編號： 166

國立成功大學 106 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：生物力學

考試日期：0213，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。

1. Define the following terms:

(1) Stress and strain in mathematical formulas (4%)

(2) Viscoelastic material and an examples of biomaterial (5%)

(3) Hagen-Poiseuille flow (4%)

(4) Moment of inertia for an area (4%)

2. The hydrostatic pressure of human blood may be altered by posture. Given that a human's blood pressure at the exit of heart is P_0 and the distance from the heart to the head and to the feet are L and 2L, respectively (Fig. 1). The pressure drop between the arterial and venous vessels is P_{loss}. Note that the viscosity of blood is ρ and the pressure loss due to the blood vessels is ignored.

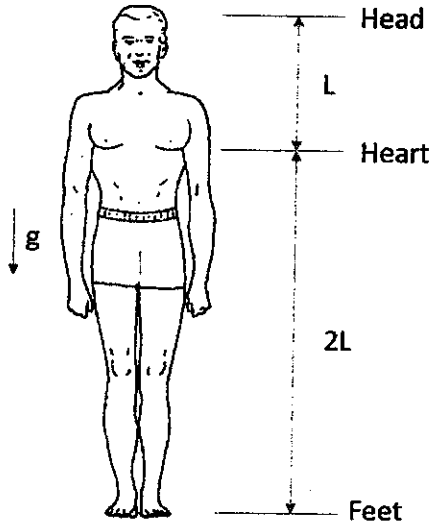

Fig. 1

(1) Describe the arterial and venous pressures at head, heart, and feet in terms of P_0, L, P_{loss}, and ρ in the pulmonary circulation and systemic circulation when the human body is in standing posture. (12%)

(2) Compare the blood pressures between standing and lying postures and state their difference. (6%)

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3. Referring to Fig.2, what are the values of σ_{xx}, σ_{xy}, σ_{yx}, and σ_{yy} in this 2D state of stress? (10%)

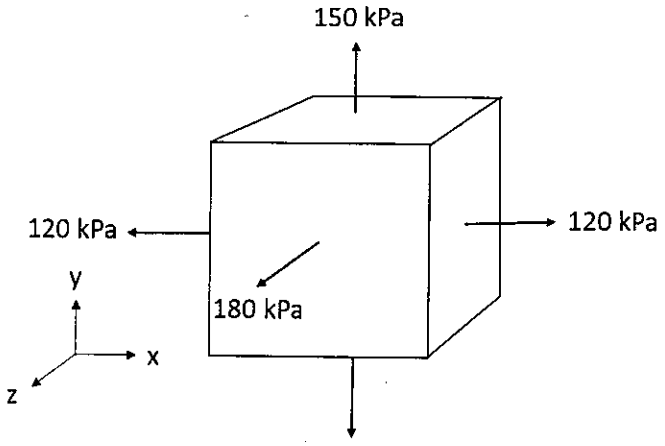

Fig. 2

4. Assume you are a delivery man who carries a box on the way to your client. At this moment, the lumbar portion of your spine supports the entire weight of the upper torso and the force load imposed on it (Fig. 3). Consider the disk (A) between L5 and the uppermost vertebra of the sacrum region. Let g=10 m/s^2.

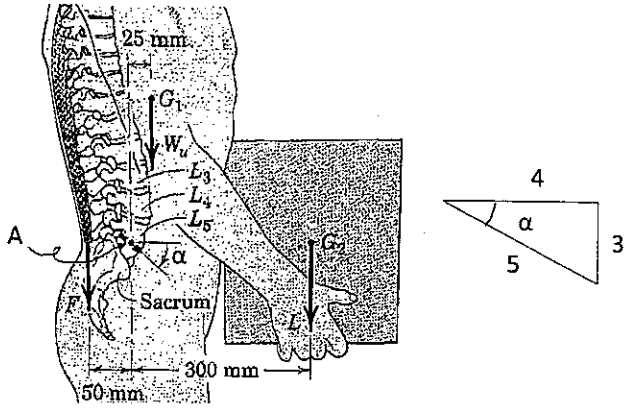

Fig. 3

(1) Draw the free body diagram of the upper torso. (4%)

(2) **Determine** the compressive force ***C*** and the shear force ***S*** supported by this disk A in terms of the body weight *W* (100 kg) when *L*=0. The weight W_u of the upper torso is 50% of the total body weight *W*. Also, **determine** the vertical force ***F*** which the rectus muscles of the back exert on the upper torso acts. (12%)

(3) Repeat for the above case when *L*=*W*/5. (12%)

5. For measuring a soft tissue under forces (Fig. 4). Design an experimental setup using strain gauges whereby you can measure a complete 2D strain (ε_{xx}, ε_{xy}, ε_{yy}) in a small region. The strain transforms are given as follows: (14%)

$$\varepsilon'_{xx} = \varepsilon_{xx}\cos^2\alpha_1 + 2\varepsilon_{xy}cos\alpha_1 sin\alpha_1 + \varepsilon_{yy}\sin^2\alpha_1$$
$$\varepsilon''_{xx} = \varepsilon_{xx}\cos^2\alpha_2 + 2\varepsilon_{xy}cos\alpha_2 sin\alpha_2 + \varepsilon_{yy}\sin^2\alpha_2$$
$$\varepsilon'''_{xx} = \varepsilon_{xx}\cos^2\alpha_3 + 2\varepsilon_{xy}cos\alpha_3 sin\alpha_3 + \varepsilon_{yy}\sin^2\alpha_3$$

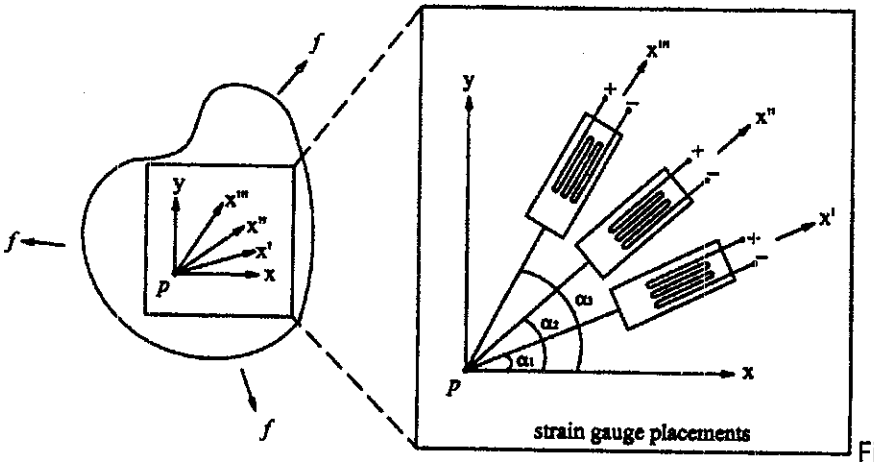

Fig. 4

6. Blood is a non-Newtonian fluid.

(1) Define the term "Newtonian fluid". (5%)

(2) Explain how the viscosity of blood varies with velocity? (8%)