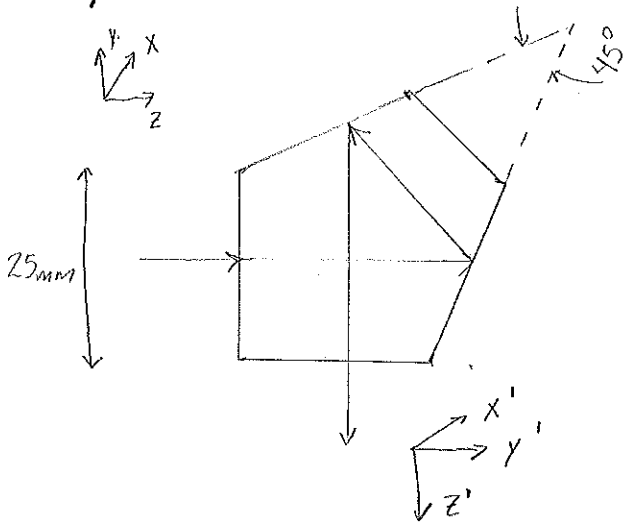


OPTI 421/521
Introductory Optomechanical Engineering
Homework, 3

Part 1

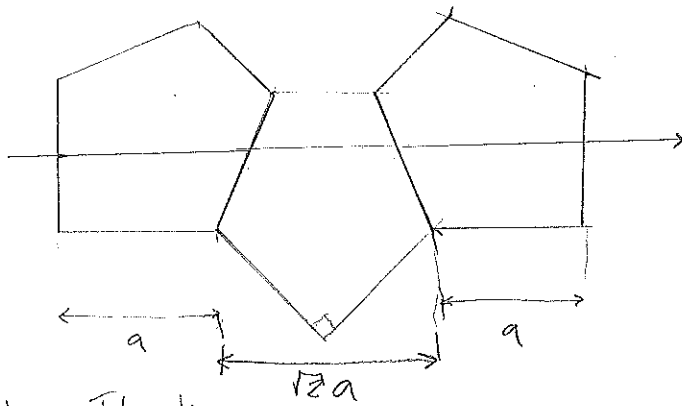
1) Penta



Mirror Matrix

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix}$$

Tunnel Diagram



$$t = a + a + \sqrt{2}a$$

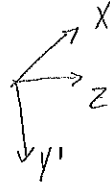
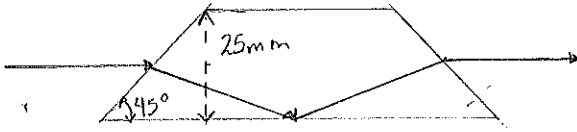
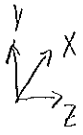
$$a = 25\text{mm}$$

Reduced Thickness

$$\tau = \frac{t}{n} = \frac{25 + 25 + \sqrt{2} \cdot 25}{1.5} = 56.9\text{mm}$$

	L.O.S	Image Rotation
Pitch α	0	0
Roll γ	1:1 \uparrow	1:1 \uparrow
Yaw β	1:1 β	1:1 β

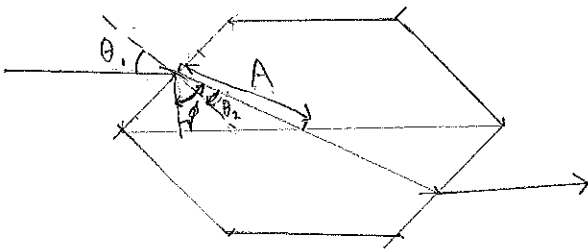
2) Dove



Mirror Matrix

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Tunnel Diagram



Use Snell's law

$$\theta_1 = 45^\circ$$

$$\theta_2 = \sin^{-1} \left(\frac{\sin 45^\circ}{1.5} \right) = 0.4909 \text{ rad}$$

