國立成功大學 109 學年度碩士班招生考試試題

系　所：航空太空工程學系
考試科目：材料力學
考試日期：0210，節次：1

※ 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. This problem consists of two parts:

1) The straight and uniform cantilever beam shown in Figure 1 has the length L, moment of inertia of the cross section I, and Young's modulus E, and is loaded at the free end by the force P, which is vertical to the beam. Derive the linear relationship between the free-end deflection δ and the force P from the "basic differential equation of the deflection curve of a beam" and appropriate boundary conditions. (17%)

2) Shown in Figure 2 are two straight, uniform, and parallel cantilever beams that are brought into frictionless contact at their free ends without any preload. The length, moment of inertia of the cross section, and Young's modulus of one beam are denoted by L_1, I_1, and E_1, respectively, and those of the other by L_2, I_2, and E_2, respectively. Then the force F, vertical to the beams, is applied at the free-to-rotate end of one beam and causes a contact reaction force from the other beam. Employ the result derived in Part 1 above to determine the respective reaction forces, R_1 and R_2, at the two fixed ends. (8%)

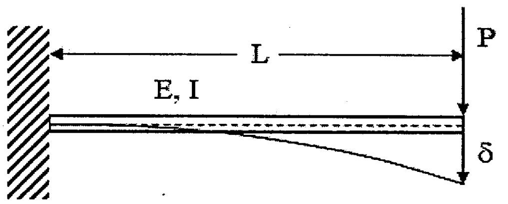


Figure 1

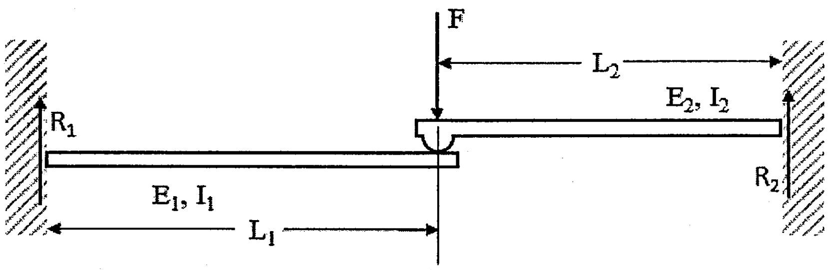


Figure 2

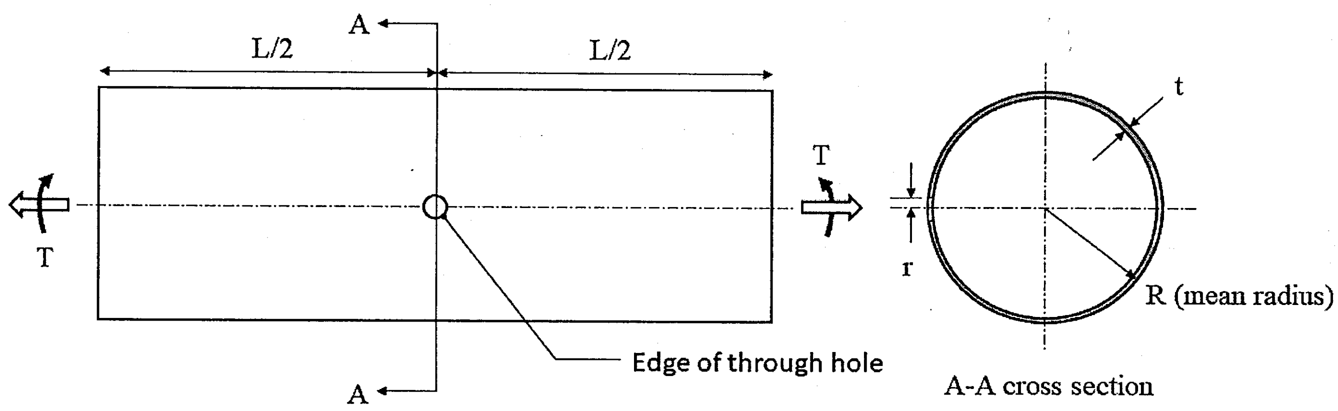
※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

2. The length, mean radius, and thickness of the thin-walled circular cylinder shown in the figure below are denoted by L, R, and t, respectively. R is about 5% of L, and t is about 2% of R. The small circular hole with the radius r shown in the figure is drilled through the wall of the cylinder. The radius of the through hole, r, is about 5% of the mean radius of the cylinder, R. The axis of the through hole vertically intersects the axis of the cylinder at half the length of the cylinder. As shown in the figure, the cylinder is subject to the torsional load (torque) T at the ends of the cylinder.

1) Describe the primary nature of the stress concentration on the edge of the through hole, provide a sketch of your estimated location of the stress concentration, and provide the rationale (or argument) for your answers. (10%)

2) Estimate the stress concentration in terms of T, R, t, and a stress concentration factor. (10%)

3) Estimate the value of the stress concentration factor and provide the rationale (or argument) for your estimate. (5%)



Note: Not drawn to scale

※ 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。

3. (25%) Consider a prismatic bar subjected to an axial load P.

(a) If the bar is assumed to be linearly elastic, find the ***axial stiffness k*** of the bar in terms of Young's modulus E, cross-sectional area A, and length L.

(b) What is the *strain energy density* of the bar?

(c) If we keep increasing the load P until failure occurs, discuss the possible **failure modes.** (Note that P may be tensile or compressive)

4. (25%) The shear flow q in a thin-walled member of thickness t is defined as

$$q = \tau t. \quad (\tau = \text{shear stress})$$

Consider a channel section having the dimensions shown in Figure 4-1, where $t << h$.

(a) Find the ***moment of inertia*** of the area about the horizontal axis of symmetry.

(b) If the section is subjected to a vertical shear force V (Figure 4-2) and consider pure bending, find the **resultant force** F_f and the ***maximum shear flow*** in the section.

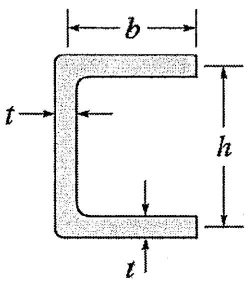


Figure 4-1

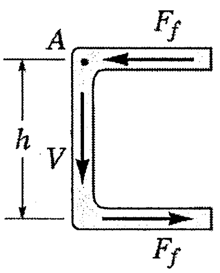


Figure 4-2