Assignment - II Spring 2019-20
AE238: Aerospace Structural mechanics

Problems:

1. What do you understand by the terms listed below as applicable to materials? Give description and where possible figures in the explanation. (a) Material Strength; (b) Stiffness; (c) Toughness; (d) Bauschinger effect; (e) Creep.

2. With reference to the present configuration (x, y, z), the state of stress (σ) at a point is given by

$$[\sigma] = \begin{bmatrix} 2 & 4 & 3 \\ 4 & 0 & 0 \\ 3 & 0 & -1 \end{bmatrix} \text{MPa}$$

   Find the stress vector and the magnitude of the normal stress on a plane that passes through the point and is parallel to the plane $x + 2y + 2z - 6 = 0$.

3. If the state of stress is such that the components $\sigma_{xz}, \sigma_{yz}, \sigma_{zz}$, are equal to zero, then it is called a state of plane stress.

   (a) For plane stress find the principal values and the corresponding principal directions.

   (b) Determine the maximum shearing stress.

4. Do the previous problem for the following state of stress: $\sigma_{xy} = \sigma_{yx} = 1000$ MPa, all other stress tensor components are equal to zero.

5. Consider a thin rectangular panel loaded as shown below. Show that the Airy stress function

$$\phi = c_1 x^2 + c_2 xy + c_3 y^2$$

   solves the problem. Find the constants c_1, c_2, c_3.

6. A solid shaft of circular cross-section supports a torque of 50 kNm and a bending moment of 25 kNm. If the diameter of the shaft is 150 mm calculae the values of the principal stress components and their directions at a point on the surface of the shaft.

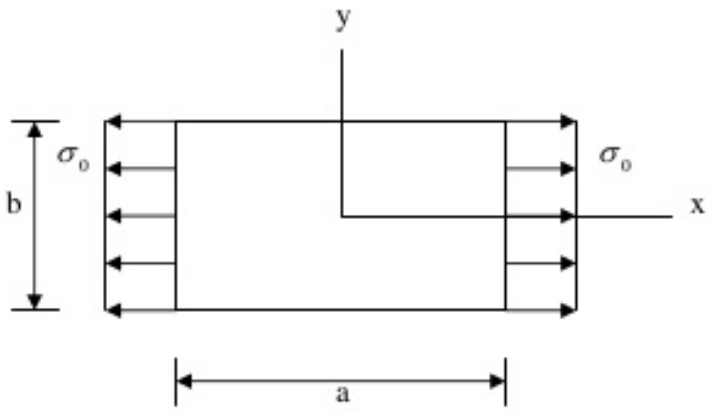

Figure 1: Thin rectangular panel subjected to uniform tension

7. A cantilever beam of rectangular cross-section and made of Al is to be replaced by a carbon fiber reinforced plastic composite beam having the same length 'L' and width 'b', and it must have the same tip deflection 'w' under the same tip load 'P'. Compare the thicknesses and weights of the two beams. Al alloy has $E = 70$ GPa and $\rho = 2700$ Kg/m^3. CFRP has $E = 140$ GPa and $\rho = 1500$ kg/m^3. Note: Tip deflection, in general, due to load at the tip in a cantilever beam is given by $\delta = \frac{PL^3}{3EI}$.