2014년도 2학기 항공기 구조역학 중간고사

1. (15 points) Given a state of stress defined by σ_1=150 MPa, σ_2=250 MPa, σ_3=-120 MPa, τ_{12}=70 MPa, τ_{13}=-50 MPa, τ_{23}=130 MPa.
   (1) Determine the principal stresses. (5 points)
   (2) Determine the principal stress directions. (10 points)

2. (30 points) Consider the cantilevered beam of length, L, with a tip spring of stiffness, k, depicted in Fig. 1. The beam is subjected to a uniform transverse load, p_o, and a tip concentrated load, P.
   (1) Write the governing differential equation and associated boundary conditions for this problem. (10 points)
   (2) Find the displacement field. (20 points)
   (Hint: the displacement field can be defined by a 4th order polynomial.)

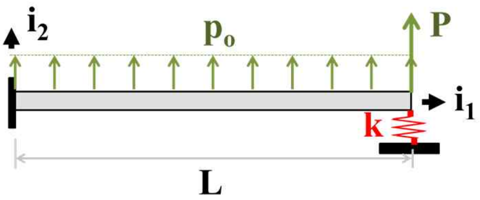

Figure 2. the cantilevered beam.

3. (30 points) The experimental set-up depicted in Fig. 2 is aimed at studying the behavior of materials under complex stress states. A thin-walled pressure vessel of radius R=11 mm and thickness t=2.0 mm is subjected to an internal pressure p_i. At the same time, a normal force, N, and a torque, Q, are applied to the sample.
   (1) Find the yield stress for the material if it is assumed to follow von Mises' yield criterion. (p_i=20 MPa, N=16 kN, Q=120 N-m) (15 points)
   (2) Find the equation of yield surface in the space for the material following von Mises' yield criterion. (15 points)
   (The equation is defined by the three loading components, the internal pressure, the applied axial force, and the applied torque.)

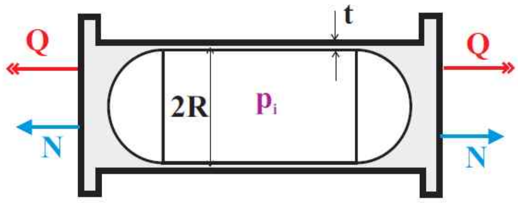

Figure 2. pressure vessel subjected to internal pressure, external loads.

4. (25 points) The thin-walled, rectangular beam section shown in Fig.3 is subjected to a horizontal shear force, V_2. The thickness of the right vertical web is $5t$, whereas that of the remaining walls is t.
   (1) Determine the centroidal bending stiffness of the section. (10 points)
   (2) Find the shear flow distribution in the section. (15 points)

$$f(s) = c + \frac{Q_3(s)H_{23}^c - Q_2(s)H_{33}^c}{\Delta H}V_3 - \frac{Q_3(s)H_{22}^c - Q_2(s)H_{23}^c}{\Delta H}V_2$$

$$Q_2(s) = \int_0^s Ex_3(s)tds \;\; ; \quad Q_3(s) = \int_0^s Ex_2(s)tds$$

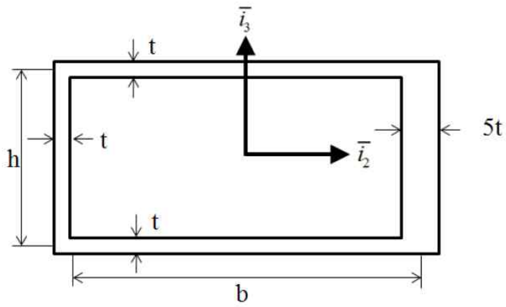

Figure 3. the rectangular beam section.