Reduced Thickness

$$\phi = 45^\circ + \theta_2 = 1.276 \text{ radians}$$

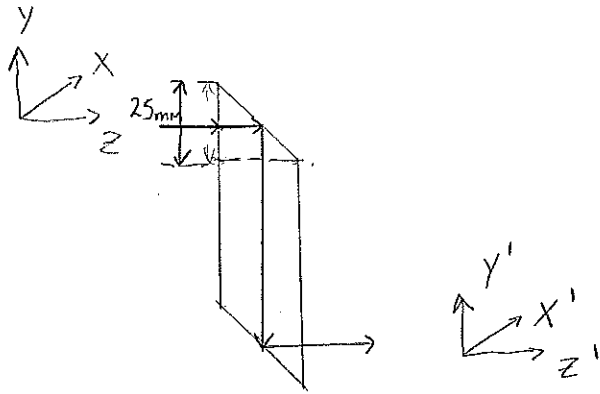
$$\cos \phi = \frac{12.5}{A}$$

$$\Rightarrow A = 43.06$$

$$z = \frac{t}{n} = \frac{2A}{n} = \underline{57.4 \text{ mm}}$$

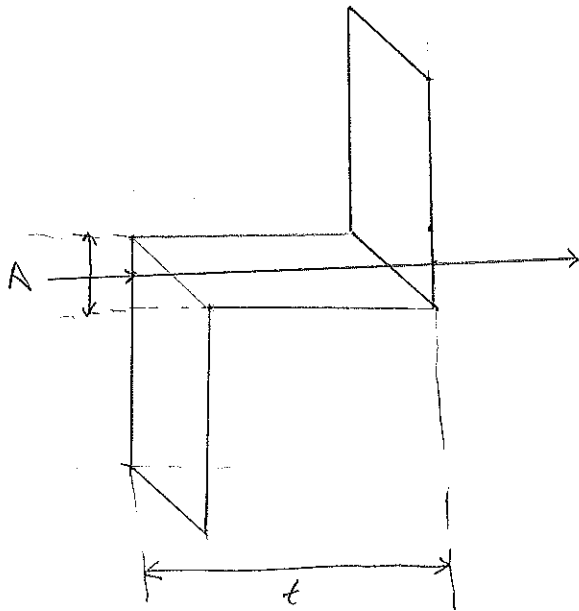
	L.O.S	Image Rotation
Pitch α	2α	0
Roll γ	0	2γ
Yaw β	0	0

3) Rhomboid



- Mirror Matrix

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$$t = d + A$$

Reduced thickness =

$$L = \frac{t}{n} = \frac{d+A}{n} = \frac{25}{1.5} + \frac{d}{1.5}$$

$$L = 16.67 + \frac{d}{1.5}$$

	LOS	Image Rotation
Pitch α	0	0
Roll μ	0	0
Yaw β	0	0

Part 2

Mirror Matrices

Porro prism

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

Rotation about X-axis

$$M_{Rx} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -\alpha \\ 0 & \alpha & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & \alpha \\ 0 & -\alpha & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -\alpha \\ 0 & \alpha & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & -\alpha \\ 0 & \alpha & -1 \end{bmatrix}$$
$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1-\alpha^2 & 0 \\ 0 & 0 & -1-\alpha^2 \end{bmatrix}$$

Rotation about Y-axis

$$M_{Ry} = \begin{bmatrix} 1 & 0 & \beta \\ 0 & 1 & 0 \\ -\beta & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -\beta \\ 0 & 1 & 0 \\ \beta & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & \beta \\ 0 & 1 & 0 \\ -\beta & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -\beta \\ 0 & -1 & 0 \\ -\beta & 0 & -1 \end{bmatrix}$$
$$= \begin{bmatrix} 1-\beta^2 & 0 & -2\beta \\ 0 & -1 & 0 \\ -2\beta & 0 & \beta^2-1 \end{bmatrix}$$

Rotation about Z-axis

$$M_{Rz} = \begin{bmatrix} 1 & -\eta & 0 \\ \eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & \eta & 0 \\ -\eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -\eta & 0 \\ \eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & \eta & 0 \\ \eta & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$
$$= \begin{bmatrix} 1-\eta^2 & 2\eta & 0 \\ 2\eta & \eta^2-1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

Roof Porro Prism

$$M = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$$

- Rotation about x-axis

$$\begin{aligned} M_{Rx} &= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -\alpha \\ 0 & \alpha & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & \alpha \\ 0 & -\alpha & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -\alpha \\ 0 & \alpha & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & -\alpha \\ 0 & \alpha & -1 \end{bmatrix} \\ &= \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1+\alpha^2 & 0 \\ 0 & 0 & -1-\alpha^2 \end{bmatrix} \end{aligned}$$

