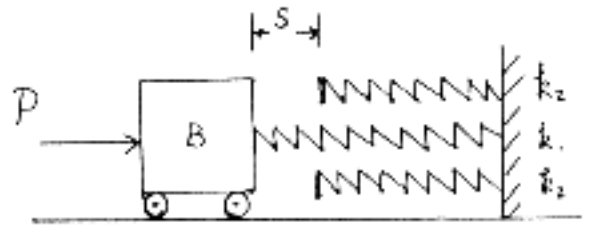
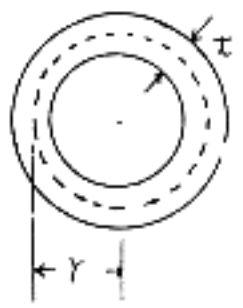
(1) A block B is pushed against three springs by a force P (see figure). The middle spring has stiffness k_1 and the outer springs each have stiffness k_2. Initially, the springs are unstressed and the middle spring is slightly longer than the outer springs (the difference in length is denoted s).
(a) Draw a force-displacement diagram with the force P as ordinate and the displacement x of the block as abscissa.(8%)
(b) From the diagram, determine the strain energy U_1 of the springs when $x=2s$.(6%)
(c) Explain why the strain energy U_1 is not equal to $P\delta/2$, where $\delta = 2s$.(6%)



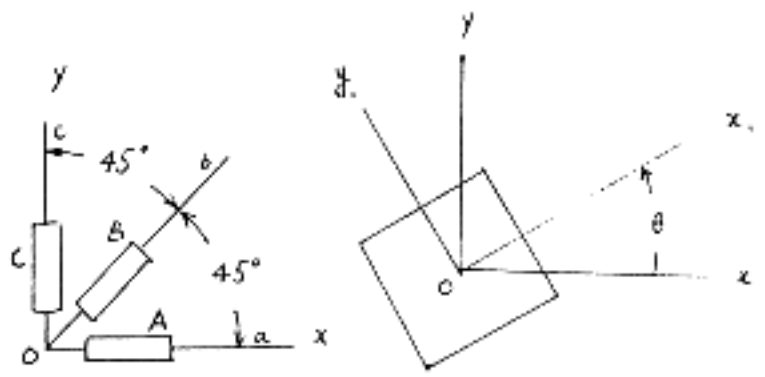
(2) Consider a circular tube subjected to a torque T. The tube has constant thickness t and radius r to the median line of the cross section ($\beta = r/t$). The cross section of the tube is shown as figure.
(a) Check the validity for the approximate formula of the average shear stress in a thin-walled tube by comparing the approximate formula with those of exact theory.(10%)
(b) Calculate the ratio ρ between the maximum shear stress obtained from the approximate formula and that obtained from the exact theory for $\beta=5$ (i.e., $\rho=(\tau_{average})_{approximate}/(\tau_{max})_{exact}$).(10%)



(3) Derive the relationship between moduli of elasticity E and G (i.e., $G = E/2(1+\nu)$ where ν is the Poisson's ratio) (20%)

(背面仍有題目,請繼續作答)

(4) A 45^0 strain rosette consists of three electrical-resistance strain gages arranged to measure strains in two perpendicular directions and also at a 45^0 angle between them (see figure). The rosette is bonded to the surface of the structure before it is loaded. Gages *A*, *B* and *C* measure the normal strains ε_a, ε_b and ε_c in the directions of lines *Oa*, *Ob* and *Oc*, respectively. Explain how to obtain the strains ε_{xx}, ε_{yy} and γ_{xy} associated with an element oriented at an angle θ to the *xy* axes.(20%)



(5) Consider an ideal column that is fixed at the base, free at the top, and subjected to an axial load P (see figure). The length and the bending rigidity of the column are *L* and *EI*. Determine the critical buckling load and the corresponding buckled shape. (20%)