國立中央大學 109 學年度碩士班考試入學試題

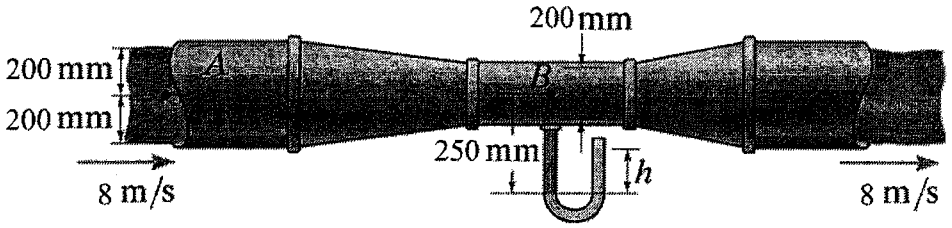
所別： 機械工程學系 碩士班 熱流組(一般生)　　共 2 頁　第 1 頁

科目： 流體力學及熱傳學

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

計算題需計算過程，無計算過程者不予計分

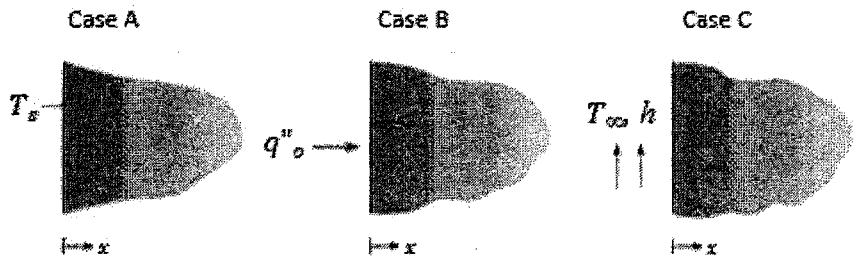
1. Water flows through the pipe at A with a velocity of 8 m/s and at a pressure of 280 kPa. Determine: (a) The velocity (5%) and the pressure (10%) of the water at B; (b) the difference in elevation h of the mercury in the manometer (10%).



2. Consider the following flow field, given in Cartesian coordinates (x, y, z):
   $\mathbf{V} = (u, v, 0) = (2t + 3y - 2, 5x, 0)$.
   (a) Is the flow steady? (3%)
   (b) Is the flow incompressible? (3%)
   (c) Is the flow rotational? (3%)
   (d) Compute the fluid acceleration. (8%)
   (e) Determine the equation of the streamline passing origin at $t = 2$. (8%)

3. Consider transient heat conduction in a semi-infinite solid for three different surface conditions. The solid has a uniform initial temperature, $T(x, 0) = T_i$.
   Case A: The surface temperature is fixed at $T(0, t) = T_s > T_i$.
   Case B: The surface is subject to a constant heat flux q''_o.
   Case C: The surface is subject to convection with a fluid temperature $T_\infty > T_i$ and convection coefficient h.

(a) Write down the governing equation and the boundary conditions respectively for the three cases. Clearly define your variables and parameters. Write down your assumptions too. (10%)
(b) Sketch how temperature changes with time in the solid respectively for the three cases. (9%)
(c) These three transient problems have a common length scale that is proportional to the square root of time. Write down this length scale. (2%)
(d) Write down the other length scale respectively for case B and C. (4%)



參考用

注意：背面有試題

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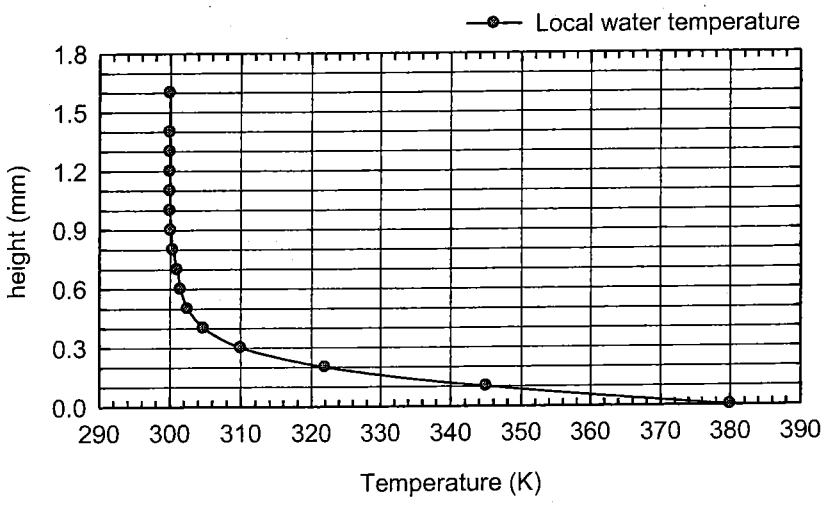
4. The figure below (next page) shows the local temperature measurements at various height of water flow over an isothermal flat plate. Please find the thermal boundary layer thickness (2%) and convective heat transfer coefficient (5%) from this measurement.



5. Fully developed water flow in a circular tube with inside diameter is 12.7 mm is heated at constant surface temperature condition from 300 K to 320 K. Please evaluate the convective heat transfer coefficient at flow rate of 0.1 kg/s and 0.1 kg/min. (18%)

Water properties and useful equations are listed below:

Temperature (K)	ρ (kg/m^3)	c_p (kJ/kg·K)	μ (N·s/m^2)	k (W/m·K)	Pressure (kPa)
290	999.0	4.184	1,080 x 10^{-6}	0.598	1.917
310	993.0	4.178	695 x 10^{-6}	0.628	6.221
330	984.3	4.184	489 x 10^{-6}	0.650	17.19
350	937.7	4.195	365 x 10^{-6}	0.668	41.63
370	960.6	4.214	289 x 10^{-6}	0.679	90.40
390	945.2	4.239	237 x 10^{-6}	0.686	179.4

Nu = 4.36 for q" = constant

Nu = 3.66 for T_w = constant

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

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

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

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

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

注意：背面有試題