

九十二學年度 工程與系統科學系(所) 乙 組碩士班研究生招生考試

科目 流體力學 科號 3703 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Define following terms with physical meaning (40%)
(a) Streamline/pathline (b) Reynolds number (c) Newtonian flow
(d) Eulerian/Lagrangian methods (e) potential flow (f) Reynolds stress
2. Derive the pressure difference P_i and P_a (atmosphere) if a 1-mm-diameter tube is used (Fig.P2). (Hint: capillarity is important) (10%)
3. Consider the fluid mechanics of a faulty preloaded hyperdermic syringe that leaks around the plunger. The inside diameter of the cylinder is D , and the inside diameter of the needle exit hole is d . The plunger clearance is t . When the plunger is depressed, serum leaks out around the plunger; its velocity is the same as that of the plunger. The flow rate of the injected serum must be limited to avoid pain due to excessive local serum buildup. Develop an expression relating the serum injection velocity to the plunger speed. Assume quasi-one-dimensional, one-directional flow (Fig.P3). (15%)
4. In natural-convection problems, the variation of density due to the temperature difference ΔT creates an important buoyancy term in the momentum equation. To the first order accuracy, the density variation would be $\rho \approx \rho_0(1 - \beta \Delta T)$, where β is the thermal-expansion coefficient. The momentum equation thus becomes $\rho_0 dV/dt = -\nabla(p + \rho_0 g z) + \rho_0 \beta \Delta T g k + \mu \nabla^2 V$ where we have assumed that z is up. Nondimensionalize this equation, find the important parameters and relate them. (10%)
5. List and explain 5 approaches to reduce the drag for a moving body.(10%)

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6. Two infinite plates with a distance h apart are parallel to the xz plane with the upper plate moving at speed V , as in Fig.P6. There is a fluid of viscosity μ and constant pressure between the plates. Neglecting gravity and assuming incompressible turbulent flow $u(y)$ between the plates, use the logarithmic law and appropriate boundary conditions to derive a formula for dimensionless wall shear stress versus dimensionless plate velocity. Sketch a typical shape of the profile $u(y)$. (15%)

