The couple $M$ acts in a vertical plane and is applied to a beam of the cross section shown. Determine the stress at point A.

The centroidal moments of inertia of the section are
\[ I_{yy} = 7.24 \times 10^6 \text{ mm}^4 \]
\[ I_{zz} = 2.61 \times 10^6 \text{ mm}^4 \]
\[ I_{yz} = -2.54 \times 10^6 \text{ mm}^4 \]

The moment components along the centroidal principal axes are
\[ M_u = M \sin \theta_m = 3 \times \sin 23.83 \]
\[ M_v = M \cos \theta_m = 3 \times \cos 23.83 \]
\[ M_w = 2.744 \text{ kN} \cdot \text{m} \]

The coordinates of the point A in the system of centroidal principal axes are
\[ u_A = y_A \cos \theta_m + z_A \sin \theta_m \]
\[ u_A = -76.9 \times \cos 23.83 + 50.5 \times \sin 23.83 \]
\[ u_A = -49.94 \text{ mm} \]

\[ v_A = -y_A \sin \theta_m + z_A \cos \theta_m \]
\[ v_A = -(76.9) \times \sin 23.83 + 50.5 \times \cos 23.83 \]
\[ v_A = 77.26 \text{ mm} \]
The combined normal stress at point A is

$$\sigma_A = \frac{M_u \times v_A}{I_u} - \frac{M_v \times u_A}{I_v}$$

$$\sigma_A = \frac{1.212 \times 10^6 \times (77.26)}{8.362 \times 10^6} - \frac{2.744 \times 10^6 \times (-49.94)}{1.488 \times 10^6}$$

$$\sigma_A = 103.34 \text{ MPa}$$

Checking:

$$\sigma_A = -\frac{y I_{yy} - z I_{yz}}{I_{yy} I_{zz} - I_{yz}^2} M_z$$

$$\sigma_A = -\frac{(-76.9) \times 7.24 - 50.5 \times (-2.54)}{7.24 \times 2.61 \times 10^{12} - (-2.54 \times 10^6)^2} (3 \times 10^{12})$$

$$\sigma_A = 103.34 \text{ MPa}$$