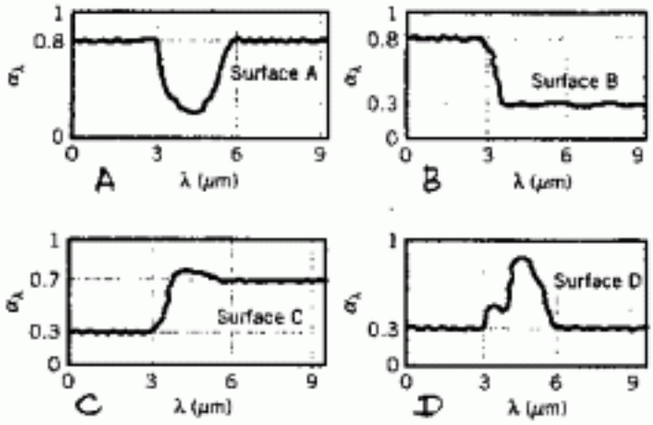
九十一學年度 動力机械工程 系（所） 甲 組碩士班研究生招生考試

科目 熱流學（II） 科號 1301 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Under what conditions can your fluid system be assumed a continuum? If the assumption of continuum is no longer valid, discuss how you will re-construct the analysis of the fluid systems? (5%)

2. Describe what the turbulent flow is? (5%; Do not specify Reynolds number only.)

3. Four diffuse surfaces having the spectral characteristics shown are at 300 K and are exposed to solar radiation. Which of the surfaces may be approximated as being gray? Why? If the surfaces are moved into a laboratory, then which is gray? Why? (10%)



Figures for Problem 3

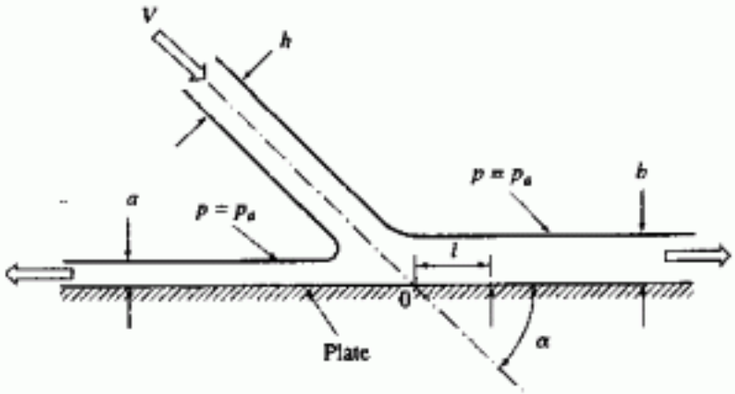


Figure for Problem 4

4. A steady, incompressible, frictionless, two-dimensional jet of fluid with density ρ, breadth h, velocity V, and unit width impinges on a flat plate held at an angle α to its axis. Gravitational forces are to be neglected.

(a) Determine the total force on the plate, and the breadths ***a*** and ***b*** of the two branches. (8%)

(b) Determine the distance l to the center of pressure (c.p.) along the plate from the point of o. (8%)

(c) Discuss how your answers will change if the whole system accelerates toward the right? (4%)

5. Consider a forced laminar flow along a flat plate having a uniform wall temperature T_w. The free stream has velocity U_∞ and temperature T_∞. All of the thermophysical properties are assumed constant. Let $\delta_t(x)$ denote the thickness of the thermal boundary layer.

(a) Represent the temperature distribution inside the thermal boundary layer with a cubic polynomial. (10%)

(b) Determine the local Nusselt number $Nu_x = \dfrac{h(x)x}{k}$ for $\Pr >> 1$. (10%)

(c) Compute the average Nusselt number in the region $0 \le x \le L$. (5%)

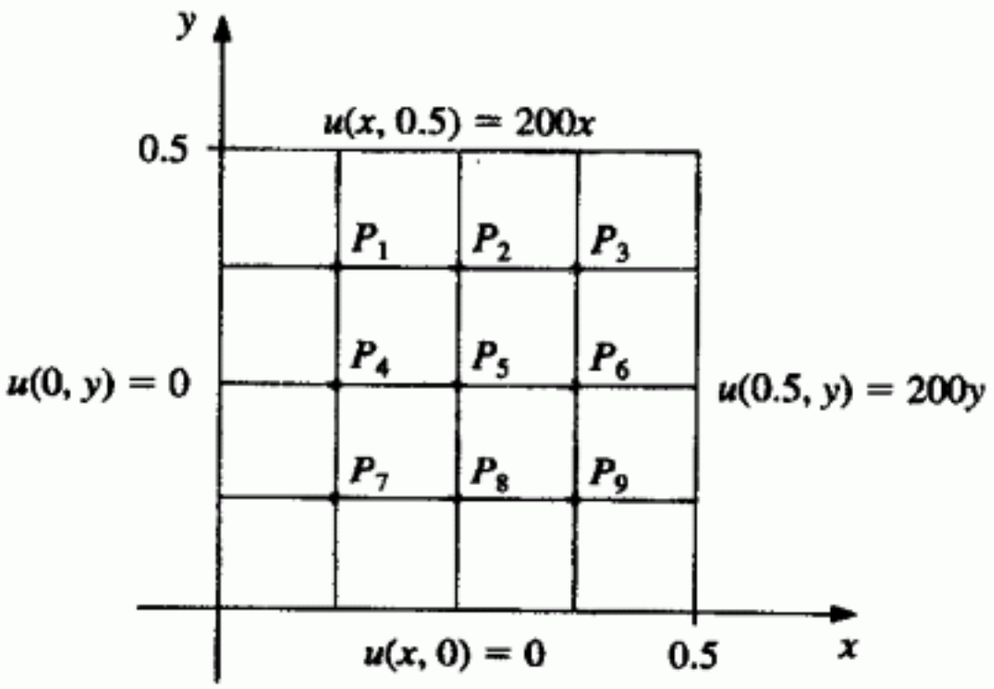
(d) From the result obtained in (b) it is seen that increasing the Prandtl number increases the Nusselt number Nu_x. Could you conclude from this that decreasing the thermal diffusivity would enhance (增強) the heat transfer rate? Why? (5%)

[Hint]: 1. Assume $\partial^2 T/\partial y^2 = 0$ at $y = \delta_t(x)$.

2. $\delta_t(x) = 4.51\, x\, Re_x^{-1/2}\, \Pr^{-1/3}$ for $\Pr >> 1$.

3. $Re_x = U_\infty x/\nu$ and $\Pr = \nu/\alpha$.

6. Consider a steady-state heat conduction problem in a thin square metal plate with 0.5 m in each side. If two adjacent boundaries are held at 0° C, while the temperature on the other two sides increases linearly from 0° C to 100° C. (See the figure below, u(x, y) is the temperature distribution.)



(a) Please derive the governing equation to evaluate the temperature distribution, u(x, y), on this plate, if conduction in the z-direction is negligible and no heat generation within the plate. What are the mathematical equation and boundary conditions? (10%)

(b) Please describe how to evaluate the temperatures at locations P1 to P9, using numerical methods. If you don't know how, just guess them using your engineer instinct. (10%)

(c) What is the exact solution, using analytical methods, of the temperature distribution, u(x, y), in this plate ? (10%)