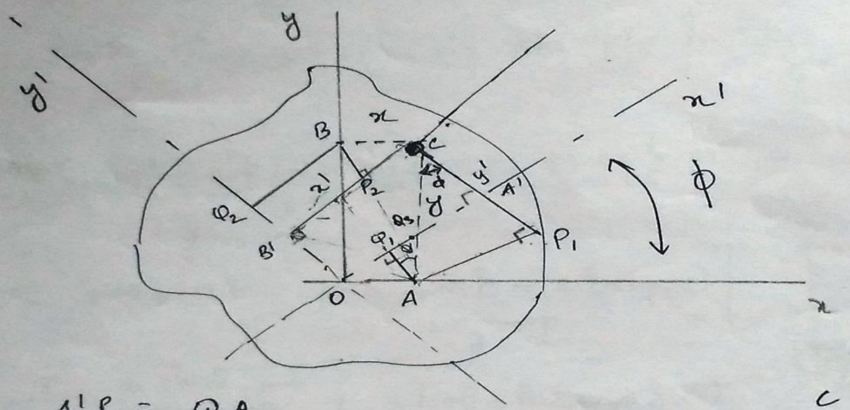
Subject Code & Name**: 23AST205-Aerospace Structures**

TOPIC: 3. **Principal axis method bending equation**

...cipal axis method:

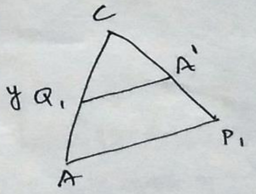
For any unsymmetric section, there exist a set of axis for which the product of inertia $I_{xy} = 0$

$$\sigma_z = \frac{M_{xp}}{I'_{xx}} y_p + \frac{M_{yp}}{I'_{yy}} x_p$$



$A'P_1 = Q_1 A$

$B'P_2 = BQ_2$

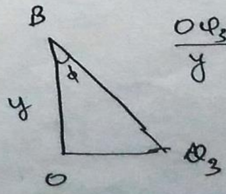


$y' = CP_1 - A'P_1 = y\cos\phi - x\sin\phi$

$x' = CP_2 + B'P_2 = x\cos\phi + y\sin\phi$

$$I_{xx} = \int y^2 \, dA$$

$$I'_{xx} = \int y'^2 \, dA$$



$\frac{OQ_3}{y} = \sin\phi$

$$= \int (y^2\cos^2\phi + x^2\sin^2\phi - 2xy\cos\phi\sin\phi)\,dA$$

$$I_{xx}^{p} = I_{xx}\cos^2\phi + I_{yy}\sin^2\phi - I_{xy}\sin 2\phi$$

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$$I_{yy}^{p} = I_{yy}\cos^2\phi + I_{xx}\sin^2\phi + I_{xy}\sin 2\phi$$

$$I_{x'y'} = \int x'y'\,dA$$

$$= \int (y\cos\phi - x\sin\phi)(x\cos\phi + y\sin\phi)\,dA$$

$$= \int (xy\cos^2\phi + y^2\cos\phi\sin\phi - x^2\sin\phi\cos\phi - xy\sin^2\phi)\,dA$$

$$= (\cos^2\phi - \sin^2\phi)I_{xy} + \frac{I_{yy}\sin 2\phi}{2} - \frac{I_{xx}\sin 2\phi}{2}$$

$$I_{xy}^{p} = \left(\frac{I_{yy} - I_{xx}}{2}\right)\sin 2\phi + I_{xy}\cos 2\phi$$

For prinpal axis $I_{xy} = 0$

$$\tan 2\phi = -\frac{2I_{xy}}{I_{yy} - I_{xx}}$$

$$M_{xp} = M_x\cos\phi - M_y\sin\phi$$

$$M_{yp} = M_y\cos\phi + M_x\sin\phi$$