- Rotation about y-axis

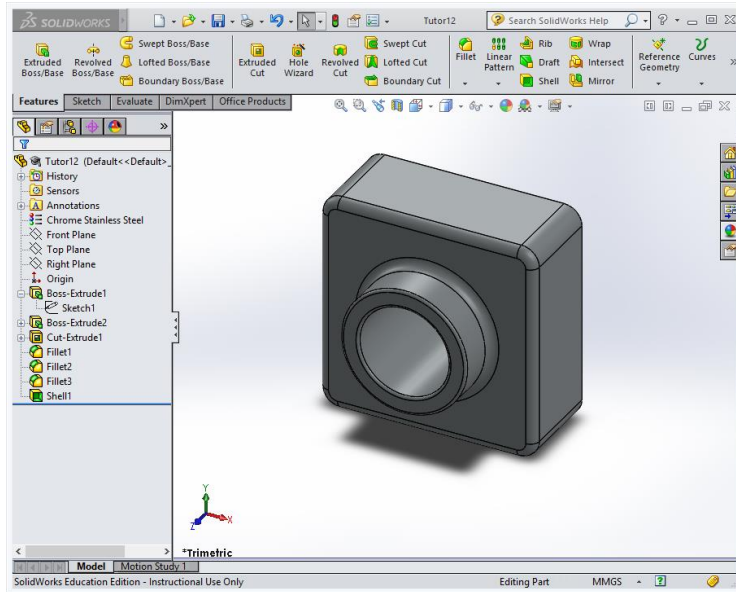
$$\begin{aligned} M_{Ry} &= \begin{bmatrix} 1 & 0 & \beta \\ 0 & 1 & 0 \\ -\beta & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -\beta \\ 0 & 1 & 0 \\ \beta & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & \beta \\ 0 & 1 & 0 \\ -\beta & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & \beta \\ 0 & -1 & 0 \\ -\beta & 0 & -1 \end{bmatrix} \\ &= \begin{bmatrix} -1-\beta^2 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -\beta^2-1 \end{bmatrix} \end{aligned}$$

- Rotation about z-axis

$$\begin{aligned} M_{Rz} &= \begin{bmatrix} 1 & -\eta & 0 \\ \eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} 1 & \eta & 0 \\ -\eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -\eta & 0 \\ \eta & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & -\eta & 0 \\ \eta & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \\ &= \begin{bmatrix} -1-\eta^2 & 0 & 0 \\ 0 & -\eta^2-1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \end{aligned}$$

