國立台灣大學九十三學年度碩士班招生考試試題

科目：材料力學(B) 題號：253

1. The beam of length L shown in Figure 1(a) has a uniform cross-sectional property, i.e., EI = constant. It is built in the wall on the left and simply supported on the right. The deflection $w(x)$ and transverse load per unit length $q(x)$ are shown in the positive direction. The sign conventions of a positive bending moment $M(x)$ and a transverse shear force $V(x)$ are given in Figure 1(b). (Total 23%)

   (a) Given $\frac{d^2w}{dx^2}=\frac{M}{EI}$, show that $\frac{d^4w}{dx^4}=\frac{q}{EI}$ using the condition of equilibrium. (7%)

   (b) Write down the boundary conditions at $x=0$ and $x=L$ of the beam. (4%)

   (c) If $q(x)=q_0$, q_0 is a constant, determine the deflection $w(x)$ of the beam. (8%)

   (d) Draw the shear force and bending moment diagrams using the deflection $w(x)$ obtained in (c). (4%)

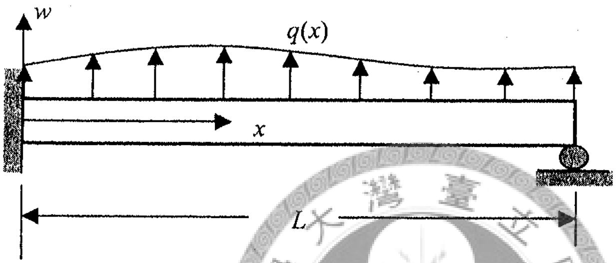

Figure 1 (a)

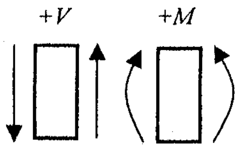

Figure 1(b)

2. When a beam with a uniform cross-sectional property (EI = constant) is axially loaded by a compressive force P, the equation of equilibrium can be written as $\frac{d^4w}{dx^4}+\frac{P}{EI}\frac{d^2w}{dx^2}=\frac{q}{EI}$, where $q(x)$ is the distributed load on the transverse direction. When $q(x)=0$, the compressive force P that makes $w(x)\neq 0$ is called the critical load. Determine the critical load for the beam shown in Figure 2. (12%)

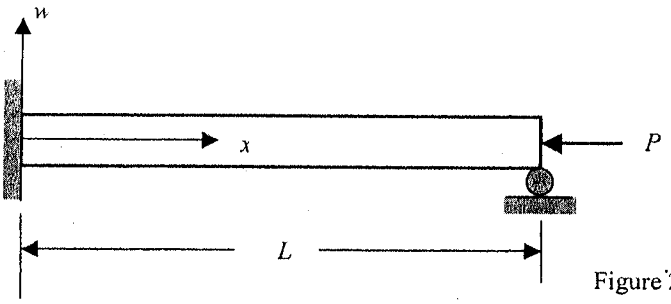

Figure 2

3. A stiff beam of length $2a$ is hinged at one end and supported by two springs of spring constant k as shown in Figure 3. Where should a force P be applied so that the stiffness of the system (defined as P divided by the deflection under P) is $20k/9$? Please express the answer c in terms of a. (10%)

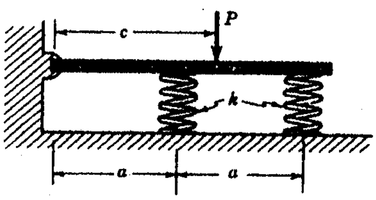

Figure 3

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4. The bar shown in Figure 4 consists of material with shear modulus $G = 28$ GPa and has a solid circular cross section. Part A is 40 mm in diameter and Part B is 20 mm in diameter. (Total 25%)
   (a) Draw the torque diagram of the bar. (5%)
   (b) Determine the magnitudes of the maximum shear stresses in Parts A and B. (10%)
   (c) Determine the location where maximum (absolute) angle of twist occurs and find its value in degrees. (10%)

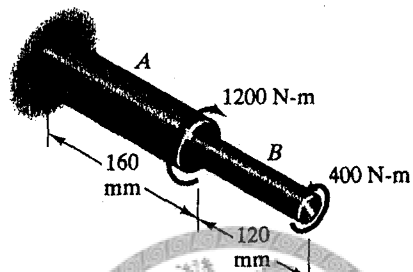

Figure 4

5. The pressure in a cylindrical tank as shown in Figure 5 is monitored by a 45° strain rosette mounted on its surface. Unfortunately, during service, gages a and c have become inoperative. Only gage b gives a strain reading of 100×10^{-6}. If $d = 1$ m, $t = 10$ mm, $E = 207$ GPa, and $\nu = 0.3$, find the pressure in the tank. (15%)

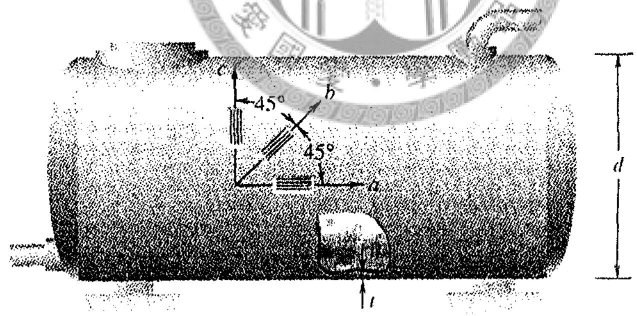

Figure 5

6. A section of pressurized steel pipe experiences a twisting moment T as shown in Figure 6. If $T = 100$ kip·in, determine the largest p that the pipe can sustain before point A yields (use any criterion you like). The outside diameter of the pipe is 12 in, and the wall thickness is 0.125 in. (15%)

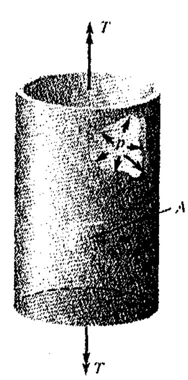

Figure 6

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