國立成功大學
111學年度碩士班招生考試試題

編　號： 131

系　所： 航空太空工程學系

科　目： 材料力學

日　期： 0219

節　次： 第 1 節

備　註： 不可使用計算機

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第 1 頁，共 3 頁

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1. (20%) A solid uniform circular shaft of radius ***c*** is subjected to a torque ***T***.
   (a) Determine the fraction of ***T*** that is resisted by the material contained within the outer region of the shaft, which has an inner radius of ***c***/2 and outer radius ***c*** (Figure 1).
   (b) Comment on the result.

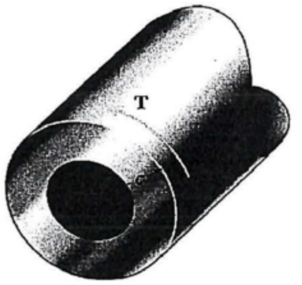

Figure 1

2. (30%) The simply supported beam shown in Figure 2(a) has the cross section shown in 2(b).

(a) Find the maximum bending stress in the beam.

(b) Evaluate the percentage of bending moment resisted by the flange areas in a cross section.

(c) Find the maximum shear stress in the beam.

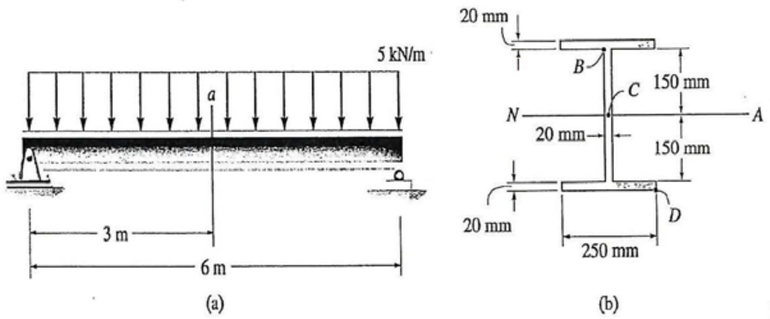

Figure 2

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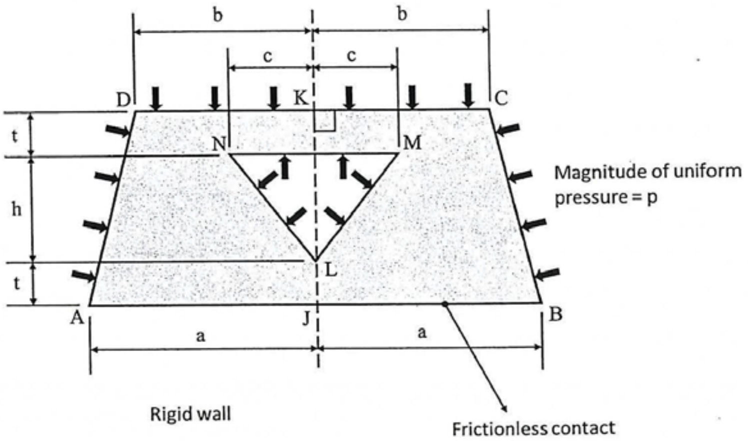
3. (25%) The trapezoidal thin plate ABCD shown below has the internal triangular cut-out LMN. Sides AB, CD, and MN are parallel with one another. Reference line JK passes through L and is perpendicular to sides AB, CD, and MN. All the dimensions required to define the original stress-free geometry of the plate are given in the figure. The plate is made of an isotropic linear elastic material whose Young's modulus and Poisson's ratio are E and ν, respectively. Sides BC, CD, DA, LM, MN, and NL are subject to uniform pressure (compressive loading) with the magnitude p (p > 0) shown in the figure, while side AB is in frictionless contact with the rigid wall. The plate is deformed by the loading on the boundaries. <u>Determine the length of the deformed side LM.</u>



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4. (25%) The thin rectangular bi-material plate shown in the figure consists of the two rectangular halves, each with the length a and width b measured in the x direction and y direction of the x-y coordinate system, respectively. One half is made of an orthotropic linear elastic material and the other is made of an isotropic linear elastic material. The two materials are perfectly bonded along their straight interface, which is parallel with the x axis. The principal material axes of the orthotropic material are denoted by 1 and 2, pointing in the +y direction and -x direction, respectively. The two materials are perfectly bonded along their straight interface, which is parallel with the x axis. The elastic constants of the orthotropic material are as follows: Young's moduli (E_1, E_2), Poisson's ratios (ν_{12}, ν_{21}) with respect to the principal material coordinate system. Therefore, referring to the principal material coordinate system, the relation between the normal strains (ε_1, ε_2) and normal stresses (σ_1, σ_2) for the orthotropic material is

$$\begin{Bmatrix}\varepsilon_1\\ \varepsilon_2\end{Bmatrix} = \begin{bmatrix}1/E_1 & -\nu_{21}/E_2\\ -\nu_{12}/E_1 & 1/E_2\end{bmatrix}\begin{Bmatrix}\sigma_1\\ \sigma_2\end{Bmatrix}$$

On the other hand, the elastic constants of the isotropic material are as follows: Young's modulus (E), Poisson's ratios (ν). Additionally, it is known that $E = E_2 < E_1$ and $\nu = \nu_{21}$. The two edges of the plate parallel with the y axis are subject to the uniform tensile stress σ_x, while the other two edges parallel with the x axis are subject to the uniform tensile stress σ_y. The loading results in deformation of the plate. <u>Determine all the dimensions required to define the geometry of the deformed bi-material plate. Sketch the deformed shape and indicate all the required dimensions in the sketch.</u>