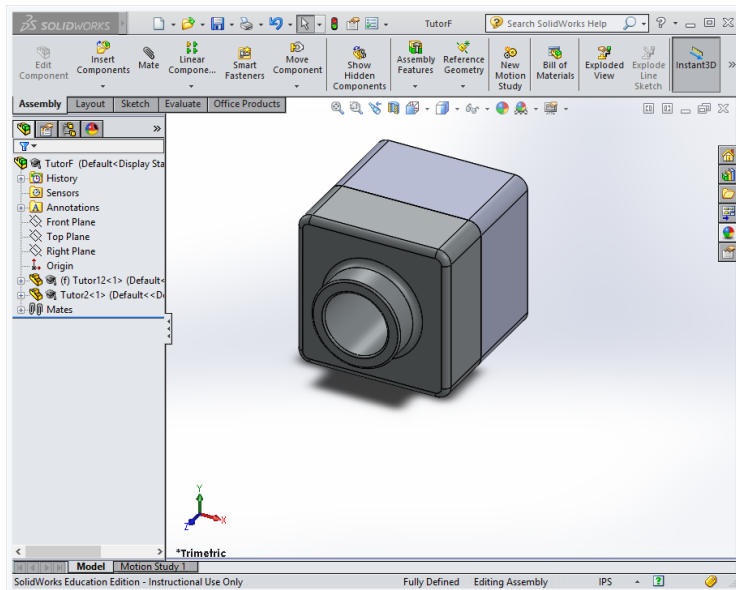
Part 3) SolidWorks assignment

Lesson 1. Parts



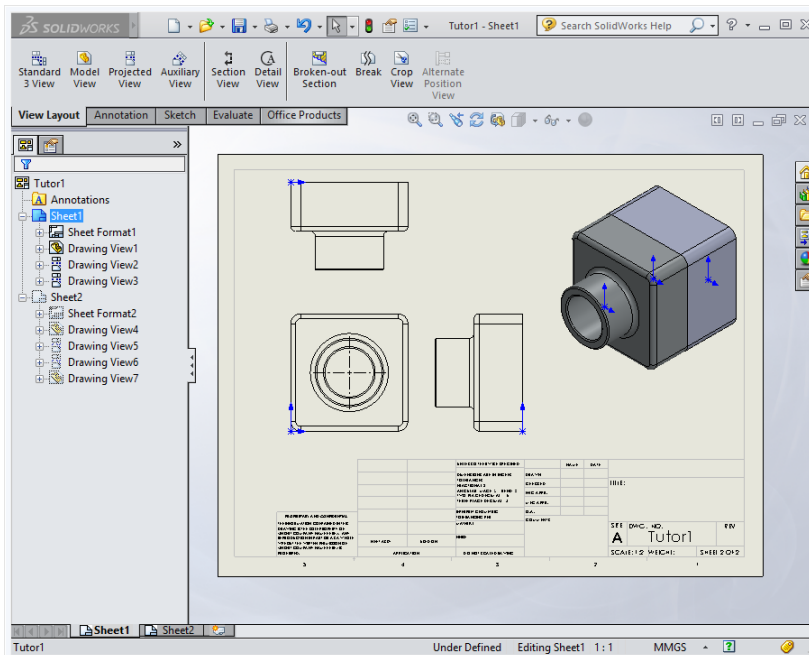
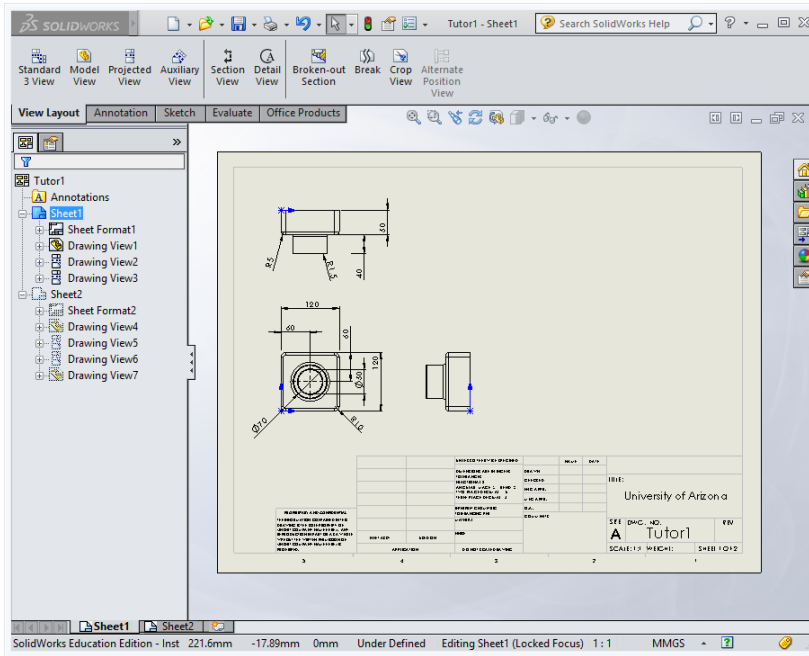
End First Tutorial

Lesson 2. Assemblies

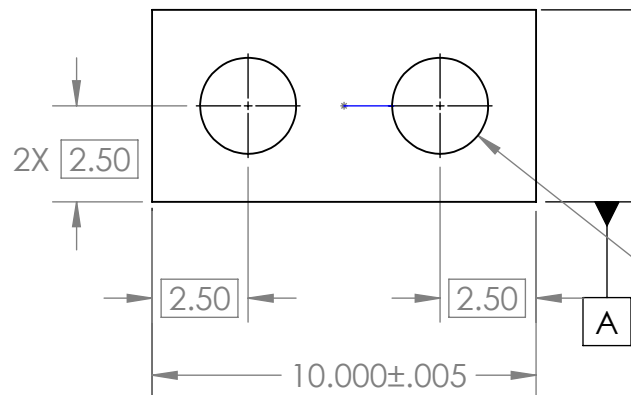
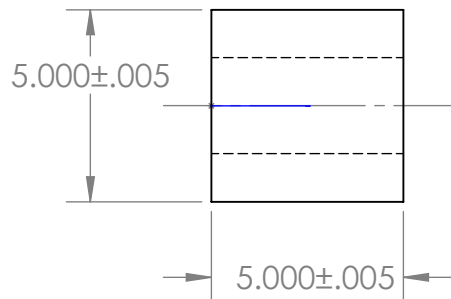


