow or turbulent flow at the end of the plate (x=2.0 m)? (3%)
   (c) Calculate the local heat transfer coefficient at the midpoint (x=1.0 m) of the plate. (5%)

7. Air at temperature of 350 K and mass flow rate of 10 kg/hr is heated in a circular tube at constant wall temperature of 450 K and leaves at 400 K. The tube inside diameter is 10 mm. Please calculate the heat transfer coefficient at fully developed region. (9%)

Air properties and useful equations are listed below:

Temperature (K)	ρ (kg/m³)	c_p (kJ/kg·K)	μ (N·s/m²)	k (W/m·K)
300	1.1614	1.007	184.6×10^{-7}	0.0263
350	0.9950	1.009	208.2×10^{-7}	0.0300
400	0.8711	1.014	230.1×10^{-7}	0.0338
450	0.7740	1.021	250.7×10^{-7}	0.0373

Nu = 4.36 for q" = constant

Nu = 3.66 for T_w = constant

$$Nu = 0.332\,Re^{0.5}\,Pr^{1/3}$$

$$Nu = 0.0296\,Re^{0.8}\,Pr^{1/3}$$

$Nu = 0.023\,Re^{0.8}\,Pr^{n}$, where n = 0.3 for cooling, n = 0.4 for heating

$$Nu = 0.023\,Re^{0.8}\,Pr^{1/3}$$

$$Nu = 0.027\,Re^{0.8}\,Pr^{1/3}\left(\frac{\mu}{\mu_s}\right)^{0.14}$$

注意:背面有試題