編號： 163 國立成功大學 105 學年度碩士班招生考試試題

系　　所：生物醫學工程學系

考試科目：流體力學　　考試日期：0227，節次：2

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

I. The cardiovascular system is responsible for the major mass transport in the human body. Therefore, the human health is associated with the quality of blood flow. Please address the following problems:

(a) Write down the Hagen-Poiseuille equation for the tube flow in Fig. 1 and explain the relationship between the pressure, flow rate and diameter of the tube. (8%)

(b) Explain how the viscosity of blood is different from water and why? (4%)

(c) What factors may alter the viscosity of blood? (including increased or decreased?) (8%)

(d) What is Reynolds number (*Re*)? How does it vary from the ascending aorta to the femoral vein in the human systemic vessels? (6%)

(e) What mechanisms dominate the transport of water and solutes across capillary walls and how they vary from upstream to downstream? (8%)

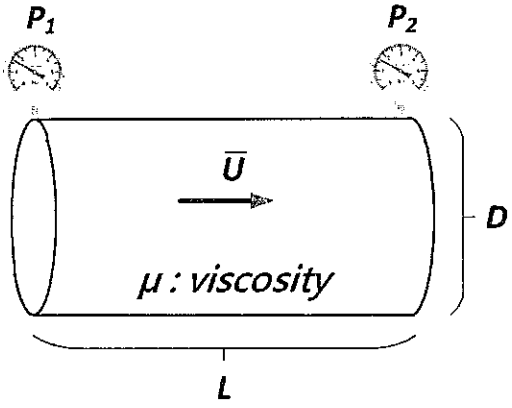

Fig. 1

II. In fluid dynamics, the Bernoulli equation (BE) is vital to interpret the behavior of fluid flow.

(a) What assumptions are made in the BE? (8%)

(b) Please come up with an example that is relevant to the BE. (5%)

(c) Based on the BE, some simple flow measurement techniques are developed, such as the Ventri tube as shown in Fig. 2. Please derive the following flowrate from the BE for the tube. (10%)

$$Q = A_2 \sqrt{\frac{2(p_1 - p_2)}{\rho[1 - (A_2/A_1)^2]}}$$

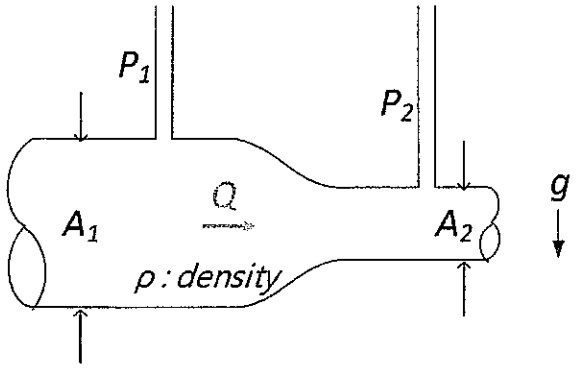

Fig. 2

(d) In a real flow, energy dissipation is inevitable. Therefore, the BE must be modified with additional terms, named major and minor head losses. Discuss the head losses regarding what they are and how they correlate with the BE. (10%)

III. Flow profile can be delineated by seeding tracer particles, termed flow visualization. Assume the flow velocities are measured to be $u = y/(x^2 + y^2)^{3/2}$, $v = -x/(x^2 + y^2)^{3/2}$, $w = 0$.

(a) Is the continuity assumption satisfied? (10%)

(b) Determine if the Bernoulli equation can be used here in this flow field? (10%)

(c) Derive the *x*-*y* equation of the streamline that passes the point (3, 4) and draw it in a planar Cartesian coordinate system. (13%)