國立成功大學

111學年度碩士班招生考試試題

編　號：124

系　所：系統及船舶機電工程學系

科　目：流體力學

日　期：0219

節　次：第 2 節

備　註：可使用計算機

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (20%)

   Simplify the Navier-Stokes equation as much as possible for the case of incompressible hydrostatics, with gravity acting in the negative z-direction. Begin with the incompressible vector form of the Navier-Stokes equation,

   $$\rho \frac{D\vec{V}}{Dt} = -\vec{\nabla}P + \rho\vec{g} + \mu\nabla^2\vec{V}$$

   explain how and why some terms can be simplified, and give your final result as a vector equation.

2. (20%)

   Derive the Reynolds Transport Theorem and indicate the physical significance of each term. (20%)

   $$\frac{DB_{sys}}{Dt} = \frac{\partial B_{CV}}{\partial t} + \int_{cs}\rho b\vec{V}\cdot\vec{n}dA$$

   $$= \frac{\partial}{\partial t}\int_{cv}\rho b d\forall + \int_{cs}\rho b\vec{V}\cdot\vec{n}dA$$

3. (20%)

   A hypodermic syringe (Fig. 1) is used to apply a vaccine. If the plunger is moved forward at the steady rate of 20 mm/s and if vaccine leaks past the plunger at 0.1 of the volume flowrate out the needle opening, calculate the average velocity of the needle exit flow. The inside diameters of the syringe and the needle are 20 mm and 0.7 mm.
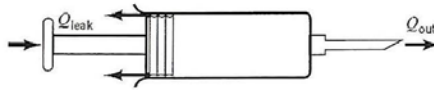

   Figure 1

4. (20%)

   A tornado consists of a whirling mass of air such that the wind essentially move along horizontal circular streamlines, Fig. 2.　Determine the pressure distribution within the tornado as a function of r.
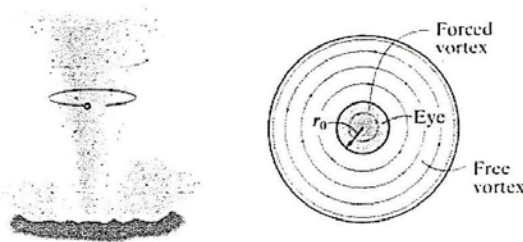

   Figure 2

5. (20%)

The motor on a small boat has a propeller with a radius of 60 mm., Fig. 3.　If the boat is traveling at 2 m/s, determine the thrust on the boat and the ideal efficiency of the propeller if it discharges water through it at 0.04 m3/s.
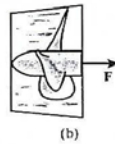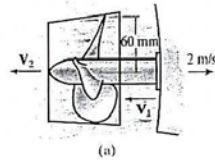

Figure 3