八十六學年度 動力機械 系(所) 甲 組碩士班研究生入學考試

科目 熱流學(II) 科號 360 共 3 頁第 1 頁 *請在試卷【答案卷】內作答

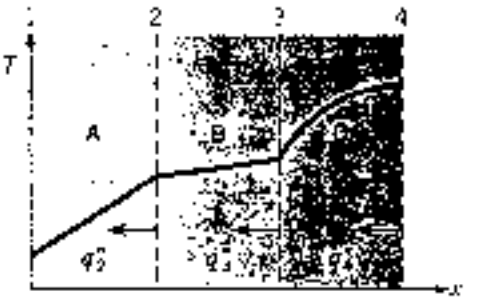
1. Problem : Heat Conduction (25%)

(a) To determine the effect of the temperature dependence of the thermal conductivity on the temperature distribution in a solid, consider a material for which this dependence may be represented as

$$k = k_0 + a\,T$$

where $k_0$ is a positive constant and a is a coefficient that may be positive or negative. Sketch the one-dimensional, steady-state temperature distribution associated with heat transfer in a plane wall for three cases corresponding to $a > 0$, $a = 0$ and $a < 0$. (9%)

(b) Consider a different problem of heat conduction as follows. The steady-state temperature distribution in a composite plane wall of three different materials, each of constant thermal conductivity, is shown below




(i) Comment on the relative magnitudes of heat flux $q_2''$ and $q_3''$, and of and $q_4''$. (6%)

(ii) Comment on the relative magnitudes of thermal conductivity $k_A$ and $k_B$, and of $k_B$ and $k_C$. (6%)

(iii) Sketch the heat flux as a function of x. (4%)

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科目 熱流學(II) 科號 360! 共 3 頁第 2 頁 *請在試卷【答案卷】內作答

2. Problem: Laminar Boundary Layer Flow (25%)

An initially uniform laminar flow passes over a wide long flat plate, on which a boundary layer develops, as shown in the Figure. Two regions,the boundary layer region and the free stream region, are divided by the broken line.

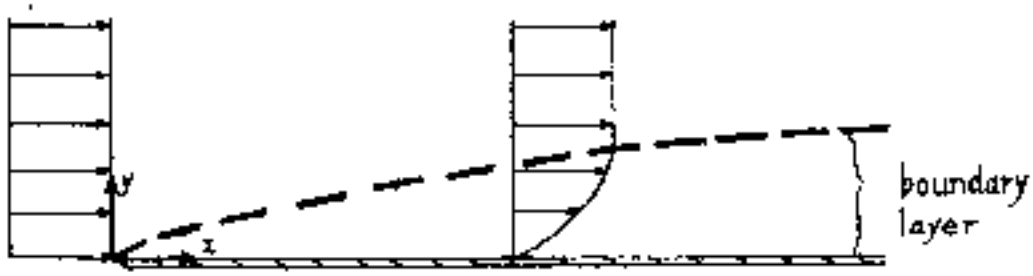
(a) Draw the streamlines of the flow field. (4%)

(b) Which region(s) can the Euler's equation and the Navier-Stokes equation be applied to? (4%)

(c) Discuss on the vorticity in the two regions, respectively. (5%)

(d) According to Bernoulli's equation, the pressure on the flat plat should be significantly larger than in the free stream since the velocity is zero on the plate. Do you agree? Discuss on this statements. (6%)

(e) Compare the magnitude of local wall shear stress $\tau_w$ respectively at a small and a large x position. You need to explain how you make the judgment (6%)



八十六學年度 動力機械 系(所) 甲 組碩士班研究生入學考試

科目 熱流學(II) 科號 2601 共 3 頁第 3 頁 *請在試卷【答案卷】內作答

3. Problem: Thermodynamics (1st and 2nd law) (25%)

Please prove or define the followings,

(a) Internally reversible, totally reversible and irreversible processes (3%)

(b) Factors that render a process irreversible (3%)

(c) Which cycle has a higher thermal efficiency, reversible or irreversible cycles ? Why ? (3%)

(d) Using the increase-in-entropy principle, show that the direction of heat transfer must be from a higher temperature body to a lower temperature one. (8%)

(e) Prove that a violation of the Clausius statement of the second law leads to a violation of the Kelvin-Planck statement and vice versa. (8%)

4. Problem: General (25%)

(a) Please illustrate the difference between the laminar viscosity and the turbulent viscosity. (5%)

(b) Please give the definition of the Nusselt number and describe a way to measure it. (10%)

(c) What is the Reynolds analogy? How do you use it ? (10%)