

**ME 530 Homework #1**Name \_\_\_\_\_  
Due September 9, 2020

1.

- (i) Using
- $\det[a_{ij}] = \varepsilon_{ijk} a_{1i} a_{2j} a_{3k}$
- equation, establish the determinant of
- $a_{ij}$

$$\begin{bmatrix} 100 & 50 & 40 \\ 50 & 200 & 30 \\ 40 & 30 & 60 \end{bmatrix}$$

- (ii) Given

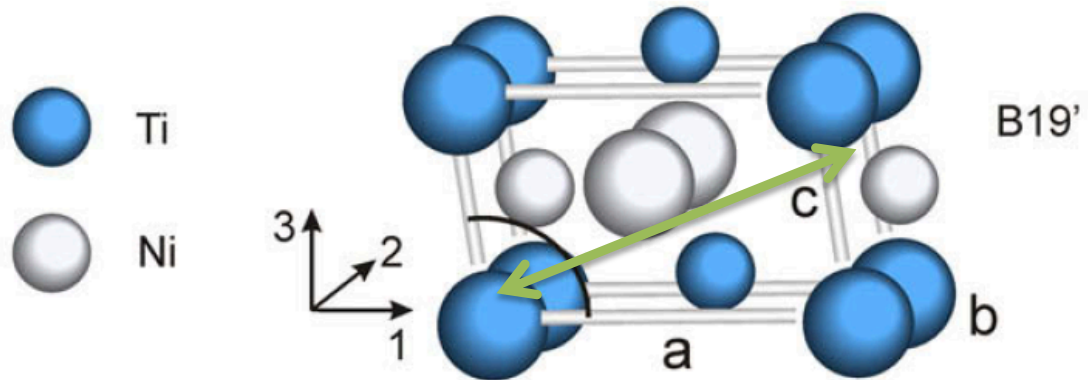
$$\sigma_{ij} = \begin{bmatrix} 100 & 50 & 40 \\ 50 & 200 & 30 \\ 40 & 30 & 60 \end{bmatrix}; \quad \ell_j = \begin{bmatrix} 1/\sqrt{2} \\ 1/\sqrt{2} \\ 0 \end{bmatrix}$$

Determine  $\sigma_{ij} \ell_j = ?$ 

- (iii) Given
- $C_{ijk\ell} = \lambda \delta_{ij} \delta_{k\ell} + \mu [\delta_{ik} \delta_{j\ell} + \delta_{i\ell} \delta_{jk}]$

where  $\lambda$  and  $\mu$  are constants, determine  $C_{1111}$ ,  $C_{1123}$ ,  $C_{1122}$ ,  $C_{3333}$ ?

2. The 13 elastic constants for the monoclinic phase of NiTi (in the martensitic phase) are given in Table 3 (the B19' values) from the paper by M.F.-X. Wagner, W. Windl / Acta Materialia 56 (2008) 6232–6245 . The values are in GPa. Treat all lattice vectors as orthogonal even though the angle between 1 and 3 is slightly higher than 90°.

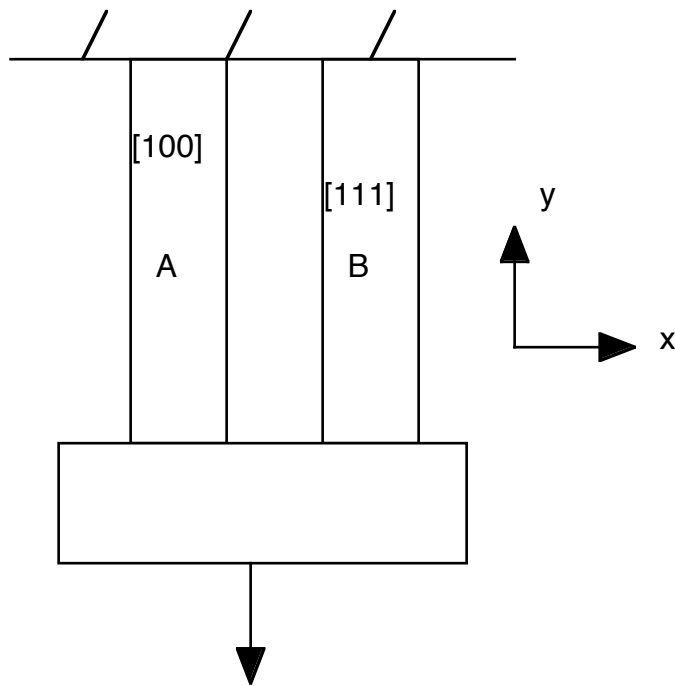


$c_{ij}$ (GPa)	B19'
$c_{11}$	223
$c_{12}$	129
$c_{13}$	99
$c_{15}$	27
$c_{22}$	241
$c_{23}$	125
$c_{25}$	-9
$c_{33}$	200
$c_{35}$	4
$c_{44}$	76
$c_{46}$	-4
$c_{55}$	21
$c_{66}$	77

Experimentally, this material has been known to shear on the systems listed below. Calculate the shear modulus for the following shear system.

- (i)  $(\bar{1}02) [2\bar{0}1]$  -green arrow

3. A hypothetical composite material is composed of two fcc grains of iron as shown below:



The composite is stretched under isostrain conditions in the y direction. Note that the elastic moduli of the two grains are not the same. The critical resolved shear stress of the fcc iron is 40 MPa. As the applied load is increased which bar will yield first? \*Determine the stresses in Grains A and B in the y direction when first yielding is detected.