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(I) 科號 >60> 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Problem: Compressible Flow (25%)

(a) The speed of sound is the speed of a vanishingly weak wave. To define this speed of sound, two obvious choices are an isothermal process and an isentropic process. Which one is correct?, and why? (10%)

(b) Can you explain that the speed of sound for water is greater than that for air? (5%)

(c) The outer potential flow is accelerated for a subsonic wedge boundary-layer flow. Is it possible that the speed of potential flow downstream is greater than the speed of sound? (10%)

2. Problem: Thermodynamic Cycle (25%)

(a) On a P – v and T – s diagram, compare the ideal Otto cycle and ideal diesel cycle which have the same inlet state, heat input Q_H, and compression ratio. (7%)

(b) Derive the mathematical expressions for the slope of the curves of the heating (or combustion) process in the T s diagram for both cycles. Also explain physically why the slopes are different for the two cycles. (9%)

(c) Apply the T – s diagram to compare the thermal efficiencies associated with the ideal Otto cycle and the ideal diesel cycle having operation conditions as in (a). You need to explain first how a T – s diagram of an ideal cycle can be used for the estimation of thermal efficiency. (9%)

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

3. Problem: Turbulent Channel Flow (25%)

In fully developed incompressible two-dimensional channel flows, please

(a) Write down the momentum equations for laminar and turbulent flows in the fully developed regimes(using Reynolds averaging if the flow is turbulent, upper case character for mean flow quantity, U,V, and lower case character for turbulence quantity, u,v). (5%)

(b) Derive the velocity profiles for both the laminar and turbulent flows. Indicate any assumptions made and difficulties encountered. (5%)

(c) If the inlet mass flow rates are the same, draw the axial velocity profiles across the channel on the same graph. Comment on your results. (y-co-ordinate channel height, x-co-ordinate velocity level) (5%)

(d) If the inlet pressure levels are the same for both the laminar and turbulent flows, draw the pressure level as flow develops downstream. Comment on your results. (y-co-ordinate pressure level, x-co-ordinate distance downstream) (5%)

(e) Plot the shear stress levels across the channel for laminar and turbulent flows on the same graph. Comment on your results. (y-co-ordinate channel height, x-co-ordinate stress level) (5%)

4. Problem: Heat Convection (25%)

(a) Given the volumetric thermal expansion coefficient

$$\beta = -\frac{1}{\rho}(\partial\rho/\partial T)_p \approx -\frac{1}{\rho}(\rho_\infty - \rho)/(T_\infty - T)$$

Please write down the governing equations for a laminar boundary layer flow that is driven by buoyancy forces. Assume steady, two-dimensional, constant property condition in which the gravity force acts in the negative x direction. Make all the other necessary assumptions and apply the so-called Boussinesq approximation to reduce the x-momentum equation to a form where it is apparent how the buoyancy force is related to the temperature difference. (15%)

(b) Give the conditions for a flow to be thermally fully developed in a heated circular tube. Also show that in the thermally fully developed flow of a fluid with constant properties, the local convection coefficient is a constant, independent of x. (10%)