End Second Tutorial

Lesson 3. Drawings



End Third Tutorial

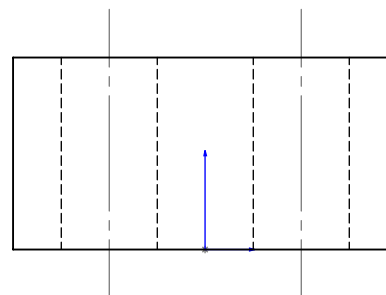


	0.002	
	0.0017	A

	2X ϕ 2.50		
	0.001		
	0.0017	A	
	0.002	A	B

	0.0017	A
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B

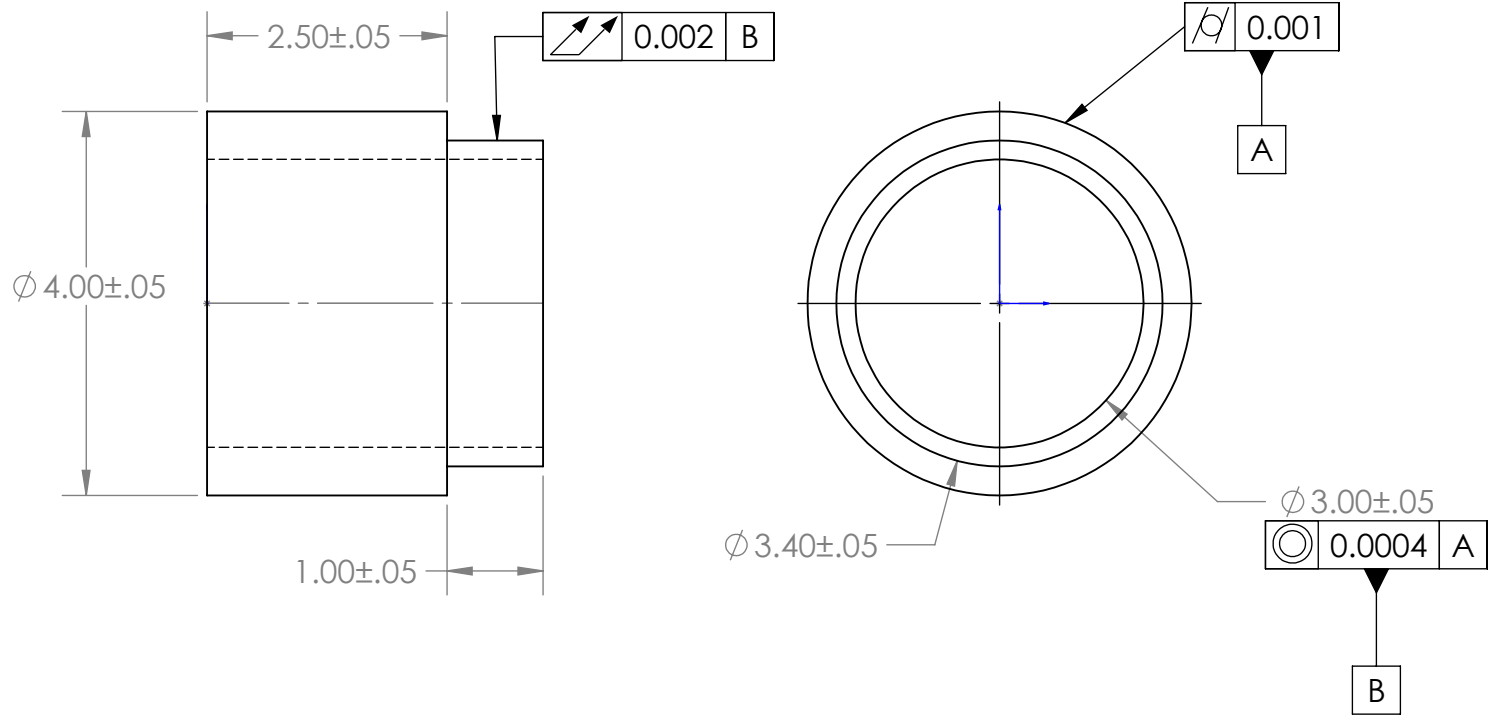


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