

## 2014-2 항공기 구조역학 Homework #1

### Problem 1.2. Principal stresses

Given a state of stress defined by:  $\sigma_1=200$  MPa,  $\sigma_2=300$  MPa,  $\sigma_3 = -100$  MPa,  $\tau_{12} = 50$  MPa,  $\tau_{13} = -80$  MPa and  $\tau_{23} = 100$  MPa, (1) Determine the principal stresses. (2) Determine the principal stress directions. Note: you should consider using a software package to handle the computations.

### Problem 1.5. Stress states on two sets of faces

The plane stress state at a point is known and characterized by the following stress components:  $\sigma_1 = 250$  MPa,  $\sigma_2 = 250$  MPa, and  $\tau_{12} = 0$  MPa in a coordinate system  $\mathcal{I} = (\bar{v}_1, \bar{v}_2)$ . Find the stress components  $\sigma_1^*$ ,  $\sigma_2^*$ , and  $\tau_{12}^*$  in a coordinate system  $\mathcal{I}^* = (\bar{v}_1^*, \bar{v}_2^*)$ , where  $\bar{v}_1^*$  is at a 25 degree angle with respect to  $\bar{v}_1$ .

### Problem 1.7. Stress rotation formulæ in matrix form

Show that the plane stress stress rotation formulae given by eq. (1.47) can be recast in the following compact matrix form

$$\begin{bmatrix} \sigma_1^* & \tau_{12}^* \\ \tau_{12}^* & \sigma_2^* \end{bmatrix} = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix} \begin{bmatrix} \sigma_1 & \tau_{12} \\ \tau_{12} & \sigma_2 \end{bmatrix} \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$$

### Problem 1.11. Stresses in a pressure vessel

A cylindrical pressure vessel of radius  $R$  and thickness  $t$  is subjected to an internal pressure  $p_i$ . At any point in the cylindrical portion of vessel wall, two stress components are acting: the hoop stress,  $\sigma_h = Rp_i/t$  and the axial stress,  $\sigma_a = Rp_i/(2t)$ . The radial stress, acting in the direction perpendicular to the wall, is very small,  $\sigma_r \approx 0$ . The pressure vessel features a weld line at a 45 degree angle with respect to the axis of the cylinder, as shown in fig. 1.19. (1) Find the direct stress acting in the direction perpendicular to the weld line. (2) Find the shear stress acting along the weld line.

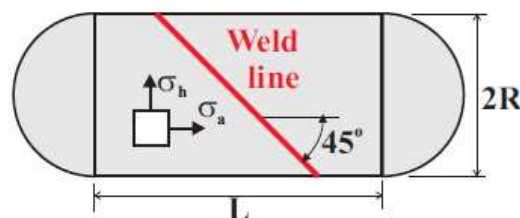
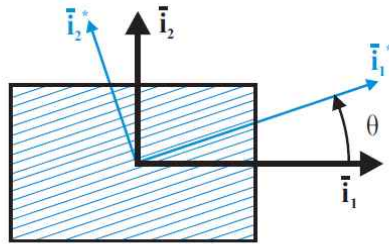


Fig. 1.19. Pressure vessel with a weld line.

**Problem 1.13. Stresses in a composite material layer**

A layer of unidirectional composite material is subjected to a state of stress  $\sigma_1 = 245$  MPa,  $\sigma_2 = -175$  MPa, and  $\tau_{12} = 95$  MPa. As depicted in fig. 1.21, the fibers in the unidirectional composite material layer run at an angle  $\theta = 25$  degrees with respect to axis  $\bar{x}_1$ . (1) Find the direct stress acting in the direction of the fiber. (2) Find the direct stress acting in the direction perpendicular to the fiber.



**Fig. 1.21.** Layer of unidirectional composite material with fiber direction.