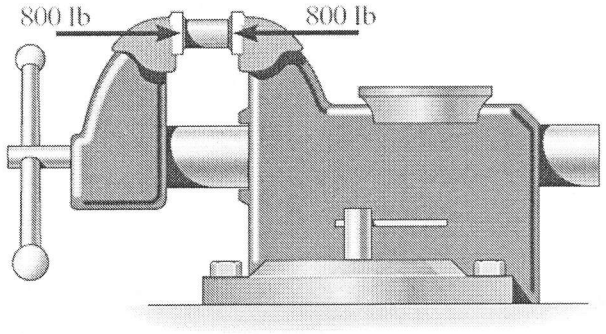
CME 260 – Mechanics of Materials
Exam #2 (02/09/2022)

Tech ID or Star ID: Grading

Do one of the two problems shown below (the second problem is on the back).
Show your work (you will not receive any credit if all you have is a final answer, right or wrong).

1. A section of solid cylindrical rod (originally 1.5 inches long with a diameter of 0.5 inches) is made of 2014-T6 Aluminum. It is placed in a vice and a load of 800 lb is applied as shown. With the load applied, determine:
(a) the change in the length of the rod
(b) the new diameter of the rod



2014-T6 Al: $E = 10.6 \times 10^6$ psi (1 pt)
$\nu = 0.35$

(a) $\varepsilon_{long} = \frac{\sigma}{E} = \frac{\frac{-800\ lb}{\frac{\pi}{4}(0.5\ in)^2}}{10.6 \times 10^6 \frac{lb}{in^2}} = -3.844 \times 10^{-4} \frac{in}{in}$ (3 pts)

$\delta_{long} = \varepsilon_{long} L = (-3.844 \times 10^{-4} \frac{in}{in})(1.5\ in)$
$= -5.766 \times 10^{-4}\ in$
or $\boxed{-5.77 \times 10^{-4}\ in}$ (2 pts)

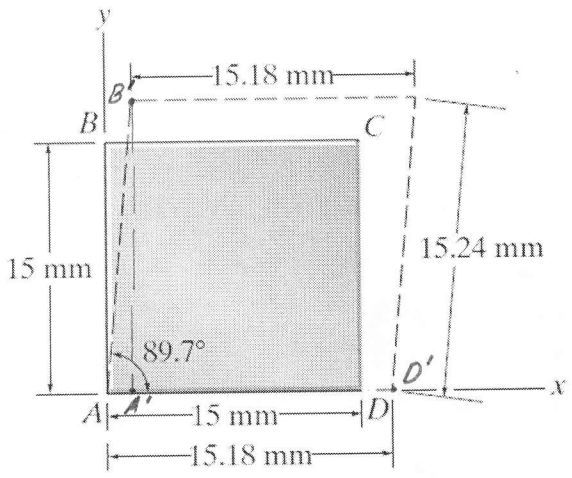
(b) $\nu = \frac{-\varepsilon_{lat}}{\varepsilon_{long}} \longrightarrow \varepsilon_{lat} = -\nu\, \varepsilon_{long}$

$\varepsilon_{lat} = -(0.35)(-3.844 \times 10^{-4} \frac{in}{in})$
$= 1.345 \times 10^{-4} \frac{in}{in}$ (2 pts)

$d_{new} = d(1 + \varepsilon_{lat})$
$= 0.5\ in\ (1 + 1.345 \times 10^{-4} \frac{in}{in})$
$= \boxed{0.50006725\ in}$ (2 pts)

or $\delta_d = \varepsilon_{lat}\, d$
$= (1.345 \times 10^{-4} \frac{in}{in})(0.5\ in)$
$= 0.00006725\ in$ (1 pt)
$d_{new} = \delta_d + d$
$= \boxed{0.50006725\ in}$ (1 pt)

2. A material, originally square, is deformed into the dashed position. Determine:
(a) the average shear strain at corner A relative to the x, y axes.
(b) the average normal strain that occurs along the diagonal BD.



alternate (b) see figure A', B', D'

$A'B' = 15.24\,mm \cos(0.3°)$
$= 15.23979\,mm$
$A'D' = 15.18\,mm - AA'$
$= 15.18\,mm - 15.24\,mm \sin(0.3°)$
$= 15.18\,mm - 0.079796\,mm$
$= 15.1002\,mm$

$B'D' = \sqrt{(15.23979\,mm)^2 + (15.1002\,mm)^2}$
$BD_{deform} = 21.4538\,mm$ (2 pts)

(a) $89.7\,deg\left(\frac{\pi\,rad}{180\,deg}\right) = 1.56556\,rad$ (2 pts)

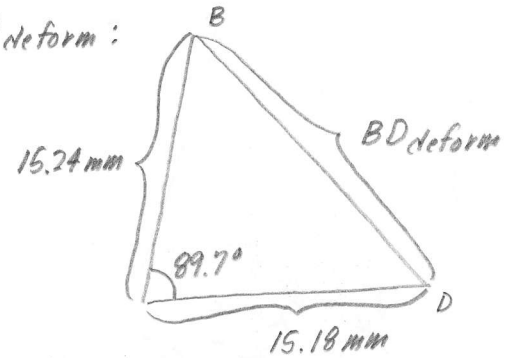
$\gamma_A = \frac{\pi}{2} - 1.56556\,(rad)$

$= 0.005236\,rad$

or $\boxed{0.00524\,rad \quad 5.24\times10^{-3}\,rad}$ (3 pts)

(b) $BD_{orig} = \sqrt{(15\,mm)^2 + (15\,mm)^2} = 21.2132\,mm$ (1 pt)

BD_{deform}:



law of cosines:

$(BD_{deform})^2 = (15.24\,mm)^2 + (15.18\,mm)^2 - (2)(15.24\,mm)(15.18\,mm)\cos(89.7°)$

$BD_{deform} = \sqrt{460.2674\,mm^2}$
$= 21.4538\,mm$ (2 pts)

$\varepsilon_{BD} = \frac{21.4538\,mm - 21.2132\,mm}{21.2132\,mm}$

$= 1.1342\times10^{-2}\,\frac{mm}{mm}$

or $\boxed{1.13\times10^{-2}\,\frac{mm}{mm}}$ (2 pts)