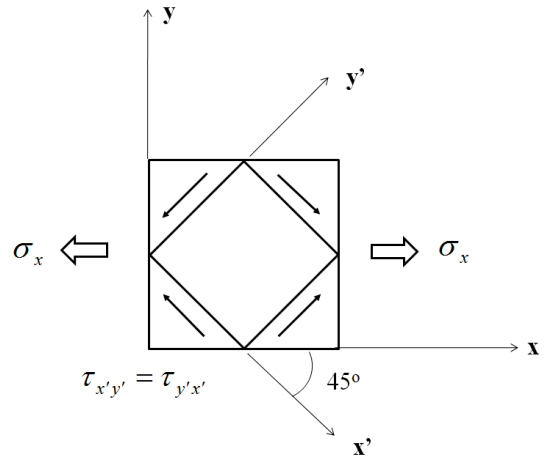
Winter 2016
MS/ME/MedE 115 **Problem Set 2.** **J.R. Greer**

Problem 1. In isotropic elasticity, Young's modulus(E), shear modulus(μ), and Poisson's ratio (ν) have the relation $\mu = \dfrac{E}{2(1+\nu)}$. Derive this relation by using the uniaxial loading along x-direction shown below:

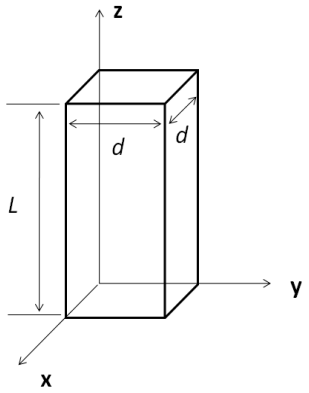


(a) Express ε_x and ε_y in terms of σ_x, ν and E.

(b) Calculate $\tau_{x'y'}$ and $\gamma_{x'y'}$

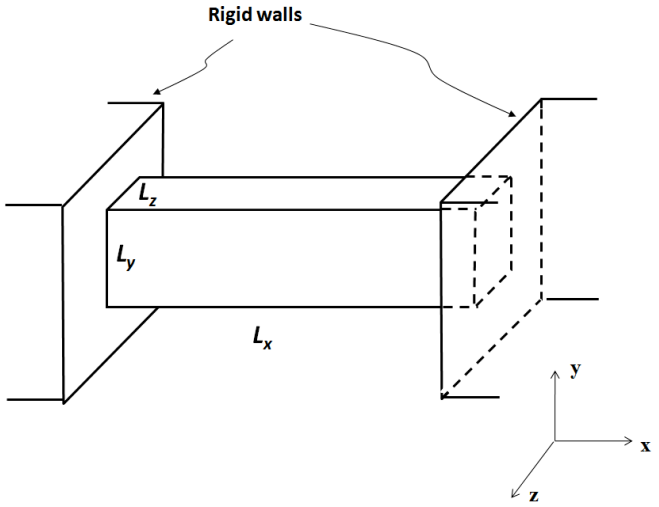
(c) Now derive the expression for μ.

Problem 2. A short, solid cast iron square bar is subjected to the compressive normal stresses, 40 MPa along z-direction, 10 MPa along x-direction, and 20 MPa along y-direction. For E = 100 GPa, ν =0.25, d_x=d_y = 120 mm, and L = 200 mm, determine the change in (a) length ΔL and widths Δd_x, Δd_y and (b) the volume of the bar ΔV.



Problem 3. Consider the rectangular gold bar, which is placed between two rigid walls. The bar is heated up from room temperature (25°C) to 325 °C. Assume that the bar expands thermally, but the rigid walls do not. Calculate all stress and strain components. Note that the thermal strains are developed equally along three directions by the amount of $l \cdot \Delta T$. The material parameters of Au are given below. (Assume frictionless interface between Au and the walls)

Linear thermal expansion coefficient (l) : 14×10^{-6} K^{-1}
Young's modulus (E) : 79 GPa
Poisson's ratio (ν) : 0.42



Problem 4. Among the given metals, find the two most elastically isotropic and the two most elastically anisotropic materials.

Element	Structure	C_{11}	C_{44}	C_{12}	C_{33}	C_{66}	C_{13}	C_{14}
Pb	FCC	49.5	14.9	42.3				
Mo	BCC	460.0	110.0	176.0				
Ta	BCC	267.0	82.5	161.0				
Co	HCP	307.0	75.3	165.0	358.1		103.0	
Zn	HCP	161.0	38.3	34.2	61.0		50.1	
Ti	HCP	162.4	46.7	92.0	180.7	69.0		
Be	HCP	292.3	162.5	26.7	336.4	14.0		
Sn	Tetragonal	73.5	22.0	23.4	87.0	22.6	28.0	
Hg	Rhombohedral	36.0	12.9	28.9	50.5		30.3	5.0